# Appendix 3.8: Bournes Pond Inlet NPC Volume 1 Narrative


# Town of Falmouth, Massachusetts

## Bournes Pond Inlet Widening
## Notice of Project Change
## Project Narrative and Appendices
## Volume 1 of 2

January 2016

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# 1. Introduction

The Town of Falmouth (Town) is engaged in a multi-decade effort to restore the water quality and habitats in coastal ponds that have been degraded by excess nitrogen from human activities and land development. Beginning in 2007, Falmouth has focused its planning on the southern coastal ponds—Little, Great, Green and Bournes Ponds and Waquoit Bay—as being the most impaired (Figure 1). Watershed by watershed, the Town is developing plans to restore these estuaries. The Massachusetts DEP approved the Targeted Watershed Plan for Little Pond on October 6, 2014. This Notice of Project Change starts the process for the Bournes Pond watershed by widening the inlet to restore tidal flushing and improve habitat. By December 2019, the Town intends to have plans for all five estuaries, consistent with the advice in Massachusetts Environmental Policy Act (MEPA) Certificate (EEA #14154) (see Appendix A).

Each estuary is unique. The Massachusetts Estuaries Project (MEP) has collected a wealth of baseline information about nitrogen loads and level of degradation in each pond. The EPA and the DEP have established a Total Maximum Daily Load (TMDL) that the Town must meet in order to restore a healthy habitat. Falmouth's planning approach for each estuary evaluates cost, efficacy, and environmental impact using two broad approaches:

- Meet the TMDL with a combination of site-appropriate alternatives including inlet widening, shellfish aquaculture, Permeable Reactive Barriers, and Innovative/Alternative Septic Systems; and
- Meet the TMDL with sewers alone.

The Town uses an "adaptive management" approach as outlined in the Cape Cod Commission's Area-wide 208 Watershed Management Update. This approach acknowledges that there is uncertainty in project design and implementation. Projects will be carefully monitored, progress assessed, and plans recalibrated as necessary.

As requested in the MEPA certificate, the purpose of this Notice of Project Change is twofold:

1. Identify the Project's potential contribution towards attaining water quality standards within the watershed; and
2. Identify potential environmental impacts; summarize alternatives considered to avoid, minimize, and mitigate impacts; and identify measures that will be incorporated to avoid, minimize, and mitigate impacts.

The structure of this Notice of Project Change document is as follows:

- Section 2 through Section 7 describe the Inlet Widening Project, provide historical background, present preliminary design, discuss potential environmental impacts and mitigation efforts, list all required permits, and establish a timetable for project completion.
- Section 8 presents an analysis of non-traditional alternative technologies that can be used in concert with inlet widening to achieve the TMDL, and an evaluation of traditional wastewater management (sewering) as another approach to meet the TMDL. The analysis includes a preferred scenario, contingency planning, adaptive management planning, and a cost comparison of all alternatives.

- Section 9 provides information on any changes to the project since the FEIR filing and an update on the “Pilot Projects” specifically listed in the MEPA certificate. Section 10 lists References.

# 2. Project Area Description

The Bournes Pond Inlet Widening Project (Project) is a water quality improvement and tidal restoration project being advanced by the Town of Falmouth and the Town's Water Quality Management Committee (WQMC). The widened inlet will permanently and immediately improve water quality due to increased tidal flushing with an increase in water exchange of over 9 million gallons per tide. Widening will remove approximately 50% of the target nitrogen load and enhance eelgrass and shellfish habitats. This will be accomplished by increasing the width of the inlet from 50-feet to the optimal size of 90-feet.

The location of the existing Bournes Pond Inlet is shown on Figure 2. Currently Bournes Pond has an existing single span bridge and two jetties. There is no change in bridge height planned, so the intentional restriction of large boats from entering this pond remains intact. The new bridge design specifies a 25-foot extension of the western jetty, complemented by the removal of 25-feet of groin currently located to the west of that jetty. This results in no net increase in the footprint of coastal structures.

Improvements for a fishing platform are being coordinated through the Department of Fish and Game, Office of Fishing and Boating Access, and will be separately funded and permitted outside of this project. Existing and proposed conditions are shown on Figure 3.

The Bournes Pond Inlet intersects Menauhant Beach (West and East). Menauhant Road runs across the inlet with a single span bridge. Parking areas run along the road and manmade dunes serve as a barrier to the parking areas, road, and bridge. See Figure 4 for these key features.

The project is within a barrier beach-coastal beach system, velocity zone, Natural Heritage and Endangered Species Program (NHESP) Priority Habitat, and Chapter 91 Jurisdiction (see section 5). Required permits and authorizations are further detailed in Section 6.

A conceptual sketch of the two-span bridge being proposed which includes the inlet opening increase from the 1985 reconfiguration, proposed areas to be dredged, proposed jetty modifications, proposed beach nourishment areas, and limits of reconstruction are shown on Figure 5. Please note this figure has been revised for the NPC from the Figure 3 of 5 included in Technical Memorandum BP-1 (Appendix B).

# 3. Bournes Pond Background

## 3.1 Bournes Pond Historical Inlet Widths

Historically, the inlet was generally wider than the existing 50-foot inlet that was constructed in 1985. However, immediately prior to the 1985 inlet relocation, the historical inlet that had been maintained further to the west had shoaled to the point where it was causing severe degradation of water quality as a result of severely inhibited tidal exchange. To quantify previous inlet widths and locations, historical maps were digitized to assess inlet widths over the past 170+ years. A total of six historical maps from 1844 to 1969 containing the Bournes Pond inlet were compiled to examine the change in inlet width over time. The scanned paper maps were georeferenced and the shorelines extracted. Measurements were taken at the mouth of the inlet to determine the approximate stable width of the inlet. The measured inlet widths and map source are summarized in Table 1 and the shorelines are presented in Figures 6 through 8. Based on the available historical information, the minimum mapped inlet width prior to the closed condition experienced in the late 1970's was an 88-foot inlet in 1874, similar to the inlet width of the presently proposed project. Inlet widths for other time periods varied between 114-feet and 400-feet, where the widest inlet may be a result of storm breaching. During the contemporary time period, it appears that the inlet width in 1969 was 209-feet wide. In 1938, just two months before the 1938 Hurricane, the inlet mouth was 114-feet wide with a narrowing to approximately 60 to 70-feet inside of the inlet entrance. However, anecdotal information indicates that the inlet again widened as a result of this storm. Overall, the historical inlet information for Bournes Pond demonstrates that the proposed 90-foot wide inlet is well within the range of previously mapped inlet widths and is generally at the lower end of the historical stable inlet widths observed at the Bournes Pond entrance.

Table 1 Bournes Pond Historical Inlet Width Summary

| Year | Inlet Width (ft) | Source |
|---|---|---|
| 1844 | 400 | United States Coast and Geodetic Survey<br>Library and Archives<br>Acc. No. 1041 |
| 1874 | 88 | Survey of the Coast of the United States<br>Coast Chart No. 12<br>Monomoy and Nantucket Shoals to Block Island |
| 1896 | 138 | United States Coast and Geodetic Survey<br>Coast Chart No. 112<br>Vineyard Sound and Buzzards Bay<br>Massachusetts |
| 1920 | 132 | United States Coast and Geodetic Survey<br>Coast Chart No. 112<br>Vineyard Sound and Buzzards Bay<br>Massachusetts |
| 1938 | 114 | NOAA T-Sheet<br>Survey T-5704<br>Vineyard Sound, MA |
| 1969 | 209 | United States Coast and Geodetic Survey<br>Chart No. 1209<br>Nantucket Sound and Approaches |

## 3.2 Planning and Implementation of the Current 1985 Bridge

The current single-span bridge was constructed in 1985 after several years of permitting and planning. The pond inlet was relocated from the western portion of the beach as shown in Figure 4 to a location in the middle of the beach as recommended by the Final Environmental Impact Report (Weston & Sampson, 1981). This inlet relocation project was performed because the historic inlet was unstable and infilled frequently, leading to water quality problems in Bournes Pond. A 100-foot span bridge was originally proposed but a final 50-foot span bridge was approved. This inlet relocation provided significant water quality improvements, and long-time residents still comment on the positive change. It is noted that, in the 1980's, data and modeling procedures did not exist to optimize the inlet system for water quality improvements, as they do now.

## 3.3 Massachusetts Estuaries Project Evaluations and Nitrogen Limit Development

### 3.3.1 Evaluations of Bournes Pond's Nutrient-Related Ecological Health

The Massachusetts Estuaries Project Technical Report (MEP, April 2005) documented the nutrient-related ecological health of Bournes Pond. Pertinent excerpts of this documentation for Bournes Pond are provided in Appendix C. The full MEP report is available at www.oceanscience.net/estuaries/GreatGreenBournes.htm. The following text briefly summarizes their evaluations and findings.

Evaluations on dissolved oxygen in the pond's bottom waters identified that the upper portion of the pond (Route 28 to the main Bournes Pond basin) is "severely degraded/significantly impaired by nutrient enrichment" based on dissolved oxygen sensors placed in that area and chlorophyll a data. The sensors recorded large depletions (values down to 4 and 3 mg/L) over long periods.

Evaluations on eelgrass distribution identified that Bournes Pond currently supports eelgrass beds although they are significantly reduced in aerial coverage. The current distribution is an approximate 64% reduction (49 acres) from the coverage documented from 1951 through 2001; with 40% of the 49 acres lost between the 1995 and 2001 eelgrass surveys. The eelgrass distribution for the surveys completed in 2001, 1995, and 1951 are illustrated on Figure 9.

A benthic infauna analysis evaluated several sediment and water quality samples and identified that most of Bournes Pond has infaunal habitat that is moderately to significantly impaired.

Based on these evaluations and standard MEP procedures, a threshold nitrogen concentration of 0.45 mg/L was identified for sampling location B3 (sentinel station) as illustrated on Figure 10. The threshold concentration is the target concentration needed to restore the nutrient-related ecological health of Bournes Pond. Figure 10 also indicates the projected concentration in other parts of the pond when the threshold concentration of 0.45 mg/L occurs at sentinel station B3.

### 3.3.2 MEP Development of Existing and Threshold Nitrogen Loads

Existing watershed loads were developed based on the land use in the Bournes Pond Watershed. The Bournes Pond Watershed along with all of the CWMP watersheds and related CWMP items are illustrated on Figure 1. The watershed loads are evaluated in great detail in the MEP report and the total existing loads are summarized in Table 2.

The MEP water quality model was run multiple times to evaluate several load reductions to identify a threshold load that would produce the threshold concentration at the sentinel station. These threshold loads are also summarized in Table 2.

Table 2 Existing and Threshold Loads for Bournes Pond

| Subembayment | Existing Source | | | Total Existing Load (kg/day) | Threshold Controllable Watershed[1] Load (kg/day) | Total Threshold Load plus Existing Atmospheric Deposition and Benthic Flux Loads (kg/day) |
|---|---|---|---|---|---|---|
| | Controllable Watershed[1] Load (kg/day) | Direct Atmospheric Deposition (kg/day) | Benthic Flux Net (kg/day) | | | |
| Bournes Brook | 3.29 | - | - | 3.29 | 1.97 | 1.97 |
| Bournes Pond (Proper) | 9.61 | 1.61 | 19.28 | 30.5 | 1.31 | 22.2 |
| Subtotal | 12.9 | 1.61 | 19.28 | 33.79 | 3.28 | 24.17 |
| Israels Cove | 2.05 | 0.26 | -0.14 | 2.17 | 0.27 | 0.39 |
| **Total** | **14.95** | **1.87** | **19.14** | **35.96** | **3.55** | **24.56** |

Notes:

1. Comprised of septic system, fertilizer, and stormwater loads.

### 3.3.3 MEP Evaluations on Possible Modification of the Bournes Pond Inlet

During the hydrodynamic and water quality modeling of Bournes Pond by the MEP, it was identified that there is significant tidal dampening with the existing 50-foot inlet. Water quality model runs were then completed with a simulated 100-foot wide opening which produced minimal tidal dampening. Water quality evaluations were completed and the estimated nitrogen concentrations in the estuary with a 100-foot wide inlet were compared to the existing nitrogen concentrations with the existing 50-foot inlet. This comparison (for the sentinel station location) indicated a reduction in concentration from 0.782 mg/L to 0.569 mg/L. The following summary statement and recommendation were made in the MEP report: "Widening the inlet would certainly make the threshold limit more practically attainable, where significantly less nitrogen load would need to be removed within the watershed. Potential environmental and regulatory implications exist for reconfiguration of the inlet; therefore, a complete analysis of the costs, benefits, and impacts of this strategy would be required prior to further consideration of this option. From an engineering cost perspective alone, it likely is cheaper to modify the inlet than to sewer a large portion of the upper watershed." This observation helped to guide the Town toward their CWMP recommendations.

## 3.4 Nitrogen TMDL Development

MassDEP utilized the findings of the MEP technical report as the basis of a TMDL report (MassDEP, April 2006) prepared for USEPA review. EPA approved the report and the TMDL values proposed by MassDEP in July 2007. The final TMDL values are:

- Bournes Pond: 24.17 kg/day
- Israels Cove: 0.39 kg/day
- Total Bournes Pond System: 24.56 kg/day

These are the Total Threshold Controllable Watershed Loads, plus Existing Atmospheric-Deposition and Benthic-Flux Loads shown in Table 2.

It is generally believed that the nitrogen loads from direct atmospheric deposition and benthic flux are not controllable by the Town in their nutrient management efforts to meet the nitrogen limits. By comparing the Existing Controllable Watershed Load to the Threshold Controllable Watershed Load in Table 2 it is possible to estimate the needed nitrogen load to remove (14.95 kg/day minus 3.55 kg/day = 11.4 kg/day). **This equates to approximately 4,000 kg/year to be removed.**

## 3.5 Falmouth CWMP Evaluations

The Town initiated a CWMP Project in 2007 with the primary focus to develop a plan to meet the nitrogen TMDLs described above for Bournes Pond and similar TMDLs for Little Pond, Great Pond, Green Pond, and Waquoit Bay. The plan was completed in September 2013 with the filing of the Comprehensive Wastewater Management Plan (CWMP) Final Environmental Impact Report (FEIR) and Targeted Watershed Management Plan (TWMP).

The plan is described in detail in the Executive Summary of the 2013 CWMP Report and the main components are listed below:

1. Sewer extension to significant portions of the Little Pond Watershed (Little Pond Sewer Service Area) which is contiguous to Falmouth's existing sewer system.
2. Improvements to the Blacksmith Shop Road WWTF.

3. Construction of new treated water recharge sand infiltration bed Nos. 14 and 15 at Site 7, which is north of the Blacksmith Shop Road WWTF.

4. Implementation of the Town's approved Nitrogen Control Bylaw for Fertilizer.

5. Evaluation of the following non-traditional wastewater and nutrient management alternatives through demonstration projects:

   5.a. Shellfish aquaculture demonstration project to harvest/mitigate excessive nitrogen in the estuaries (see section 9.2.1).

   5.b. Inlet widening of Bournes Pond and Little Pond which are the two ponds that were identified by the MEP that could benefit from reduced tidal dampening at their inlets.

   5.c. Permeable Reactive Barriers to treat nitrogen loads in the groundwater before it emerges into the estuaries (see section 9.2.2).

   5.d. Improved stormwater management.

   5.e. Eco-Toilets (composting and urine-diverting toilets).

6. Evaluation of feasibility and performance of Innovative/Alternative (I/A) (denitrifying) septic systems

7. Adaptive management throughout the 20-year planning period (2015-2035).

8. Coordination with the County and neighboring towns on shared watersheds.

9. Continued investigation of the long-term option of treated water discharge through an ocean outfall.

The plan was accepted by the EOEEA as summarized in the January 10, 2014 Certificate EEA Number 14154 (attached in Appendix A). It was also accepted by the Cape Cod Commission as summarized in their February 27, 2104 Development of Regional Impact (DRI) approval decision.

Significant progress has been made on the plan as listed below (the numbering corresponds to the numbering of the CWMP recommendations identified above):

1 – 3 The sewer extension to the Little Pond Sewer Service Area as well as the Blacksmith Shop Road WWTF Improvements and the new infiltration beds at Site 7 have been designed, approved by MassDEP, bid, and awarded to a general contractor for construction that began in the spring of 2015.

4 The Town's new Nitrogen Control Bylaw for fertilizer management was approved by Town Meeting in 2012 and is being implemented as part of the Little Pond Targeted Watershed Management Plan. Annual letters are mailed to all property owners within 100 feet of an estuary.

5a The shellfish aquaculture demonstration project was implemented in Little Pond for the past three growing seasons and showed localized water quality improvement as well as high oyster growth rates and survival.

5b The inlet widening demonstration project for Bournes Pond is proceeding as detailed in this NPC.

5c The feasibility of Permeable Reactive Barriers (PRBs) to treat the groundwater before it recharges to the coastal estuaries was evaluated town-wide and found to be technically feasible with possible cost-effectiveness. Site-specific groundwater investigations for possible PRB pilot locations are ongoing.

5d Improved stormwater management evaluations are proceeding as part of a EPA-funded project to design and construct treatment systems.

5e Feasibility investigations of Eco-Toilets are proceeding in association with Barnstable County Department of Health and Environment evaluations to sample and calculate nitrogen removal performance of these systems. Also, property owners in the Little Pond Sewer Service Area were given the opportunity of installing Eco-Toilets instead of connecting to the sewer extension. Only one of the approximate 1,400 property owners in this area decided to move forward with the opportunity. This experience may indicate that Eco-Toilets do not have sufficient public acceptance in a densely-developed and vacation home area such as the Little Pond Sewer Service Area.

6 A demonstration project funded by EPA to test the cost and efficacy of Innovative/Alternative Septic Systems is proceeding in collaboration with the Buzzards Bay Coalition. The Barnstable County Department of Health and Environment will be monitoring the performance of 20 installations over a 12 month period.

7 An Adaptive Management Plan (AMP) was outlined in the CWMP and submitted (October 22, 2014) to CCC and MassDEP. This plan provides the Town commitment to document the steps that will be taken to implement the CWMP and demonstrate compliance with the CWMP and the nitrogen TMDLs. The AMP is a living and evolving document. Changes are expected to occur as the Town moves forward with its wastewater-implementation and nutrient-management program. The WWTF Discharge Permit needs to be renewed every five years (by regulatory statute) and will provide a formal opportunity for permitted change. The MEPA approval of the CWMP requires Notices of Project Change every five years, which will provide an additional opportunity for change. It is understood that environmental monitoring activities may document changes and that mid-course corrections to CWMP implementation may be needed.

8 Coordination with the County and neighboring towns on shared watersheds is proceeding as part of the 208 planning process. Falmouth and Mashpee are jointly funding a study of the Quashnet/Moonakis subembayment to determine the best strategy for restoration of this system.

9 Investigation of an ocean outfall is still a consideration as recommended by MassDEP in their CWMP/FEIR comment letter.

The CWMP Report is available at the Town Web site at www.falmouthmass.us/deppage.php?number=521.

## 3.6 Modeling, Nitrogen-Removal, and Preliminary Design Evaluations

As part of the CWMP Project, additional modeling and cost evaluations were completed to investigate the feasibility of enlarging the Bournes Pond inlet. These evaluations were summarized in Technical Memorandum BP-1 dated March 12, 2013, which is attached as Appendix B. The main findings of these evaluations are listed below.

1. The optimal size for a new inlet would be 90 feet to maximize tidal exchange as well as provide sufficient scour velocity in the inlet to minimize shoaling.

2. The capital cost to increase the inlet size to 90 feet with a new bridge was estimated at $5.52 million with the following details:
    - Bridge and road work at $2.5 million.
    - Jetty modifications at $0.8 million.
    - Dredging and beach nourishment at $0.075 million.
    - Permitting and special study allowance at $0.3 million.
    - Design at $0.4 million.
    - Fiscal, legal, and engineering during construction at $0.52 million.
    - Contingency (25%) at $0.92 million.
3. **This enlarged inlet would reduce the amount of nitrogen that would need to be removed from the watershed and would have an effective nitrogen removal of approximately 2,000 kg/year. This removal is approximately half of the nitrogen that needs to be removed to meet the Nitrogen TMDL as indicated in Section 3.4.**
4. The cost to remove this amount of nitrogen through traditional wastewater management (sewers) would be $12.8 to $19.1 million to collect and treat the wastewater from 273 to 407 homes. These costs are 2.3 to 3.4 times the cost of a new inlet opening at $5.52 million.

Based on these evaluations, the Town decided to proceed with further evaluations of the Bournes Pond inlet opening. Technical Memorandum BP-1 (Appendix B) provides the details on the following evaluations that produced the findings listed below:

- Use of the MEP hydrodynamic and water quality models.
- Additional data collection at the inlet area to update the MEP models.
- Calculation of the optimal inlet size at a velocity of 3-feet per second to minimize shoaling and inlet blockage.
- Preliminary design components to minimize costs, maintain the current character of the bridge and inlet, minimize environmental impacts, and improve fishing opportunities including:
    - Use of a double-span bridge in the same style and appearance as the existing single span structure (Figure 5).
    - Maintaining the same elevation of the bridge to keep the same clearance under the bridge and eliminate the need to fill wetlands due to a taller bridge. It was a Town decision to NOT increase boat access to the pond through the inlet, and NOT create secondary impacts from boat traffic.
    - Utilizing the west jetty.
    - Moving the east jetty.
    - Removing existing shoal restrictions inside and outside the pond, placing the sand on the beach as part of a long-term beach protection program, and maintenance dredging of the channel.

- Improving the surface of the jetty to provide a fishing platform for enhanced fishing access (separately funded and permitted project).
- Providing erosion mitigation and site restoration activities during and after construction.

- Basis of alternative cost evaluations to remove the same amount of nitrogen through wastewater collection, treatment, and relocation methods.
- Alternative evaluations for different types of bridges.

## 3.7 Additional Modeling and Flooding and Coastal Erosion Analysis

As part of CWMP development, additional modeling evaluations were requested to determine whether a larger inlet would increase flooding of properties on the shores of Bournes Pond and whether Menauhant Road and the barrier beach leading to a new inlet would be subject to greater coastal erosion and/or damage from sea level rise. The "Bournes Pond Inlet Opening Flooding and Coastal Erosion Analysis" report, ACRE 2015 was prepared to answer these questions and is attached in Appendix D.

The main findings of that analysis include:

- Widening of the inlet opening from 50 to 90-feet does not increase flooding potential for the properties on the pond.
- Regardless of the inlet width, during a 100-year storm surge, the entire barrier beach and Menauhant Road will be inundated.
- Any storm surge greater than 4.5-feet NAVD will overtop Menauhant Road.
- There is a broad range of sea level rise projections, and sea level rise is not expected to be a critical issue during the 75 year life of this project.
- There is existing beach erosion west of the bridge; and if it continues at historic rates, Menauhant Road would be threatened in approximately 40 years.
- Beach nourishment can mitigate this erosion.

The report (Appendix D) provides great detail on the following evaluations that produced the findings listed above:

- Historic shoreline change data evaluation.
- Historic sea level rise data evaluation.
- Sea level rise projections.
- Modeling analysis of flood flows through the existing 50-foot and proposed 90-foot inlets.
- Storm frequency evaluation.

## 3.8 Town and Public Reviews

There has been significant Town and public review of the projects and evaluations summarized above:

- The MEP technical report and MassDEP TMDL report underwent detailed public and regulatory review.

- The CWMP/FEIR/TWMP document went through page-by-page review by the Town DPW, and WQMC, followed by a public meeting before the Board of Selectmen and subsequent review and comment by regulatory agencies.
- The Technical Memorandum BP-1 was part of the CWMP and went through the same reviews as the CWMP/FEIR/TWMP document.
- The Flooding and Coastal Erosion Analysis Report went through page-by-page review at a public meeting of the WQMC followed by a general presentation to which the Beach Committee, Conservation Commission, and Waterways Committee had been invited.
- The Board of Selectmen have reviewed this entire process and have voted unanimously for the preparation and submittal of this NPC.

# 4. Bournes Pond Inlet Opening Evaluations and Preliminary Design

## 4.1 Background on the Inlet Opening Evaluation

Evaluations by the Massachusetts Estuaries Project (MEP) documented water quality problems in Bournes Pond in the MEP Technical Report entitled “Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Great/Perch Pond, Green Pond, and Bournes Pond, Falmouth, Massachusetts”, Final Report April 2005. These evaluations documented impaired water quality in Bournes Pond and identified that the pond currently exceeds its nitrogen loading threshold. The evaluations identified several ways that the nitrogen threshold could be met in the future; and the opening of the pond inlet was identified as a possible way to increase tidal flushing to the pond to help meet the threshold (the discussion related to this topic starts on page 197 of the Technical Report).

Based on the MEP evaluation, Massachusetts Department of Environmental Protection (MassDEP) developed Total Maximum Daily Loads (TMDLs) for Bournes Pond in their report titled “Great, Green, and Bournes Pond Embayment Systems, Total Maximum Daily Loads for Total Nitrogen (Report #96-TMDL-6 Control #181)” dated April 2006.

Based on the MEP evaluations and the approved TMDL, the Town of Falmouth initiated a Comprehensive Wastewater Management Planning Project in 2007 to investigate cost-effective methods (among other goals) to meet the nitrogen TMDL for Bournes Pond. Evaluations as part of the CWMP project resulted in a Technical Memorandum dated March 10, 2008 from GHD to the Town of Falmouth to evaluate the benefits of enlarging the Bournes Pond Inlet. In 2011, the Town approved Article 17 which included pursuing inlet widening of Bournes Pond as a non-traditional method to meet the TMDL. In 2013 and 2014, Falmouth Town Meeting and the voters approved bonding for design and construction of a widened inlet and a new bridge. The Executive Office of Energy and Environmental Affairs (EOEEA #14154) in January 2014 approved the Final CWMP/FEIR document which included widening Bournes Pond inlet as a “Pilot Project”.

Technical Memorandum BP-1 (included in Appendix B) summarizes the preliminary design evaluations and nitrogen removal benefits for the inlet opening, and is the Town’s next step to proceed with this non-traditional wastewater and nutrient management project.

## 4.2 Technical Evaluations and Selection of Preferred New Inlet Opening

The hydrodynamic modeling by ACRE started at the beginning of the project to:

- Collect additional elevation data at the inlet;
- Update the hydrodynamic model; and
- Complete several model runs to optimize size and positions of the inlet opening.

These hydrodynamic evaluations are briefly summarized later in this memo, and detailed in Appendix BP-1-2 located in Appendix B of this NPC. The four scenarios evaluated include:

- Scenario 1: Replace the existing bridge with a new single-span bridge.
- Scenario 2: Replace the existing bridge with a double-span bridge.

- Scenario 3: Add one or more precast concrete culverts to the east of the existing bridge to increase the opening size.
- Scenario 4: Replace the existing bridge with a group of precast concrete culverts

Each of these scenarios is described below with findings of the elimination (screening) of two of the scenarios.

### Scenario 1—Single Span Bridge

Under this scenario the existing bridge would be removed and replaced with a 97-foot single span structure. This proposed bridge would likely be comprised of pre-stressed, concrete 1400 New England Bulb Tees supporting a reinforced concrete deck and bituminous pavement. The bridge would be founded on timber pile supported abutments with the westerly abutment positioned within the footprint of the existing west abutment. The bridge would provide for a 90-foot average clear channel width with no intermediate piers. Reconstruction and extension of the west jetty, construction of a new east jetty, and armoring of the channel bottom under, and 20 feet each side, of the bridge would be required (see Appendix BP-1-1 located in Appendix B of this NPC).

As the proposed superstructure would be approximately 3-feet deeper than that of the existing bridge, the profile of Menauhant Road would need to be raised necessitating the reconstruction of approximately 200-feet of Menauhant Road on either side of the bridge and the installation of retaining walls along the north side of the road to prevent filling of the adjacent environmental resource areas.

This Scenario was anticipated to have the highest capital costs due to the increase in roadway profile, additional structures within the barrier beach system, extent of roadway reconstruction, increase in bridge length and superstructure depth, and as a result was screened out for further evaluation.

### Scenario 2—Two Span Bridge

Under this scenario the existing bridge would be removed and replaced with a two span structure having two equal 50 foot spans. The proposed bridge would likely be comprised of 21-inch deep pre-stressed, concrete deck beams supporting a reinforced concrete deck and bituminous pavement. The bridge would be founded on timber pile supported abutments and center pier with the westerly abutment positioned within the footprint of the existing west abutment. The bridge would provide for two 45-foot average clear channels with an overall average width of 90 feet. Reconstruction and extension of the west jetty, construction of a new east jetty, and armoring of the channel bottom. Subsequent design does not include armouring the channel bottom (see Appendix BP-1-1 located in Appendix B of this NPC).

The proposed superstructure would be approximately the same depth as the existing bridge thereby allowing the profile of Menauhant Road to be maintained and limiting the reconstruction of Menauhant Road to approximately 100 feet either side of the bridge.

This Scenario was accepted for further evaluation.

### Scenario 3—Existing Bridge with Adjacent Box Culverts

Under this scenario the existing bridge would be retained and two precast concrete box culverts installed to the east of the existing bridge and channel. Each culvert opening is likely to be 19-feet wide by 12-feet high and supporting a standard roadway section Hot Mix Asphalt or HMA top, intermediate and base courses, sub-base and gravel borrow over the top of the culvert. Due to concerns over the site’s location and exposure to ocean storm events the culverts would be anchored to a concrete base slab supported by timber piles (see Appendix BP-1-1 located in Appendix B of this NPC).

This Scenario would provide for a 100-foot average clear channel but would require armoring extending into the channel for the protection of the interface between the culverts and existing bridge. This would result in two distinct channel openings passing under Menauhant Road. Reconstruction and extension of the west jetty and construction of a new east jetty would also be required.

With this Scenario the profile of Menauhant Road would be maintained and thereby limit the reconstruction of Menauhant road to approximately 100-feet either side of the bridge.

Due to the double channel opening separated by a “land mass”, shoaling was a major concern for this system. Additionally, a wider overall inlet width would be required to maintain the same tidal prism, further exacerbating shoaling and creating inlet stability concerns. This Scenario was screened out for further evaluation.

### Scenario 4—Multiple Box Culverts

Under this scenario the existing bridge would be removed and replaced by five (5) butted precast concrete box culverts. Each culvert opening is likely to be 19-feet wide by 12-feet high and supporting a standard roadway section (HMA top, intermediate and base courses, sub-base and gravel borrow) over the top of the culverts. Due to concerns over the site’s location and exposure to ocean storm events the culverts would be anchored to a concrete base slab supported by timber piles (see Appendix BP-1-1 located in Appendix B of this NPC).

This scenario would provide for an approximate 100-foot average clear channel with the reconstruction and extension of the west jetty and construction of a new east jetty. With this Scenario the profile of Menauhant Road would be maintained and thereby limit the reconstruction of Menauhant road to approximately 100 feet either side of the bridge.

This Scenario was accepted for further evaluation.

## Detailed Evaluation of Scenarios 2 and 4

Additional evaluation of Scenarios 2 and 4 proceeded with the following items noted for both:

- The elevation of the existing bridge’s low chord will be maintained which will maintain the existing 3-foot 3-inch freeboard.
- The roadway cross section (illustrated in Sheets 3 and 5 of Appendix BP-1-1 (located in Appendix B of this NPC) would be increased from 32-feet for 34-feet to meet minimum AASHTO design criteria.
- As a result, the roadway section will consist of the following:
  - Two 11-foot wide travel lanes
  - Two 2-foot offsets
  - One 5-foot sidewalk on the south side
  - MassDOT approval and crash-tested metal bridge railing on both sides of the bridge

Costs were developed as part of Technical Memorandum BP-1 (Appendix B) and are discussed below. After review of the costs and additional considerations of Scenarios 2 and 4, the Project Team selected Scenario 2 as the Preferred Alternative.

Estimated quantities for the major components of each scenario were determined and unit prices applied to arrive at an estimate of probable construction cost. Due to the conceptual development of the scenarios a 25% contingency was included to account for unforeseen field conditions, potential further design developments, and the general nature of the work.

The following Table 3 provides the estimate of probable construction costs including the estimated costs for the permitting, design and construction engineering/oversight:

Table 3 Capital Cost Comparison for Scenarios 2 and 4

| Estimate of Probable Construction Costs | Scenario 2 (Two-Span Bridge) ($) | Scenario 4 (Multiple Culverts) ($) |
|---|---|---|
| Bridge and Road Work | 2,500,000 | 2,600,000 |
| Jetty Modifications and Armoring | 800,000 | 720,000 |
| Dredging and Beach Nourishment | 75,000 | 80,000 |
| Permitting and Special Study Allowance | 300,000 | 300,000 |
| Design | 400,000 | 400,000 |
| Fiscal, Legal, and Engineering During Construction | 520,000 | 520,000 |
| Contingency (25%) | 920,000 | 930,000 |
| **Total** | **5,520,000** | **5,550,000** |

In addition, each scenario was evaluated for operation and maintenance costs as shown in Table 4.

Table 4 O&M Cost Comparison for Scenarios 2 and 4

| Estimate of Probable Annual Operational and Maintenance Costs | Scenario 2 (Two-Span Bridge) ($) | Scenario 4 (Multiple Culverts) ($) |
|---|---|---|
| Maintenance Dredging/Beach Nourishment | 6,000[3] | 16,000[3] |
| Bridge/Culvert Maintenance[1] | 30,000 | 25,000 |
| Jetty Maintenance[2] | 5,000 | 6,000 |
| **Total** | **41,000** | **47,000** |

Notes:

1. Bridge superstructure replacement annualized over 45 years, and roadway repaving annualized over 15 years.
2. Periodic jetty maintenance has been annualized.
3. Assumes 1,000 cubic yards of dredging every two years, where additional culvert clean-out will be required after major storms (once every 5 years).

After review of the costs and additional considerations of Scenarios 2 and 4, the Project Team selected Scenario 2 as the Preferred Alternative. Two major concerns for Scenario 4 include difficult long-term maintenance of the channel within five butted precast concrete box outlets, and concern about protection of multiple vertical walls within the channel.

On December 6, 2012 the four scenarios and the findings of the preliminary design evaluations were presented to the Town's WQMC who is overseeing the Town's Wastewater and Nutrient

Management projects. The WQMC voted unanimously to proceed with Scenario 2. The estimated capital cost to widen Bournes Pond Inlet is $5,520,000.

## 4.3 Cost Comparison Evaluations

The capital cost comparison evaluations using conservative assumptions for wastewater nitrogen are summarized below:

- The total capital cost of the new opening with double-span bridge is $5,520,000 as summarized in Table 3.
- The capital cost of removing approximately 2000 kg/yr of nitrogen with wastewater collection, advanced treatment, and treated water recharge outside of the watershed is estimated at $12,830,000 based on the following factors:
  - Wastewater system to be developed for 273 houses based upon:

    Approximately 2000 kg/yr divided by 7.3 kg/yr/house based on 151 gallons of water consumption/day/house at a wastewater nitrogen concentration of 35 mg/L. This flow and nitrogen concentration basis is from page 37 of the MEP Technical Report (excerpt attached in Appendix BP-1-3).
  - Estimated cost of $47,000 per house based on the capital cost incurred for the New Silver Beach Wastewater Project to sewer 231 properties in 2007 scaled to 2013 costs. Information on the costs and number of properties is attached in Appendix BP-1-3.

This cost comparison indicates that the cost to increase the inlet opening and remove approximately 2000kg/yr of nitrogen is approximately 43% of the costs to provide conventional wastewater management to this area. Stating this comparison in another way, removing the approximately 2000 kg/yr of nitrogen with wastewater management would be approximately two times more expensive than opening the inlet.

There is a second method to estimate the number of homes that would need to be sewered to remove the approximately 2000 kg/yr load which indicates an even greater cost savings for the inlet opening. The Massachusetts Estuaries Project (MEP) used additional factors in their nitrogen load calculations as indicated on page 33 of the Technical Report (attached in Appendix BP-1-3) as summarized below:

- The MEP assumed that 25% of the nitrogen discharged from each home is removed in the leach field as documented at MassDEP's Alternative Septic System Test Center at MMR. This means that the nitrogen concentration from the septic system is reduced from 35 mg/L to 26.25 mg/L.
- The MEP assumed that only 90% of the water consumption at each home becomes wastewater due to non-potable water uses such as irrigation and other outdoor uses. This means that the wastewater flow transporting the 26.25 mg/L of nitrogen is 136 gallons per day instead of 151 gallons per day.

These two factors indicate a daily household nitrogen load of 4.9 kg/yr per house; therefore, there is a need to sewer 407 houses to remove the approximately 2000 kg of wastewater nitrogen that is actually entering the estuary. The cost to sewer 407 houses at $47,000/house would be $19,130,000 which would be over 3.4 times the cost of the inlet opening.

The two methods used above indicate that the cost savings from inlet widening is significant.

# 5. Potential Environmental Impacts

## 5.1 Existing Conditions

The proposed Bournes Pond Inlet Widening Project is within the following jurisdictional resource areas as shown in Figure 11 (Resource Areas) and Figure 12 (Flood Zones):

- MassDEP Resource Areas: Coastal Barrier Beach Resource including Barrier Beach-Coastal Beach, Land Containing Shellfish and Land Subject to Coastal Storm Flowage.
- NHESP Priority Habitat
- Tidelands Jurisdiction Chapter 91 Historic High Water

## 5.2 Ecological Restoration Limited Project

An Ecological Restoration Limited Project is defined in 310 CMR 10.04 as:

*A project whose primary purpose is to restore or otherwise improve the natural capacity of a Resource Area(s) to protect and sustain the interests identified in M.G.L. c. 131, § 40, when such interests have been degraded or destroyed by anthropogenic influences that meet the eligibility criteria set forth in 310 CMR 10.24(8) or 10.53(4).*

An Ecological Restoration Project permitted as an Ecological Restoration Limited Project in accordance with 310 CMR 10.24(8) may result in the temporary or permanent loss of Resource Areas and/or the conversion of one Resource Area to another when such loss is necessary to the achievement of the project's ecological restoration goals. If the project is located in a Coastal Dune or Barrier Beach, the applicant must demonstrate that the use of armoring has been avoided, and minimized to the maximum extent practicable.

## 5.3 Tidal Restoration Impacts

310 CMR 10.24(8) provides for several types of Ecological Restoration Limited Projects. As documented in the joint SMAST/Massachusetts DEP report entitled “Massachusetts Estuaries Project Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Great/Perch Pond, Green Pond and Bournes Pond, Falmouth, Massachusetts” (2005), Bournes Pond is tidally restricted (Pages 86-88, 103-105, 106-107, and 197-201 in Appendix A). This MEP analysis quantified the extent of the tidal restriction. Historical inlet information also demonstrates that the existing 50-foot inlet channel width is significantly smaller than mapped inlets dating back to 1844.

The proposed inlet widening qualifies under 310 CMR 10.24(8)(e)1: Tidal Restoration Project, because the proposed project is designed to restore tidal flow. As described in 310 CMR 10.24(8)(e)1:

*A project that will restore tidal flow and that does not meet all the eligibility criteria set forth in 310 CMR 10.13 may be permitted as an Ecological Restoration Limited Project provided that in addition to the criteria set forth in 310 CMR 10.24(8)(a) through (d), the project including any proposed flood mitigation measures will not significantly increase flooding or storm damage impacts to the built environment, including without limitation, buildings, wells, septic systems, roads or other human-made structures or infrastructure*.

According to 310 CMR 10.24(8)(e)3, Other Ecological Restoration Projects; an Ecological Restoration Project that is not listed in 310 CMR 10.24(8)(e)1 and 2 may be permitted as an

Ecological Restoration Limited Project provided the project meets the criteria set forth in 310 CMR 10.24(8)(a) through (d). Such projects include eelgrass restoration, as well as possibly shellfish habitat enhancement.

Water quality modeling performed for the MEP indicates that widening Bournes Pond inlet restores tidal flow and causes a quantifiable decrease in water column Total Nitrogen (TN) within the estuary, as shown in Figure 13. TN is a measure of estuarine nutrients, and is a direct indicator of overall water quality. In some estuaries, including adjacent Waquoit Bay, excess nutrients have caused dense algal blooms to occur for several weeks at a time, blocking sunlight to submerged aquatic vegetation. Decaying algae from the blooms uses oxygen that was once available to fish and shellfish. These eutrophic conditions cause a direct degradation of both finfish and shellfish habitat (e.g. Bricker, et al., 1999). Bournes Pond is included on the EPA 303(d) list of impaired waters, and a Total Maximum Daily Load for Total Nitrogen has been established (DEP, 2006). The mitigation of TN inputs is required in Bournes Pond to restore water quality and estuarine health. **As proposed, the inlet widening effectively lowers the estuarine TN to a level equivalent to a source reduction of approximately 2,000 kg of TN per year.**

As designed, the inlet widening across the barrier beach and dune system separating Bournes Pond from Nantucket Sound necessitates reconfiguration of the existing inlet jetty system and excavation across the barrier beach. Therefore, there will be a conversion of one resource area to another (i.e. from Coastal Beach/Barrier Beach or Coastal Dune to Land Under the Ocean). The design also ensures that there will be no net expansion of coastal armoring, since the overall ‘footprint’ of the jetty structures will remain the same. In this manner, coastal armoring is minimized to the maximum extent practicable.

According to Technical Memorandum BP-1 (Appendix B), the optimized 90-foot tidal inlet will increase the tidal exchange to Bournes Pond by 10.3% which increases the tidal volume by 9 million gallons per tidal cycle. The optimized inlet dimensions ensure that the tidal exchange is maximized for inlet conditions that ensure sediment remains mobile in the channel (i.e. the widened inlet will not exacerbate shoaling within the inlet channel). In addition, a memorandum assessing both coastal erosion and flooding potential indicated that the proposed inlet widening would not exacerbate coastal flooding (see Appendix D – “Bournes Pond Inlet Opening, Flooding and Coastal Erosion Analysis”, dated November 11, 2014).

Similar to other projects aimed at removing anthropogenic tidal restrictions, the Bournes Pond Inlet widening is intended to increase tidal flushing and provide a marked improvement to water quality. While over 60 estuarine systems have been evaluated through the Massachusetts Estuaries Project DEP initiative, removal of tidal restrictions was only recommended for six sub-embayments, including Bournes Pond. It should be noted that the MEP only recommends tidal inlet improvements where there is a clear large-scale water quality benefit associated with meeting or partially meeting the goals of the EPA mandated TMDL. Overall, the TMDL goals are stipulated based on targeted improvements to the estuarine ecological health (i.e. load reductions that would achieve water quality conditions necessary for eelgrass and/or benthic infauna restoration). The systems within Southeastern Massachusetts where removal of tidal restrictions were recommended by the MEP to achieve ecological restoration goals are:

1. *Muddy Creek* (Chatham/Harwich) – Under construction and permitted as an Ecological Restoration Limited Project.
2. *Parkers River and Seine Pond* (Yarmouth) – Design is under review by MassDOT and environmental permitting discussions relative to the project meeting requirements for an Ecological Restoration Limited Project have occurred with DEP.

3. *Rushy Marsh* (Barnstable) –Historical inlet re-opened prior to implementation of the Ecological Restoration Limited Project regulations; therefore, originally proposed channel bank armoring was eliminated from the design during permitting process. Constructed inlet experienced erosion of downdrift beach and Town chose to close inlet.
4. *Farm Pond* (Oak Bluffs) – Design is being finalized.
5. *Bournes Pond* (Falmouth) – Proposed in this NPC
6. *Little Pond* (Falmouth) – Still in preliminary evaluation stages

Overall, the number of regional estuarine tidal restrictions where inlet improvements can yield demonstrable water quality improvements is quite limited. In addition, the data-driven water quality modeling analysis employed by the MEP to quantify the large-scale ecological improvements requires substantial multi-disciplinary technical expertise and several years of data collection. Together, these factors are evidence that inlet modifications occur infrequently.

Through the permitting process, the Town anticipates implementation of an appropriate monitoring plan to ensure the project goals are achieved. As indicated through communications with DEP, further refinement of how the proposed inlet widening would contribute to eelgrass and shellfish habitat restoration is sought. Specifically, DEP seeks monitoring that can quantify the enhancement in water circulation, water quality, and water clarity so that (at least in the southern end of Bournes Pond) eelgrass and shellfish habitat restoration is demonstrated.

## 5.4 Other Secondary Impacts

The southern Bournes Pond presently serves as one of the Town’s Family Shellfish Areas. The approximate 10% increase in tidal exchange associated with the proposed inlet widening project would improve water circulation throughout the entire estuary. However, the primary improvement would be in the southern basin and Israel’s Cove. Post-project tidal monitoring will be utilized to demonstrate the tidal exchange/tidal circulation improvements predicted by the hydrodynamic modeling.

Figure 14 illustrates the reduction in eelgrass coverage within Bournes Pond from 2001 to 2015. Over this time period, a loss of 6 acres of eelgrass has occurred. Based upon model results associated with the inlet widening, it is anticipated that 7.24 acres of eelgrass habitat would be restored, where the Total Nitrogen (TN) levels that would support eelgrass (0.45 mg/L or less) would expand by 7.24 acres (Figure 15). This expansion is in the approximate areas of 2001 eelgrass coverage and there have been no alterations to the bottom sediments within potential eelgrass beds over the past several decades. Ongoing water quality monitoring is planned to document both TN levels and water clarity (Secchi depths) at the historic monitoring stations throughout Bournes Pond. In this manner, water quality improvements associated with the inlet widening can be readily documented.

As the proposed work represents an ecological restoration of an impaired water body, no mitigation is proposed for impacts to resource areas. In general, most of the resource area impacts are limited to conversion of one resource area to another associated with inlet widening (i.e. conversion of Coastal Beach to Land Under the Ocean). The design effort ensures that impacts to resource areas are minimized, including preventing any increase to storm damage, no expansion of overall area/footprint of coastal engineering structures, and placement of excavated/dredged material on the barrier beach system.

## 5.5 Resource Area Impacts and Minimization Techniques

The location and extent of Massachusetts DEP regulated resources within the project work area of the Bournes Pond Inlet Widening are discussed below.

***Land Under the Ocean***

Land Under the Ocean (LUO) is defined at 310 CMR 10.25 as "land extending from the mean low water line seaward to the boundary of the municipality's jurisdiction and includes land under estuaries." Based on the topographic and bathymetric surveys, LUO begins at – 0.8 feet NAVD88 on the seaward side of Menauhant Road; however, the inlet channel area and the shoreline landward of Menauhant Road within Bournes Pond is also is considered LUO. This resource area is presumed significant to provide feeding areas, spawning and nursery grounds and shelter for coastal organisms, to reduce storm damage and flooding by diminishing and buffering the high-energy effects of storms, provide a source of sediment for seasonal rebuilding of coastal beaches and dunes, and to provide important food for birds and invertebrates. Referencing the Massachusetts Ocean Resource Information System (MORIS) database indicates that the subtidal areas south of the Bournes Pond shoreline at the terminus of the dredging footprint provide spawning and settling habitat for bay scallop (*Argopecten irradians*). The subtidal areas to the north within Bournes Pond provide habitat for quahog *(Mercenaria mercenaria).*

The excavation of LUO to accommodate the widening of the inlet channel to approximately 90 feet will extend to the east of the existing Vineyard Sound dredging footprint. The widened channel will also require the expansion of the dredging footprint within Bournes Pond, however the dredging footprints in Vineyard Sound and Bournes Pond are currently oversized relative to the existing inlet (Figure 16), so the extents of proposed new dredging have been minimized to the maximum extent possible to utilize the existing dredging footprints while accommodating the increase in inlet width through the coastal beach. To allow for the expansion of the inlet, the existing eastern inlet jetty will be removed and repositioned to the east to allow for the widening of the inlet channel (Figure 17). The outer channel depth in Vineyard Sound will remain at the permitted depth of -6 feet MLW. The widening of the inlet through the coastal beach will convert approximately 12,600 $ft^2$ of Coastal and Barrier Beach into LUO and require 3,200 CY of dredging.

The channel within Bournes Pond extends for approximately 1,500-feet north into the main body of the estuary. The channel has a permitted depth varying from -6 feet MLW at the inlet to -3.5 feet MLW at the northern terminus of the channel. The existing width of the channel varies from 60-feet at the inlet to 30-feet at the northern terminus of the channel. The inlet widening will require a widening of the channel to 90 feet. However, the permitted dredging depths will not be altered nor will the length of the channel. The proposed increase in channel width will alter 50,250 $ft^2$ of LOU and require 5,800 CY of dredging. The dredged material will be utilized for nourishment of the coastal beach and coastal dunes thus mitigating impacts to those resources. The increase in tidal flow into the system will enhance water quality and habitat contained within LOU.

***Land Containing Shellfish***

Land Containing Shellfish is defined in 310 CMR 10.34(2) as “Land under the ocean, tidal flats, rocky intertidal shores, salt marshes and land under salt pond when any such land contains shellfish.” As part of the inlet widening as described above, the existing channel within Bournes Pond will require widening to match the inlet width. The existing permitted channel is currently oversized, thus allowing the proposed channel to be minimized while still providing the necessary channel volume to improve the tidal restriction within the pond, which will lead directly to improvements in tidal flushing. The enhanced tidal flushing will reduce average total nitrogen concentrations up to 18% within the lower Bournes Pond system. From Table VIII-5 of the MEP Report, a reduction of 16.7% in TN concentration at station B4 (lower station) will meet target water quality goals. This reduction in TN concentration provides a significant improvement in water quality and water clarity, thus improving eelgrass and shellfish habitat. As described above, high total nitrogen (TN) concentrations can cause eutrophic conditions which lead to a direct degradation to both finfish and shellfish habitat (e.g. Bricker, et al., 1999). The reduction in TN associated with the inlet improvement would enhance shellfish habitat. Referencing the Massachusetts Ocean Resource Information System (MORIS) database indicates that the subtidal areas within Bournes Pond provide habitat for quahog *(Mercenaria mercenaria)* which will be enhanced through the widening of the inlet to Bournes Pond.

***Land under Salt Ponds***

Land under Salt Ponds is defined in 310 CMR 10.33(2) as "Salt Pond means a shallow enclosed or semi-enclosed body of saline water that may be partially or totally restricted by barrier beach formation. Salt ponds may receive freshwater from small streams emptying into their upper reaches and/or springs in the salt pond itself." Land under salt ponds is significant to the protection of marine fisheries and wildlife habitat and, where there are shellfish, to the protection of land containing shellfish. The widening of Bournes Pond inlet will improve the tidal flushing within the system, reducing the average Total Nitrogen Concentrations within the estuary closer to the federally mandated Threshold Total Nitrogen Limit. The improvements to tidal attenuation, water circulation, and water quality will lead to direct improvements to eelgrass coverage and shellfish habitat within the system.

***Coastal Beach***

Coastal Beach is defined at 310 CMR 10.27(2) as "unconsolidated sediment subject to wave, tidal and coastal storm action which forms the gently sloping shore of a body of salt water and includes tidal flats. Coastal beaches extend from the mean low water line landward to the dune line". This resource area is presumed significant to storm damage prevention, flood control, protection of wildlife habitat, protection of marine fisheries and where there are shellfish to land containing shellfish. The proposed widening of the inlet channel will permanently alter 12,600 $ft^2$ of Coastal Beach, and convert this resource to LUO. The inlet channel to Bournes Pond will be widened to the east of the existing inlet channel to a total width of 90 feet. Armor stone lining the existing eastern side of the channel will be repositioned to create and stabilize the widened channel and will not extend further seaward than the existing jetty structure.

Consideration will also be given to marine fisheries and wildlife habitat within the Coastal Beach to be altered. The widened channel and bridge are a water dependent project (primarily tidal restoration in addition to providing eelgrass and shellfish habitat enhancement); therefore, construction of the channel must have significant benefits on water circulation and water quality, while having negligible impacts to sediment grain size. As a primary goal of the project, construction of the widened inlet channel will improve tidal flow and circulation into and out of Bournes Pond, eliminate the tidal restriction that was created when the beach was filled and the existing inlet was created, and improve the water quality within the estuary. No impacts relative to sediment grain size are expected as a result of widening the inlet.

The function of the beach relative to storm damage prevention and flood control has been evaluated and is presented in Appendix B. During severe coastal storms the barrier beach is completely overtopped. The widened inlet does not result in any additional flooding in this circumstance because once water levels reach storm levels, the efficiency of the existing inlet continues to increase until there is no attenuation through the inlet, which will also be true with the wider inlet. Also, the increase in inlet width does not impact the function of the coastal beach to dissipate wave and storm energy.

The project includes the proposed nourishment of the coastal beach and coastal dune system both east and west of the inlet. The enhancement of the beach and dune system will further mitigate and improve the ability of the beach system to respond to storm events by increasing the volume of the beach and the volume and height of the manmade dune system that exists along Menauhant Beach.

The proposed dredged channel within Vineyard Sound and Bournes Pond contains sediment that has been tested and shown to be beach/dune compatible material. The material excavated as part of the tidal restoration project will be utilized to re-establish the beach and dune system within the 'footprint' of permitted beach and dune nourishment templates along Menauhant Beach. It is anticipated that the placement of the material to replenish the beach and dune system will mitigate for the limited impacts to the Coastal/Barrier Beach and Coastal Dune resource areas, described below. Under the stipulations within 310 CMR regarding Ecological Restoration Limited Projects, conversion of resource areas is allowed if necessary to meet project requirements. In this case, Coastal Beach will be converted to Land Under the Ocean.

***Barrier Beach***

Barrier Beach is defined in 310 CMR 10.29(2) as "Barrier Beach means a narrow low-lying strip of land generally consisting of coastal beaches and coastal dunes extending roughly parallel to the trend of the coast. It is separated from the mainland by a narrow body of fresh, brackish or saline water or a marsh system. A barrier beach may be joined to the mainland at one or both ends." The increase in channel width to reduce the tidal impairment to Bournes Pond, which lies landward of the barrier beach system, will not have an appreciable effect on the function of barrier beach system. The conversion of Barrier Beach to LOU will be mitigated by the nourishment and improvement of the Barrier Beach and Coastal Dune system. Dredging of the tidal channels will result in 9,000 CY of beach compatible material, which will be used to stabilize, restore, and enhance the barrier beach system. The enhancement of the barrier beach system through nourishment will increase the ability of the barrier beach to provide a buffer to storm waves and elevated sea levels by storms, thus benefiting the overall ecosystem function of the estuary behind the barrier beach. Under the stipulations within 310 CMR regarding Ecological Restoration Limited Projects, conversion of resource areas is allowed if necessary to meet project requirements. In this case, Barrier Beach will be converted to Land Under the Ocean.

***Coastal Dune***

Coastal Dunes are defined at 310 CMR 10.28(2) as "any natural hill, mound or ridge of sediment landward of a coastal beach deposited by wind action or storm overwash. Coastal dune also means sediment deposited by artificial means and serving the purpose of storm damage prevention or flood control. All coastal dunes are likely to be significant to storm damage prevention and flood control, and all coastal dunes on barrier beaches and the coastal dune closest to the coastal beach in any area are per se significant to storm damage prevention and flood control." Bournes Pond/Menauhant Beach is fronted by a low degraded manmade Coastal Dune system. The widening of the inlet will not result in any significant loss of Coastal Dune since the dune resources are located mainly on the western side of the inlet (which is outside the project footprint) and the dune resources on the eastern side are not within the inlet footprint. The dredging of the inlet channel will directly lead to the placement of approximately 9,000 CY of beach compatible nourishment on the coastal beach and coastal dune system fronting Bournes Pond. The nourishment will re-establish and enhance the dune system to the east and west of the inlet and will thus mitigate the limited potential impacts to resource areas, described above, while enhancing the interests of storm damage prevention, flood control and the protection of wildlife habitat along the beach.

***Land Subject to Coastal Storm Flowage***

Land Subject to Coastal Storm Flowage is defined in 310 CMR 10.04 as “Land subject to an inundation caused by coastal storms up to and including that caused by the 100-year storm, surge of record, or storm of record, whichever is greater.” The function of the beach relative to storm inundation and flood control has been evaluated and presented in Appendix B. During severe coastal storms the barrier beach is completely overtopped and the widened inlet does not result in an increase in the inland limit of the coastal high hazard area nor flooding extents and magnitude. The proposed project will not result in any changes to the Special Flood Hazard Areas nor the boundaries set forth in the effective FEMA Flood Insurance Study for the area surrounding Bournes Pond.

***Chapter 91 License – MassDEP***

Chapter 91 regulates activities on coastal waterways, including construction, dredging and filling in tidelands, including previously filled tidelands. For this project, the Chapter 91 regulated areas are areas seaward of the historic mean high water (MHW) line (Figure 11). Chapter 91 authorization is required for these jurisdictional activities (310 CMR 9.05).

# 6. Required Permits and Authorizations

Due to the proposed activities taking place within jurisdictional resources areas, several federal, state and local environmental permits and reviews will be required to implement this project, as listed below:

## 6.1 Federal

- Section 404 Clean Water Act – Army Corps of Engineers (ACOE)

## 6.2 State

- Massachusetts Environmental Policy Act (MEPA) – Executive Office of Energy & Environmental Affairs; where this Notice of Project Change (NPC) serves as the MEPA filing
- Massachusetts Endangered Species Act (MESA) – Natural Heritage and Endangered Species Program (NHESP)
- Section 401 Clean Water Act, Water Quality Certification – administered by MassDEP
- Federal Consistency Review – As administered by the Massachusetts Office of Coastal Zone Management (CZM)
- Chapter 91 License – MassDEP
- Project Notification Form (PNF) to Massachusetts Historical Commission (MHC)

## 6.3 Local

- Massachusetts Wetlands Protection Act (WPA) – Notice of Intent Application (NOI) as administered by Falmouth Conservation Commission and Massachusetts DEP. As described previously, the NOI application will indicate that the project qualifies as an Ecological Restoration Limited Project.
- Cape Cod Commission – Development of Regional Impact (DRI) Review – modification to existing Certificate of Compliance

## 6.4 Existing Dredging Permits for Bournes Pond Outer and Inner Channels

- Falmouth Conservation Commission – Order of Conditions; Comprehensive Permit for Dredging and Beach Nourishment, DEP #25-3786
- MassDEP 401 Water Quality Certification – Amendment 3, 401 WQC Transmittal No. X238551
- MassDEP Chapter 91 Waterways Permit, Waterways Application No. W11-3478, Permit No. 13266, Comprehensive Permit for Dredging and Beach Nourishment
- Army Corps of Engineers Permit No. NAE-2010-145

# 7. Timetable

Construction sequence, design summary, environmental permitting overview and recommended strategy were presented in Technical Memorandum BP-1 and summarized below (located in Appendix B).

## 7.1 Environmental Permitting Overview and Recommended Strategy

Widening of Bournes Pond Inlet is similar to many estuarine and salt marsh restoration projects that have been permitted in Massachusetts. However, the primary purpose of this project is slightly different, as it focuses specifically on water quality improvements needed to address the federal Clean Water Act, at the same time having secondary restoration benefits of marine and benthic habitats. The primary water quality improvement purpose of the project potentially can create concerns with the environmental regulatory agencies, as many of the regulatory agencies involved do not routinely consider the implications of the Clean Water Act and the related TMDL process as part of their decision-making process. Therefore, it will be critical that discussions with regulatory agencies include a background component to ensure that the environmental concerns related to the barrier beach system are considered relative to the overall ecological improvements within the estuary, as well as the Town's requirements to meet the TMDL for Bournes Pond.

Due to the unique nature of the Bournes Pond Inlet widening, it is not possible to determine the precise duration of the environmental permitting process. It is anticipated that the environmental permitting effort will likely require approximately one (1) year to complete.

## 7.2 Construction Sequence and Design Summary

In order to construct the proposed improvements, Menauhant Road would be closed to all vehicular and pedestrian traffic. Vehicular traffic would be detoured via Central Avenue, Route 28 and Acapesket Road. It is anticipated that the inlet opening would require approximately 18-24 months to construct and would require the following general sequence of construction:

1. Close Menauhant Road to traffic and institute detour
2. Install temporary water line / utility bridge
3. Demolish existing bridge superstructure
4. Install steel sheeting cofferdam and dewater east side of project site
5. Demolish existing east abutment / abandon existing piles
6. Excavate and drive timber piles for support of proposed easterly substructures
7. Form and place concrete for the proposed easterly substructure elements
8. Dredge and construct east jetty and channel; place beach-compatible material as beach/dune nourishment on Menauhant Beach east of inlet
9. Remove ends of cofferdam to open the new east side of the channel and reinstall to close off west side of channel
10. Dewater west side of project site
11. Demolish existing west abutment / abandon existing piles
12. Excavate and drive timber piles for proposed westerly substructures
13. Form and place concrete for the proposed westerly substructure elements

14. Dredge and reconstruct west jetty and channel; place beach-compatible material as beach/dune nourishment on Menauhant Beach west of inlet
15. Remove cofferdam
16. Install proposed superstructure
17. Form and place concrete deck slab, abutment backwalls and approach slabs (as appropriate)
18. Form and place sidewalk, safety curb, highway guardrail transitions and install bridge railing
19. Install permanent water line and remove temporary water line / utility bridge
20. Reconstruct approach roadway
21. Pave roadway and bridge, stripe, and open to traffic
22. Complete site restoration and clean-up

The bridge design basis would include:

- Design in accordance with the MassDOT LRFD Bridge Manual – 2013 Edition and AASHTO LRFD Specifications, 6th edition for HL-93 Live load
- Project to be bid as a local project subject to review by MassDOT's Bridge Engineer as required by M.G.L. Chapter 85, §35
- Two-span structure consisting of two equal 50-foot spans providing an average channel width of approximately 90-feet
  - Superstructure: precast concrete deck beams with a concrete deck
  - Substructure: timber pile supported cast-in-place abutments and center pier
- Existing bridge low chord elevation will be maintained
- Roadway section increased to 34-feet consisting of: two 11-foot travel lanes; two 2-foot offsets; one 5-foot sidewalk on the south side; and metal bridge railings.

## 7.3 Estimated Project Schedule

Table 5 provides an estimated project schedule based on the submission of this Notice of Project Change.

Table 5 Estimated Project Timeline

| Project Component | Estimated Date |
| --- | --- |
| Submit Notice of Project Change (NPC) | February 2016 |
| MEPA Certificate Issued | April 2016 |
| Apply to Falmouth Conservation Commission and Army Corps of Engineers | May 2016 |
| All permits in hand | Spring 2017 |
| Start Construction | Fall 2017 |
| Finish Construction | Fall 2019 |

# 8. Wastewater Management Alternatives Analysis

## 8.1 Introduction

Falmouth's Comprehensive Wastewater Management Plan and Final Environmental Impact Report, and Targeted Watershed Management Plan (CWMP/FEIR/TWMP) included Chapters 3 and 4 that focused on "Non-Traditional Nitrogen and Wastewater Management Technologies and Evaluations" and "Detailed Evaluations of Traditional Wastewater Alternatives", respectively. Core information from these chapters is presented below.

In addition to the non-traditional and traditional wastewater management alternatives that were evaluated as part of the CWMP/FEIR/TWMP, Technical Memorandum BP-1 (Appendix B) summarizes preliminary design options for an enlarged inlet and a new bridge. This report also documented the nitrogen removal benefits of a larger inlet as determined by water-quality modeling. Modeling also determined the optimal size of the new inlet to reduce shoaling. Core information from this technical memorandum is also presented below.

Falmouth's CWMP includes Little Pond, Great Pond, Green Pond, Bournes Pond, and Waquoit Bay and was issued a MEPA Certificate on January 10, 2014. The MEPA deadline for filing watershed plans for the rest of the Planning Area is December, 2019. As part of the planning process for a collection system in the Little Pond watershed, a TWMP was submitted and accepted by DEP on October 6, 2014. Plans for the remaining watersheds are currently underway.

Falmouth's planning methodology includes evaluating the cost and efficacy of alternatives and using an Adaptive Management approach to implement cost-effective solutions. Consistent with Cape Cod Commission's Area-wide 208 Plan Update, each south coast TWMP will have two scenarios:

- Meeting the TMDL with a combination of site appropriate alternatives, including: shellfish, Permeable Reactive Barriers, Innovative/Alternative Septic Systems, Inlet widening.
- Meeting the TMDL with sewers alone.

## 8.2 Overview of Non-Traditional Nitrogen and Wastewater Management Technologies and Evaluations

### 8.2.1 Background

Over a six-year period of detailed evaluations, Falmouth increasingly focused on non-traditional nitrogen and wastewater management technologies as a way to implement more economically viable and environmentally sustainable wastewater and nitrogen management solutions. Many of these technologies had not been used in the United States as part of a municipal-scale wastewater management plan and their feasibility was uncertain. Falmouth's 2011 Annual Town Meeting authorized $2.77 million for a variety of demonstration project and sewer engineering. Since then, the Town's WQMC has investigated the feasibility of the following non-traditional nitrogen management technologies and processes:

- Shellfish Aquaculture Demonstration Project to harvest/mitigate excessive nitrogen in the estuaries.

- Inlet Widening of Bournes Pond.
- Eco-Toilet Demonstration Project, which investigated the use of composting and urine-diverting toilets.
- Permeable Reactive Barriers (PRBs).
- Stormwater management initially to be evaluated for the Little Pond watershed.

Detailed evaluations of two other initiatives (not demonstration projects) have commenced and are expected to provide additional nutrient management:

- Passage in 2012 of a Comprehensive Nitrogen Control Bylaw (for fertilizer).
- Information-gathering on the feasibility and performance of individual property and clustered nitrogen removal (denitrifying) septic systems.

The eco-toilet, PRB, and on-site denitrifying septic system technologies had previously been screened from further evaluations in the 2007 Alternatives Screening Analysis Report and the ENF Document. They were formally added back into the detailed evaluations through the filing of the 2012 Draft CWMP Report that included a Notice of Project Change to evaluate these and other items.

Two other non-traditional technologies (management concepts) were evaluated but were not identified in Article 17 for demonstration projects:

- Ocean Outfall Discharge for Treated Water.
- Potential Constructed Wetlands for Increased Nitrogen Attenuation.

The ocean outfall concept had been previously screened from further evaluation in the Alternatives Screening Analysis Report and the ENF Document. It was added back into the detailed evaluations through the filing of the 2012 Draft Report and Notice of Project Change.

The demonstration projects and other non-traditional nitrogen and management initiatives are proceeding. Once they are determined to be feasible and cost-effective, they will be submitted as part of a Notice of Project Change for review by MEPA, and integrated into the CWMP Project for implementation. The Town also identified the need to increase water conservation by retrofitting all structures within the Town (public and private) with low-flow devices.

### 8.2.2 Inlet Widening of Bournes Pond with Considerations for Little Pond

Inlet Widening had been evaluated for Bournes Pond and Little Pond before the passage of Article 17. This MEP analysis indicated that widening these two inlets could provide an immediate and cost-effective improvement in water quality, and reduce the amount of sewering required for traditional wastewater nitrogen management in this watershed. These evaluations are summarized in an appendix to the CWMP. In addition, a Technical Memorandum (dated March 2008) with more detailed evaluations was an appendix to the CWMP.

After the passage of Article 17, the WQMC focused on which inlet opening to study further. Bournes Pond was chosen based on the significant gains in tidal flushing and nitrogen removal that seemed likely, as well as public support from residents in the Bournes Pond area. Moreover, some neighbors in the Little Pond area opposed widening the Little Pond inlet.

In late 2012, the Town's WQMC initiated the Bournes Pond Inlet Opening Demonstration Project to evaluate this option quantitatively and to obtain greater detail on the implications of such a project. A consultant team (GHD, Applied Coastal Research and Engineering, and BETA Group) was hired to determine optimal inlet opening size, alternative bridge types to maintain the opening, capital and O&M costs of the revised opening, nitrogen management benefits, the effective nitrogen removal that would be provided by the new inlet opening, and potential cost savings of the inlet opening as compared to removing the same amount of nitrogen through conventional wastewater nitrogen management methods. The evaluations and findings are detailed in Section 4.

Based on these findings, the WQMC and Town have decided to proceed with the following next steps:

- Advance inlet widening through a NPC to the CWMP.
- Continue with design evaluations.
- Proceed with the many permits (local, regional, Commonwealth, and Federal) that would be needed once MEPA approval is obtained.
- Bid and construct the project.
- Evaluate the effects/benefits of inlet opening through monitoring and implementation.

In 2013, Applied Coastal Research and Engineering in association with UMass Dartmouth School of Marine Science and Technology (SMAST) completed water quality modeling of the larger inlet as described in Section 5 of the Appendix BP-1-2 of Technical Memorandum BP-1, as follows:

- Updated the MEP water quality measurements, analysis and models that Massachusetts DEP developed as the basis for the Total Maximum Daily Loads (TMDLs) for Bournes Pond, including new inlet bathymetric measurements and increased grid resolution within the hydrodynamic and nutrient models.
- The existing nitrogen loading conditions were modeled with the existing inlet opening. This model run closely matched the existing average total nitrogen concentration at the Bournes Pond sentinel station for Bournes Pond. This concentration is 0.578 mg/L.
- The existing nitrogen loading conditions were modeled with the recommended larger opening of the 2-span bridge. This model run produced a projected average total nitrogen concentration of 0.555 mg/L at the sentinel station. This value may seem to be a small reduction compared to the existing nitrogen concentration of 0.578 but it is very significant when compared to the TMDL threshold concentration of 0.45 mg/L which takes into account the background nitrogen that comes into the estuary from Vineyard Sound. This indicates a lowering of the needed nitrogen concentration reduction from 0.128 mg/L to 0.105 mg/L relative to the TMDL threshold concentration.
- The "Inlet Opening Effective Nitrogen Load Reduction" value was then estimated by re-running the model with the existing inlet opening; and reducing the watershed loads from the existing loading to a condition where the sentinel station TN concentration matched the nitrogen concentration that was achieved with the larger inlet (0.555 mg/L) provided by the double-span bridge. The existing nitrogen load of 9.61 kg/day was reduced to 4.14 kg/day to match the concentration at the sentinel station. This load reduction of 5.47 kg/day is a 57% reduction which equates to a reduction of approximately 2000 kg/year within the watershed.

Because of this significant load reduction, inlet widening at Bournes Pond is a key element of water quality planning for this watershed.

## 8.3 Overview: Traditional Wastewater Management Evaluations

The following documents were prepared by GHD (Stearns and Wheler) as part of a multi-year wastewater planning effort that culminated in a Certificate from the Secretary of Environmental Affairs (January 2014) approving Falmouth's Comprehensive Wastewater Management Plan dated November 2013.

### 8.3.1 Needs Assessment (2007)

This report outlines Falmouth's wastewater planning history; defines the wastewater needs and calculates flow for the south coast watersheds; lists institutional and wastewater challenges; and lays out next steps. Chapter 5 includes a detailed build-out analysis of the Little, Great, Green, and Bournes Pond watersheds and Waquoit Bay watershed, that is based on the findings of the Massachusetts Estuaries Project Report (MEP), and verified through discussions with the Town planning department.

### 8.3.2 Alternatives Analysis (2007)

This report identifies and evaluates centralized and decentralized treatment technologies and solutions for the south coast watersheds and recommends preferred options that are grouped into alternative plans for detailed evaluation. Three alternative plans were studied in detail: (1) treating all wastewater at the Blacksmith Shop Road (BSR) plant, (2) splitting flow between the BSR plant and a new facility at the Falmouth Country Club site, and (3) splitting flow between the BSR plant and a facility at the Massachusetts Military Reservation (MMR—now Joint Base Cape Cod). Chapter 3 (p. 3-43) evaluates the feasibility of a narrowed list of locations for a new treatment plant at the Falmouth Country Club and the Augusta parcel. Chapter 4 includes a discussion of the significant advantages of using the current BSR plant.

Based on these detailed studies, the preferred option was a central collection and treatment solution fully utilizing the existing WWTF, with discharge locations in various watersheds outside West Falmouth Harbor.

### 8.3.3 Technical Memorandum (TM) #1 (2010)

This TM develops detailed costs and treated water discharge options for five wastewater management scenarios, in addition to the three that were originally included in the Alternatives Analysis.

- **Scenario 3C** includes the following components:
  - Advanced treatment at the MMR site with a treatment performance of less than 1 milligram per liter (mg/L) TOC (total organic carbon) and 1 mg/L total nitrogen on average.
  - Recharge of the treated water through infiltration wells placed in the Route 151 right-of-way (ROW) to distribute the recharge to the Planning Area watersheds.
  - This is the same Scenario 3C that was evaluated in the second group of detailed evaluations, and was the recommended alternative of the 2009 Preliminary Draft DCWMP-DEIR.
- **Scenario 3D** includes the following components:
  - Enhanced Nitrogen Removal treatment with treatment performance of 3 mg/L total nitrogen on average at the MMR site.
  - Discharge of the treated water at an outfall to the Cape Cod Canal.

- **Scenario 2A Modified** includes the following components:
  - Enhanced Nitrogen Removal treatment at the Falmouth Country Club site.
  - Subsurface recharge at the following sites:
    - Western portion of Falmouth Country Club site (Site 2B)
    - Southwest portion of Allen Property (Site 4)
    - Dupee Ball Field Property (Site 5)
- **Scenario 1A Modified** which includes the following components:
  - Advanced treatment at Blacksmith Shop Road (BSR) WWTF site to meet a treatment performance of 2 mg/L Total Nitrogen on average and less than 3 mg/L TOC.
  - Recharge of the treated water through infiltration wells placed at the northern edge of the BSR WWTF site (Site 7) and at the Land Swap Parcel (Site 10) located north of the BSR WWTF site.
- **Scenario 1D** which includes the following components:
  - Enhanced Nitrogen Removal treatment at the BSR WWTF.
  - Discharge of the treated water at an outfall to Vineyard Sound at Nobska Point.

Costs were developed and summarized in a format that would allow future considerations of cost sharing and betterment development. Subsurface investigations were also completed for the treated water recharge components of these scenarios including:

- Site visits to all recharge sites.
- Test pits at sites 4 and 5.
- Groundwater modeling (using the USGS groundwater model) was developed for the following sites/technologies:
  - Injection wells north of the existing Blacksmith Shop Road WWTF at Sites 7 and 10 as part of Scenario 1A Modified.
  - Subsurface leaching systems at sites 2B, 4, and 5 as part of Scenario 2A.
  - Injection wells along Route 151 as part of Scenario 3C.
  - Potential groundwater draw-down as part of a possible ocean outfall for Scenarios 1D and 3D.

### 8.3.4 Technical Memorandum #6 (2010)

This TM assesses the costs and non-monetary factors for a cluster versus central sewer solution for Seacoast Shores, a densely populated watershed adjacent to Bournes Pond watershed. **The summary finding is that central collection and treatment at Blacksmith Shop Road is more cost-effective and practical than either a small cluster or a larger satellite plant**, largely due to the significant difficulty in siting treatment plants and disposal sites in densely populated areas. Table 1 (p. 9) details cost differences of three different cluster system scenarios versus a centralized solution. The latter is approximately $20 million less expensive than the least-cost cluster system.

**Based on the extensive analysis of sewer options completed in Falmouth, alternatives to sewering are being pursued for the Planning Area outside Little Pond watershed.**

## 8.4 Water Quality Goals for Bournes Pond

The Massachusetts Estuaries Project Report (MEP) for Great, Green and Bournes Pond evaluates the watershed nitrogen loads, patterns of circulation and flow and water quality of these south coast estuaries. The analysis is based on extensive field data collected for water quality indicators such as total nitrogen, dissolved oxygen and chlorophyll *a*, as well as data from sediment cores, benthic infauna population counts and tide and stream gages. Modeling that is calibrated to this field data enables nitrogen removal targets to be calculated. Table VIII-3 of the MEP Report (see Table 2) provides the planning estimate for the mass of nitrogen that must be removed to meet TMDL thresholds and restore estuarine health in Bournes Pond. **The target removal load is approximately 4000 kg N/year (11 kg N/day).**

Calculations are as follows:

**Bournes Pond (main):** (9.61 kg/day – 1.31 kg/day) = 8.3 kg/day x 365 d/y = **3030 kg/yr**

**Israels Cove:** (2.05 kg/day – 0.27 kg/day) = 1.78 kg/d x 365 d/y = **650 kg/yr**

**Bournes Brook:** (3.29 kg/day – 1.97 kg/day) = 1.31 kg/d x 365 d/y = **482 kg/yr**

## 8.5 Scenarios for Meeting Target Nitrogen Removal Goal

### 8.5.1 Preferred Scenario for Bournes Pond Watershed

Falmouth's preferred scenario for achieving TMDL-compliance in Bournes Pond includes inlet widening, fertilizer controls, a PRB at Fisherman's Cove, and shellfish aquaculture. The estimated nitrogen removal from each of these measures is shown in Table 6:

Table 6 Preferred Scenario for Achieving TMDL-Compliance in Bournes Pond

| Inlet Widening (50% of the required removal of controllable load) | ~2000 kg N/yr |
|---|---|
| Fertilizer nitrogen control<br>*25% credit consistent with 208 Plan* | ~120 kg N/yr |
| Stormwater Best Management Practices (BMPs) | 0 kg N/yr |
| PRB at Fisherman's Cove | ~400 to ~1000 kg N/yr |
| Shellfish Aquaculture | ~1300 kg N/yr |
| **TOTAL:** | **~3800 to ~4400 kg N/yr** |

Inlet widening successfully addresses about half of the target nitrogen-removal goal for this watershed. In 2012, the Town adopted a Nitrogen Control Bylaw for Fertilizer that has been replicated in Orleans and Mashpee. This bylaw prohibits the application of nitrogen on turf located within 100 feet of an estuary. Enforcement through the Division of Marine and Environmental Services includes sending a letter annually to all property owners within 100 feet of estuaries, and following up on observed violations. The Conservation Commission includes this prohibition in any Order of Conditions issued. Although the estimated 120 kg N/year removed by controlling fertilizer nitrogen load is a small amount relative to the reduction target, it is an important way for property owners to become more aware of water quality issues and solutions.

Mitigation of stormwater sources of nitrogen will be evaluated on a case-by-case basis. Once infrastructure is selected for removal of nitrogen from specific storm drains and catchment areas, the mass of nitrogen will be calculated and applied. If 25% of the total load coming from stormwater is removed, the total would only be approximately 125 kg N/year. Even without credit for nitrogen load reduction from stormwater, the remaining 1880 kg N/year can be reasonably addressed with a combination of shellfish aquaculture and PRBs.

As described in Section 9.9.2, groundwater investigations are currently underway in the Bournes Pond watershed, near route 28. This is the first step in designing a PRB in the Fisherman's Cove neighborhood. Figure 18 shows two possible scenarios for the path of groundwater flow. Depending on which flow path is more accurate, and the measured concentrations of total nitrogen in the groundwater, PRBs will potentially remove between 400 to 1000 kg N/year. Analysis of the groundwater monitoring data that will be collected in the winter and spring of 2016 will establish the likely nitrogen removal from a PRB in the Bournes Pond watershed.

Even if the efficacy of PRBs is at the minimum expected rate, shellfish aquaculture is scalable to the range that may be required to address the remaining nitrogen load. A shellfish installation that could address up to 1,300 kg N/year includes growing one million oysters per acre, and bottom planting one million quahogs per acre for a bottom density of approximately 6 square inches per shellfish. One million oysters or quahogs have assimilated approximately 260 kg N into their shell and soft tissue at harvest size. This does not include any additional nitrogen-removal through the denitrification pathway. Harvesting five million shellfish annually would therefore remove at least 1,300 kg N annually.

To grow two million quahogs to a harvest size, seed that is large enough to be directly planted (25mm) can be purchased from hatcheries. However, to accommodate a growing paradigm that allows for three million oysters to be harvested annually, additional space is required for growing juveniles in floating bags for a season prior to bottom-planting. This first year grow-out in gear requires approximately 3 acres of surface water. Since Bournes Pond is 153 acres, 15 acres are available for shellfish gear per Army Corps of Engineers rule without any permit modification requirements. Therefore, there is ample area in Bournes Pond to accommodate the gear necessary. In addition to the 3 acres for gear, 5 acres of suitable bottom is required for grow-out, before factoring in an additional amount of bottom planting to address mortality. Assuming 50% survival, the amount of suitable bottom is 10 acres. Preliminary investigations by DMES confirm that there are likely to be 10 acres of suitable bottom in Bournes Pond for quahogs and oysters.

### 8.5.2 Contingency Plan: Using I/A Septic Systems

In the event that neither PRBs nor shellfish propagation prove viable for the Bournes Pond watershed, the removal of approximately 4000 kg N/year could be accomplished with inlet widening and Innovative/Alternative (I/A) Septic Systems. There are 1,191 properties in the Bournes Pond watershed according to WatershedMVP. MassDEP has granted nitrogen reduction credit of 50%, or 19 mg N/L to several I/A systems under pilot status. For planning purposes, enhanced I/A systems are likely to be able to achieve 12 mg N/L effluent. As part of a demonstration project funded by the EPA that is currently underway in Falmouth, vendors submitted test data on the performance of I/A septic systems. These data were reviewed and confirmed by a Technical Advisory Committee that included members of the Falmouth Board of Health, Falmouth Wastewater Superintendent, Buzzards Bay Coalition scientist, George Heufelder, Director of the Massachusetts Alternative Septic System Test Center, and the Technical Consultant to the Water Quality Management Committee. Based on these third-party laboratory results, a number of I/A systems remediate effluent nitrogen concentrations to 12 mg/L or less.

Based on scenario runs using WatershedMVP, approximately 1,100 I/A septic systems that achieve effluent concentrations of 19 mg/L or less would be required to remove 2000 kg N/year. Almost 800

I/A septic systems that achieve effluent concentrations of 12 mg/L or less would be required to remove 2,000 kg N/year. Ongoing operation and performance monitoring is an important aspect of this solution. An I/A system must be approved by the Falmouth Board of Health (BOH) and registered with the Barnstable County Department of Health and Environment. Quarterly performance monitoring is required. The Falmouth BOH also requires contracts for monitoring, operation and maintenance of all I/A systems. These contracts must contain annual renewal clauses.

#### 8.5.3 Sewer Scenario

Section 8.3 provides an overview of the evaluations conducted for traditional wastewater management solutions for Falmouth's south coast. The sewer scenario presented in the CWMP includes the Bournes Pond watershed as Sewer Service Area "D". This area extends beyond the Bournes Pond watershed both to the east and west and includes portions of the Green Pond and Waquoit Bay watersheds. Figure 4.6 from the CWMP highlights Sewer Service Area "D" and is included in Figure 19.

#### 8.5.4 Adaptive Management Plan

Chapter 6 of the CWMP/FEIR/TWMP includes a section on Adaptive Management.

As demonstration projects are implemented and monitored, nitrogen removal performance and costs will be evaluated. Cost effective alternatives will then be incorporated into Targeted Watershed Management Plans (TWMP and the CWMP) will be modified for their inclusion using a Notice of Project Change.

A standard set of evaluation criteria will be used to compare all wastewater and nitrogen management methods (traditional and non-traditional) on a "level playing field." The WQMC conducted a workshop on April 7, 2012 to consider expanding/modifying the criteria to be used during Adaptive Management evaluations from the criteria used as part of the Alternatives Screening Analysis. The criteria were grouped into several themes as summarized in the following Table 7.

Table 7 Evaluation Criteria Summary from WQMC Workshop in April 2012

| Evaluation Criteria Theme | Previous Criteria Used | Proposed Criteria for Adaptive Management Evaluations |
|---|---|---|
| Social | • Anticipated public acceptance<br>• Potential land requirements | • Achieves multiple benefits including public health, jobs, tourism, economy, ecology<br>• Open to alternatives<br>• Public acceptability including perception of impacts to property value<br>• Voter acceptability<br>• Level of disruption to individual properties<br>• Institutionally viable (planning, engineering & finance) |

| Evaluation Criteria Theme | Previous Criteria Used | Proposed Criteria for Adaptive Management Evaluations |
|---|---|---|
| Environmental | • Effluent quality to protect aquatic ecosystems<br>• Potential for air emissions (odor and noise) | • Protect ecological value: restoration of water quality and habitat in ponds and estuaries<br>• “Robustness” for meeting standards: attention to nitrogen, phosphorus, emerging constituents, carbon and other alterations and stressors<br>• Avoid externalization<br>• Work up from the estuary biological metrics for a health aquatic environment<br>• Energy efficiency - life cycle energy use |
| Economic | • Capital cost<br>• Operating costs | • Capital and operating costs<br>• Cost per pound of nitrogen removed<br>• Advance the low-hanging fruit<br>• Affordability within available tax limits<br>• Indirect costs and benefits (e.g. job creation)<br>• Total property owner cost<br>• Capacity to pay taxes<br>• Amenability to types of financing (e.g. betterment)<br>• Ease of distributing costs |
| Ease of Implementation | • Ease of implementation<br>• Ease of operation and maintenance | • Don’t be constrained by current regulations |
| Resource Use | • Energy use | • Maximize resource recovery and minimize non-renewable resource use (water, nutrients, energy) |
| Ease of Regulatory Approvals | • Meeting regulatory requirements | • Compliance with regulations and TMDL as a floor<br>• Measure compliance at the sentinel level not by percentage of properties sewered<br>• Necessary regulatory changes identified for each alternative |
| Resilience/Adaptability | • Flexibility | • Resilience to climate change/aging population<br>• Able to manage uncertainty (modular, spaced)<br>• Flexible to growth |

The Cape Cod Commission DRI review process that followed the FEIR review process included the development of a separate Adaptive Management Plan. The Town meets with the CCC twice a year to provide project updates.

## 8.6 Cost Comparisons

### 8.6.1 Cost of Inlet Widening

As detailed in Table 4-1 of Falmouth's CWMP, four alternative openings and bridge conceptual designs were evaluated to replace the existing 50-foot span bridge and opening, and to widen the inlet an additional 40-feet to the east. From the evaluation, a two-span bridge was selected as the most practical and cost-effective at a total capital cost of $5,520,000. Please refer to Table 3 for the capital cost comparisons.

Bournes Pond Technical Memorandum #1 (Appendix B, pp 17 – 18) details a comparative analysis of sewer costs versus inlet widening costs, and finds that sewering is between 2.3 and 3.4 times more expensive than widening the inlet to achieve the same nitrogen removal. The range is based on whether a single house contributes 35 mg N/L (DEP number) or 26.25 mg N/L (MEP number) to the estuary. The sewer cost calculation was based on the New Silver Beach small satellite sewer system at a cost of $47,000/parcel (scaled to 2013 dollars), and the widened inlet removing approximately 2000 kg N/year. This cost per sewered parcel is consistent with planning estimates for sewering the entire peninsula, based on analysis presented in the Town's approved CWMP, bid results in 2015 from the Little Pond Sewer Project, and WatershedMVP estimates from the Cape Cod Commission.

### 8.6.2 Cost for Satellite Treatment

As detailed in Section 8.3.4, Tech Memo #6 (GHD, 2010) assesses the costs and non-monetary factors for a cluster versus central sewer solution for Seacoast Shores, a densely populated watershed adjacent to Bournes Pond watershed. Based on this analysis, the cost of a Satellite Plant that would remove 4,000 kg N from the Bournes Pond Watershed is $69.5 million.

### 8.6.3 Cost for Central Sewer

***Approved Comprehensive Wastewater Management Plan (2013)***

Chapter 4 (Table 4.2, Table 4.4 and Figure 4.6) details the area and costs associated with the preferred sewering scenario and is referred to as Scenario 1E. This sewer scenario is the result of analyses of detailed cost as presented in Table 4.4 (such as disposal site options) and non-cost factors. **It is the lowest cost scenario for a central sewer option in the south coast of Falmouth, including a comparative analysis of different discharge methods for treated effluent disposal.** It is a well thought-out central sewer option that enjoys the highest economies of scale possible.

This scenario includes Little, Great, Green, and Bournes Pond as well as Waquoit Bay, designated as areas A-E in Figure 4.6. The Bournes Pond watershed is substantially contained within area "D". Using data from Table 4.2, and 4.4, it is possible to calculate a cost per parcel for this preferred scenario (areas A – E) *cost from January 2010 Engineering News Record index 8660.*

- This cost per parcel is $350M/7750 parcels = ~$45,000/parcel
- Number of parcels in the Bournes Pond lower watershed (from WatershedMVP) = Approximately 1100

Based on this analysis, the cost of a central sewer to remove 4000 kg N from the Bournes Pond Watershed is $49.5 million.

### *Little Pond Sewer Service Area (LPSSA)*

The LPSSA is a peninsula with a smaller area and higher density than Bournes Pond. Bid numbers for this project are available for comparison. This sewer project includes two lift stations and a collection system for approximately 1400 properties (260,000 MGD). Significant infrastructure that reduces sewer implementation costs also exists: one current lift station can be used, and a force main to the existing WWTF is already installed. In addition, a discharge location (Site 7) is available near the current WWTF. Even with these cost-saving features, the LPSSA project cost is approximately $37 million, not including permitting and construction of the discharge site or required upgrades to the WWTF.

### *WatershedMVP Analysis, Cape Cod Commission*

Using WatershedMVP, it is possible to develop planning scenarios for both a central sewer option as well as a large satellite plant option that treats the sewage from approximately 1,100 homes. This planning tool was developed as part of the Cape Cod Commission regional planning update (208 Plan), and has been approved by both DEP and EPA. Output of this model includes a map of the treatment area and a spreadsheet that details capital, operation and maintenance costs, nitrogen-removal, flow (gallons/day) and parcel counts.

The results of these scenario runs are as follows:

- Central Sewer for Bournes Pond watershed south of Route 28, with cost of WWTF removed because Falmouth already has a Plant: $52,248/parcel.
- Satellite Treatment for Bournes Pond watershed south of Route 28: $57,381/parcel.

### 8.6.4 Cost for Innovative/Alternative (I/A) Septic Systems

Approximately 1,100 I/A septic systems that achieve an effluent discharge to the soil absorption system (SAS) of 19 mg/L would be required to remove 2000 kg N/year. If enhanced performance of 12 mg/L were assumed, then almost 800 I/A systems would be required.

Fifteen vendors supplied information on capital costs (equipment and installation) as part of a prerequisite for participating in the West Falmouth Harbor Shoreline Septic Remediation demonstration project. Average equipment costs for I/A systems were quoted at approximately $14,000, not including the installation of a soil absorption system (SAS). Preliminary installation cost estimates are highly variable depending on the landscaping, access and other features associated with each property. For a standard site, the average cost provided by vendors is in the range of $7,500. Engineering and permitting costs are approximately $3500, if Conservation Commission approval is also required. The total cost based on preliminary cost data from the WFHSSA demonstration is $25,000 without the installation of a new SAS, which adds approximately $15,000 to the cost of an I/A system installation. Using a planning estimate of $25,000 per installation, the capital cost of I/A systems to remove 2000 kg N from the Bournes Pond Watershed ranges between $20 million and $27.5 million.

### 8.6.5 Cost for Shellfish Aquaculture

Based on budgets for the Little Pond Shellfish Demonstration, the cost for this alternative is $200,000. Shellfish costs include purchase of all required equipment as well as seed and labor costs to install, operate, and maintain the project.

### 8.6.6 Cost for Permeable Reactive Barriers

Based on information on the capital cost of installing injection well PRB, the costs for this alternative totals $2.6M.

Table 8 Estimated PRB Costs

| Sailfish Drive – 1,400 linear feet | |
|---|---|
| Planning | $72,400 |
| Design/Permitting | $60,000 |
| Construction | $2,100,000 |
| Contingency | $354,720 |
| Total Capital Cost | $2,587,120 |

### 8.6.7 Cost Summary

Table 9 provides a cost comparison summary of the various scenarios discussed. Each scenario would meet the TMDL and remove 4000 kg per year of nitrogen. The preferred scenario—inlet widening, plus shellfish plus a PRB—is not only the least costly by far, it provides a permanent, lasting, and **immediate** improvement to water quality and eelgrass and shellfish habitat in Bournes Pond.

Table 9 Scenario Cost Comparison Summary

| Scenario | Capital Cost Estimate |
|---|---|
| Satellite Sewer System | $69.5 M |
| Centralized Sewer System | $49.5 M |
| Inlet Widening plus Innovative/Alternative Septic Systems | $25.5 M to $32.7 M |
| Inlet Widening plus Shellfish and PRB | $8.3 M |

# 9. Compliance with MEPA Certificate Requests

## 9.1 Changes to Project Since FEIR Filing

The Secretary's FEIR Certificate states that changes to the project since the FEIR filing should be included in the Notice of Project Change.

The Certificate stated that the NPC for the Bourne's Pond Inlet Widening should be provided to the MEPA Office by December 31, 2014. Subsequent discussions with the MEPA have clarified that the NPC would be submitted in 2015 after Flooding Evaluations were completed.

As a result, Bournes Pond Inlet Opening Flooding and Coastal Erosion Analysis, ACRE & GHD, January 2015, was completed and is attached in Appendix D. This evaluation is the only update at the time of this filing to the project since the FEIR filing.

## 9.2 Update on "Pilot Projects" Listed in MEPA Certificate #14154

Falmouth began implementing pilot projects to demonstrate the effectiveness of alternative wastewater management techniques in 2012. The MEPA Certificate requests updates on three specific Pilot Projects as part of any NPC filing:

- Little Pond Shellfish Demonstration
- Permeable Reactive Barrier in West Falmouth
- Bournes Pond Inlet Widening (the subject of this NPC)

### 9.2.1 Little Pond Shellfish Pilot Project

Working through the Water Quality Management Committee (WQMC) and the Department of Marine and Environmental Services (DMES), implementation of the Little Pond Shellfish Pilot Project (Shellfish Pilot) began in the spring of 2013 and continued through the fall of 2015. This time span fulfills the MassDEP request for three years of data to evaluate shellfish aquaculture as an alternative technique for nitrogen-removal. Based on the success of this project, DMES plans to continue growing oysters in Little Pond as one of the Town's propagation programs.

Significant quantities of shellfish have been successfully grown in Little Pond throughout the project period. Propagation begins in January when the Town orders seed from several hatcheries in anticipation of the spring growing season. In late May/early June the seed arrives, and is installed in a Town upweller in Falmouth Harbor. In 2013, two batches of 1.25 million juvenile oysters each were procured, for a total of 2.5 million oysters. In 2014 and 2015, 1.5 million seed and 2 million seed were purchased (respectively). Each year, once shellfish reach approximately 6mm, they were tested for diseases as required by DMF and then relayed into Little Pond in late June. By the end of the first growing season (late October), oysters have reached an average size of 1.5 inches, with very high survival rates (approximately 80%). These juveniles are then relayed out of Little Pond and into other water bodies for depuration, spawn and eventual harvest one year later. Little Pond is permanently closed to shellfishing due to high coliform counts; DMF limits growth of juveniles in nurseries to 2-inches.

MassDEP indicated that three years of water quality data are needed to form the basis of a TMDL-credit for nitrogen removal that is attributable to oyster aquaculture. The Town has achieved a number of milestones to establish and quantify the causal relationship between shellfish cultivation and improved water quality. In general, water samples were taken twice monthly from June through October. This monitoring protocol includes nutrients as well as other water quality parameters[1] and surveys of benthic organisms. This suite of water quality factors is based on those analyzed as part of the Little Pond MEP Report. In addition, during July and August, data was collected in 1-hour intervals using two continuous monitoring buoys. Sampling parameters included dissolved oxygen, salinity, temperature, pH and turbidity. Discharge from a storm drain near the project site was also monitored.

In addition to water quality monitoring, the following parameters related to the shellfish were measured: survival rates, growth size classes, and nitrogen content in shell and soft tissue. The length of 20 oysters was measured monthly during the season to establish a growth rate, and samples of 100 oysters from several bags were measured at the time of relay to establish an average size. Twenty shellfish of various size classes (0.5-inch, 0.75-inch, 1-inch, 2-inches) were sent to the Boston University Stable Isotope Laboratory for nutrient content evaluations. These data confirm that the nitrogen content in the shell and soft tissue of first year oysters is a fraction of the total nitrogen content in a harvest size oyster.

The Cape Cod Commission Area-wide 208 Plan Update uses a density of one million oysters/acre for calculating the nitrogen uptake of oyster aquaculture. This Shellfish Pilot has revealed some practical considerations related to oyster density under different growing paradigms. Floating Bags are an effective system for growing oysters during their first year, with approximately 1,500 floating bags required for two million oysters. During the second year of growth, however, oyster density per bag significantly decreases from 1,200 oysters/bag to fewer than 300 oysters/bag. Therefore, bottom planting instead of continued splitting of oysters into bags is a useful component of oyster propagation for nutrient remediation.

Key findings of the Little Pond Shellfish Pilot Project include:

- Three years of water quality monitoring data show localized increases in water clarity, and reduction in Particulate Organic Nitrogen (PON) (chlorophyll *a* decreased within the shellfish growing area).
- Percent nitrogen in shell and soft tissue of oysters is consistent with Barnstable County Cooperative Extension data (Reitsma 2014).
- Shellfish grow to an average size of 1.5-inches ***in one season*** but most of the nitrogen uptake occurs during the second year of growth (to ~3 inches), accomplished by bottom planting in OTHER waterbodies.
- Percent nitrogen in dry weight shell and soft tissue correlates to Cape Cod Cooperative Extension study: approximately 2.5% and 8% respectively (Reitsma, 2014).
- The nitrogen contained in the shell and soft tissue of a 1.5-inch oyster is approximately .01 grams/oyster.
- The nitrogen contained in the shell and soft tissue of a 3-inch oyster grown off-bottom is approximately .26 grams/oyster.

[1] Total nitrogen (nitrate, nitrite, ammonia, dissolved organic nitrogen, particulate organic nitrogen), temperature, pH, chlorophyll-a, pheophytin-a, orthophosphate, salinity, dissolved oxygen, transparency (Secchi depth), benthic condition (periodical), other parameters as specified in the Quality Assurance Assessment Plan, as well as shellfish weight (periodic).

- Achieving a harvest size density of one million oysters/acre requires bottom planting for the second year of growth.
- The strategy of growing oysters in floating bags for the first year and bottom planting for the second year to achieve nitrogen-removal goals can be replicated in estuaries throughout Falmouth, beginning in West Falmouth Harbor.
- Technical Report: Little Pond Year 2 Monitoring, which includes the results from the first two years of monitoring included as Appendix F. The 2015 monitoring report will be available in the spring of 2016.

#### 9.2.2 Permeable Reactive Barrier in West Falmouth Harbor and Elsewhere

A Town-wide evaluation of potential PRB locations was completed in 2013 by CDM Smith, including a detailed evaluation in the West Falmouth Harbor area. Initially, only trench installation methods were being considered. The thickness of the aquifer (depth to freshwater/saltwater interface) at the location where a PRB would intercept the plume from the WWTF was estimated to be over 70-feet. Because trenching methods were unsuitable to this depth, the use of injection methods to deliver a carbon source was identified as a more promising alternative. However, given the environmental uncertainties associated with injecting a liquid into the ground less than 100-feet from the shores of West Falmouth Harbor, a pilot project was not supported at this location. Additional construction obstacles were the presence of many boulders, lack of uniformity in soil layers, and conflicts with utilities in the street and connections to nearby residences.

Sites along Falmouth’s south coast were identified as more feasible for either trench or injection well PRB installations. The WQMC is actively working on projects that will provide the information necessary to plan a PRB Pilot at the most advantageous location(s). Groundwater characterizations funded by the EPA and the Cape Cod Water Protection Collaborative are currently underway at two sites, Sailfish Drive (Bournes Pond watershed) and Shorewood Drive (Great Pond watershed). Data from two years of work on Shorewood Drive show significant nitrogen flux at several depths in the aquifer near the intersection with Route 28. The Acapesket Groundwater Project report by MT Environmental Resources (Appendix G) includes data from both 2014 and 2015 fieldwork. This project has just completed its scope of work. Additional data may be collected with the assistance of EPA in 2016, but that work plan is still being developed.

For Sailfish Drive, the EPA grant to conduct an Initial Site Characterization of the aquifer is in progress. The investigation includes the following elements:

- Up to six piezometers [2-inch diameter] along the shoulder of Sailfish Drive, a town-owned road
- One upstream water table well along the shoulder of Tarpon Road
- A cluster of 1-inch wells will be drilled to various depths in the aquifer until the fresh water/salt water interface is located at one location on Sailfish Drive
- Soil samples

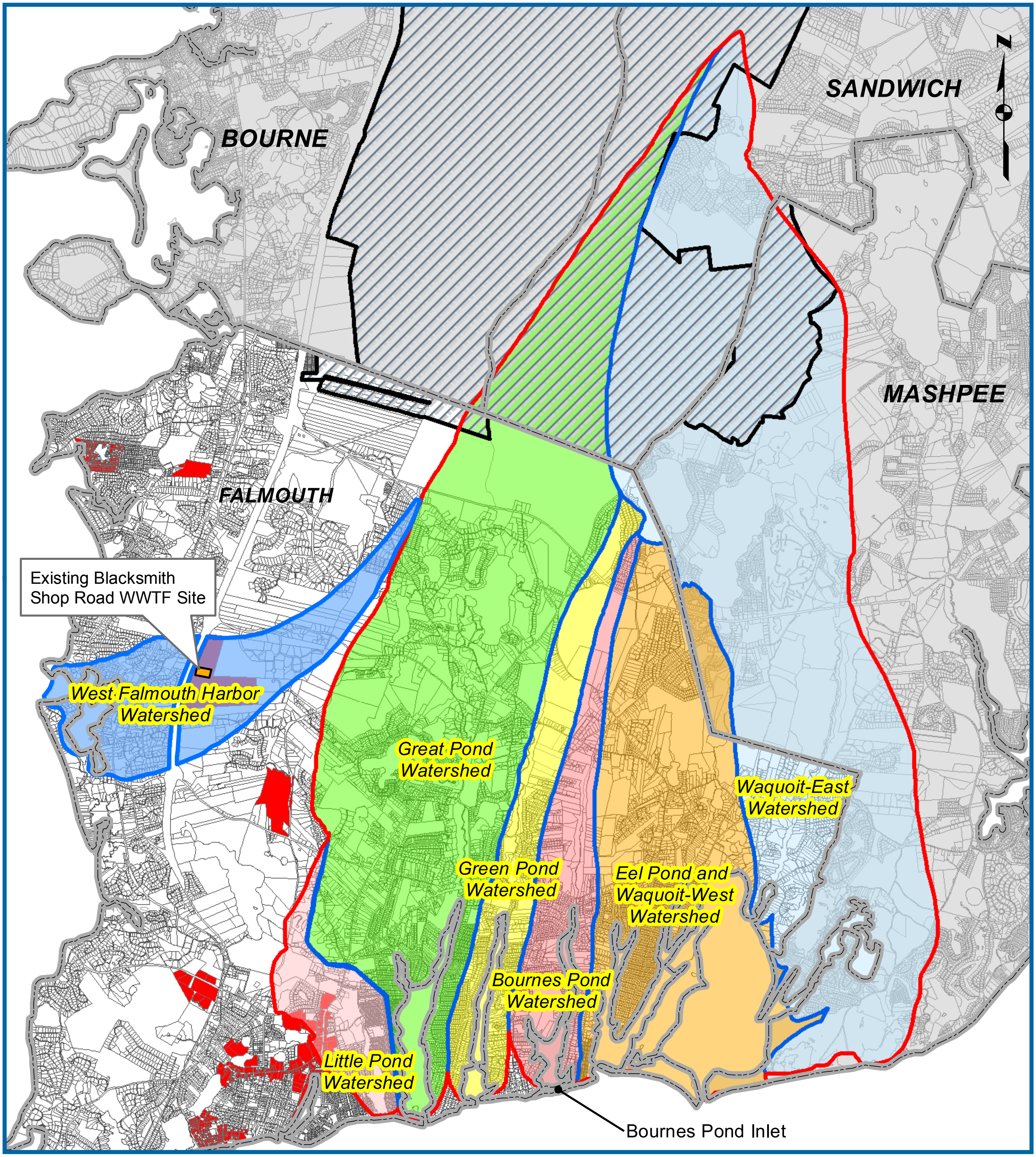
Wells will be installed, surveyed, and mapped between January and March 2016, capped, locked and mounted flush with the ground. Water samples will be collected twice (April and May) and analyzed for a variety of dissolved compounds including nitrate. A report will be issued in July. Based on the results of the Initial Site Characterization at all sites across Cape Cod, EPA will proceed at one or possibly two sites to conduct a full hydro-geologic investigation to evaluate suitability for installation of a pilot PRB. That decision will be made in the Fall 2016.

# 10. References

Bricker, S.B., C.G. Clement, D.E. Pirhalla, S.P. Orlando, and D.R.G. Farrow. 1999. National Estuarine Eutrophication Assessment: Effects of Nutrient Enrichment in the Nation's Estuaries. NOAA, National Ocean Service, Special Projects Office and the National Centers for Coastal Ocean Science. Silver Spring, MD: 71 pp.

Reitsma, J et al., Shellfish Nitrogen Content from Coastal Waters of Southeastern Massachusetts, Cape Cod Cooperative Extension & Woods Hole Sea Grant (2014).

# Figures




Legend

- CWMP Planning Area
- MEP Watershed Boundary
- Waquoit-East Watershed
- Bournes Pond Watershed
- Eel Pond & Waquoit-West Watershed
- Great Pond Watershed
- Green Pond Watershed
- Little Pond Watershed
- Parcel Boundary
- West Falmouth Harbor
- Sewered Parcel
- Town Boundary
- Parcel Boundary

Paper Size 8x11

0 0.5 1 2 Miles

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1927
Grid: NAD 1927 StatePlane Massachusetts Mainland FIPS 2001

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TOWN OF FALMOUTH, MASSACHUSETTS
CWMP

Job Number 86-18001
Revision A
Date 17 Dec 2015

CWMP PLANNING ITEMS
& BOURNES POND WATERSHED

Figure 1

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Paper Size ANSI B

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# BOURNES POND INLET & LOCUS MAP

Figure 2

N:\US\Hyannis\Projects\86\18001\GIS\Maps\MXD_Deliverables\86-15097-F02 LOCUS.mxd



Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:jjobrien

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EXISTING VIEW FROM THE SOUTH

EXISTING SINGLE SPAN BRIDGE
VIEW FROM THE WEST

PROPOSED DOUBLE SPAN BRIDGE
VIEW FROM THE SOUTH

PROPOSED DOUBLE SPAN BRIDGE
VIEW FROM THE WEST

Paper Size ANSI B

0 225 450 900 Feet

N

LEGEND

315 Norwood Park South
2nd Floor
Norwood, Massachusetts 02062
781.255.1982
www.BETA-Inc.com

TOWN OF FALMOUTH, MA
WASTEWATER AND NUTRIENT MANAGEMENT

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BOURNES POND INLET - EXISTING
& PROPOSED CONDITIONS

Figure 3

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Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:jjobrien


Paper Size ANSI B

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Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet

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TOWN OF FALMOUTH, MA
WASTEWATER AND NUTRIENT MANAGEMENT

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| Date | 17 Dec 2015 |

# BOURNES POND INLET - KEY FEATURES

Figure 4

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Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:jjobrien

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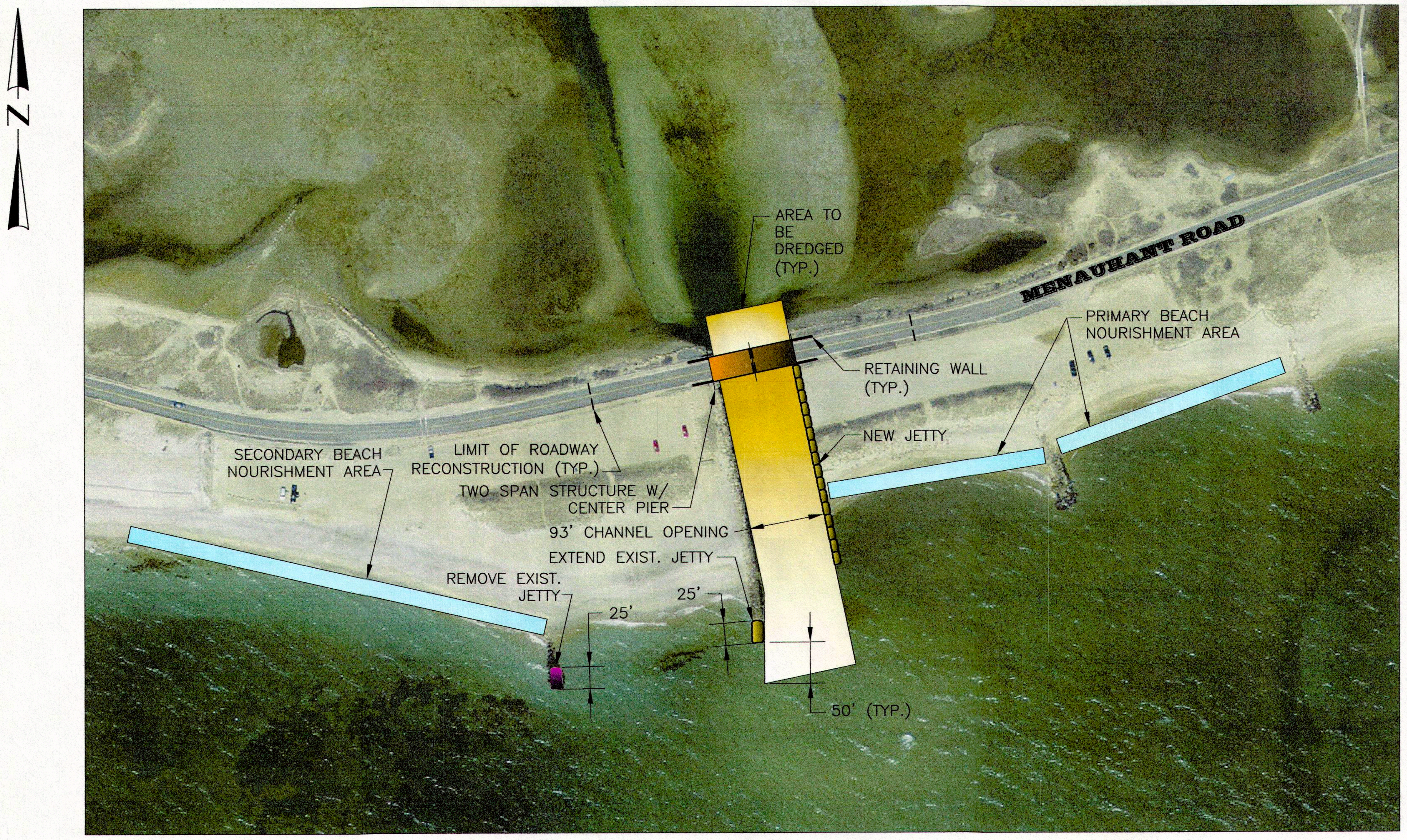
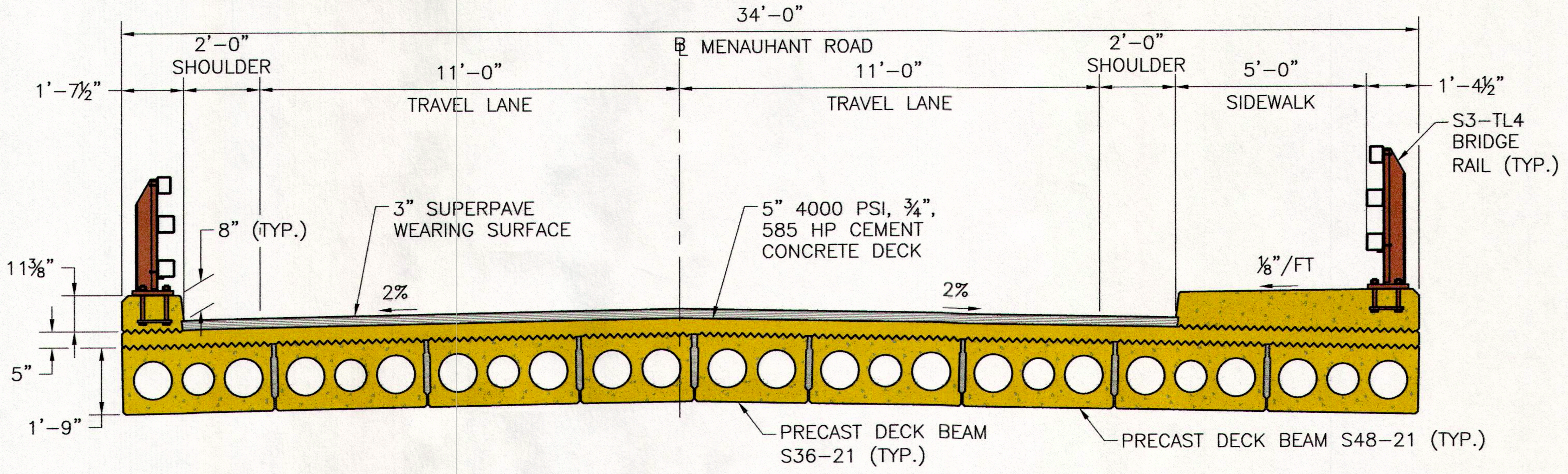


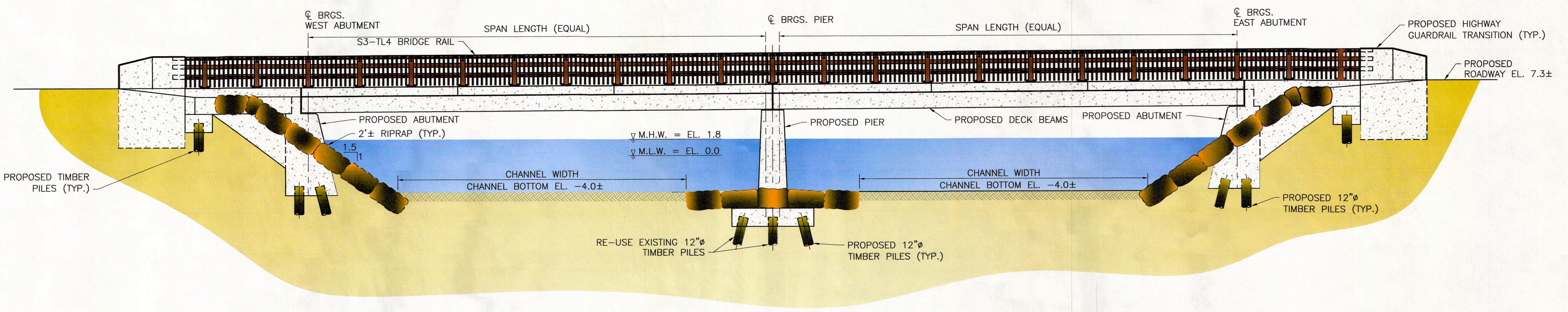

PROPOSED PLAN

SCALE: 1"=100'




PROPOSED BRIDGE CROSS-SECTION

SCALE: N.T.S.




PROPOSED ELEVATION

N.T.S.

DATUM: MEAN LOW WATER

| NUMBER | DATE | MADE BY | CHECKED BY | DESCRIPTION |
|---|---|---|---|---|

REVISIONS

DRAWN BY: PK

DESIGNED BY: PK

CHECKED BY: MG

BETA Group, Inc.
Engineers-Scientists-Landscape Architects-Planners
315 Norwood Park South
Norwood, MA 02062
781.255.1982
email: BETA@BETA-inc.com

GHD
1545 Iyannough Road
Hyannis, MA 02601
774.470.1630

SCALE:

AS SHOWN

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

CONCEPTUAL

**SCENARIO 2**
**SKETCH OF 2-SPAN BRIDGE**
**FALMOUTH, MA**

**REVISED**

JOB 4402

PLOT DATE: Dec. 03, 2012

ISSUE DATE

SHEET 3 OF 5

**NPC - FIGURE 5**

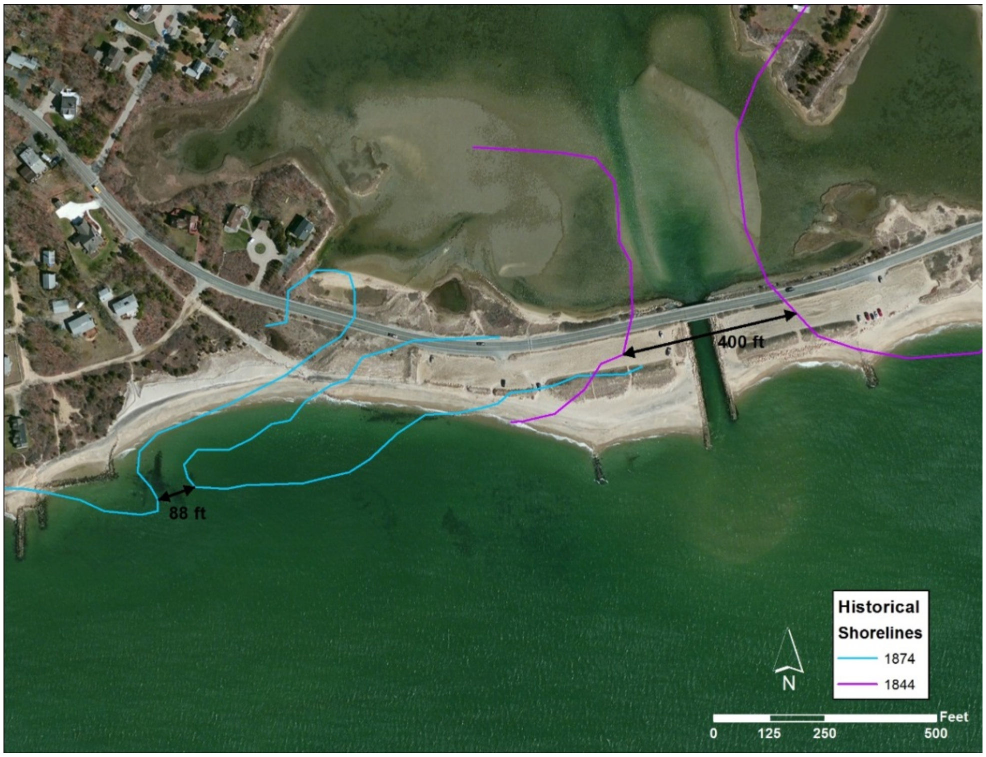


Figure 6. Historical shorelines from 1844 and 1874

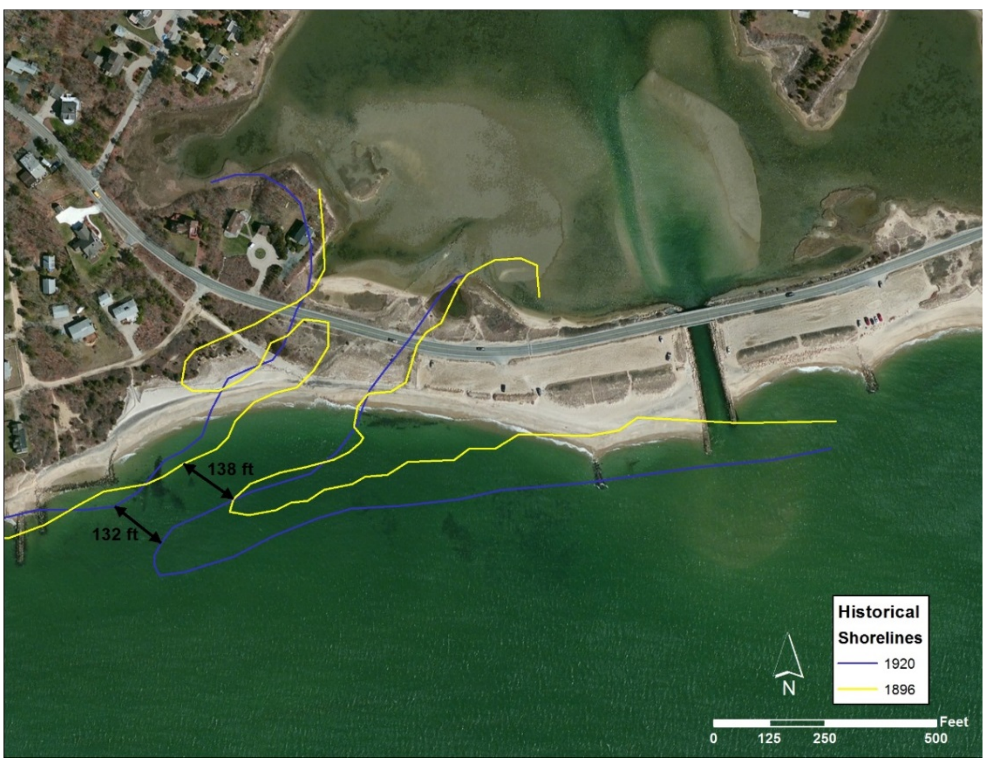



Figure 7. Historical shorelines from 1896 and 1920.

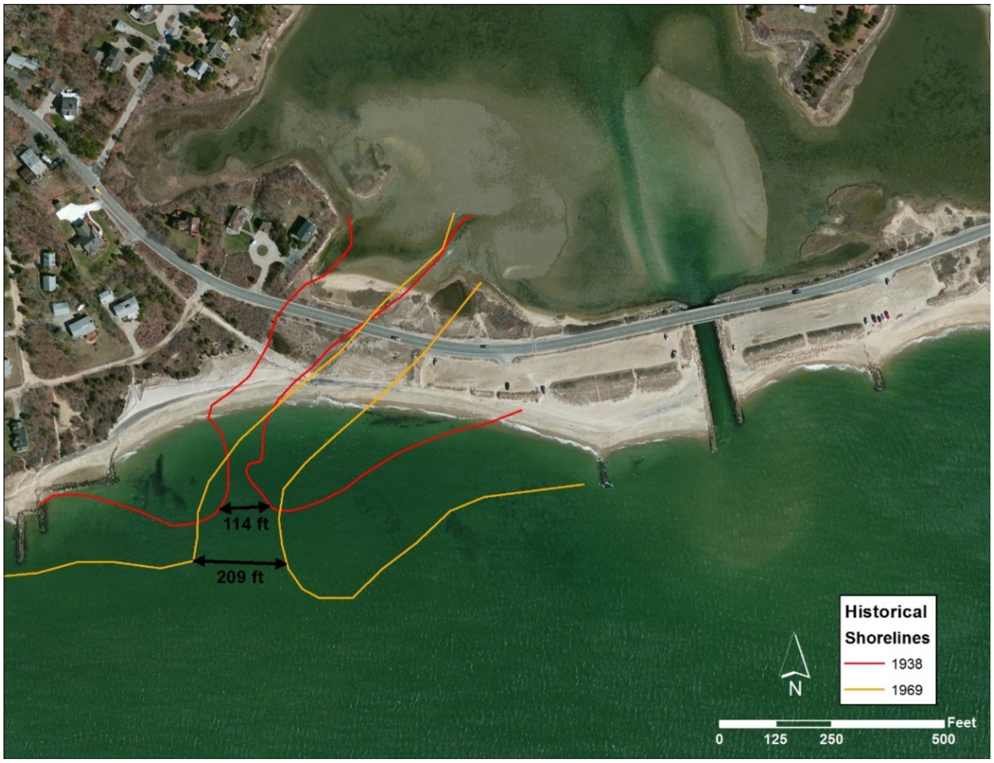


Figure 8. Historical shorelines from 1938 and 1969.

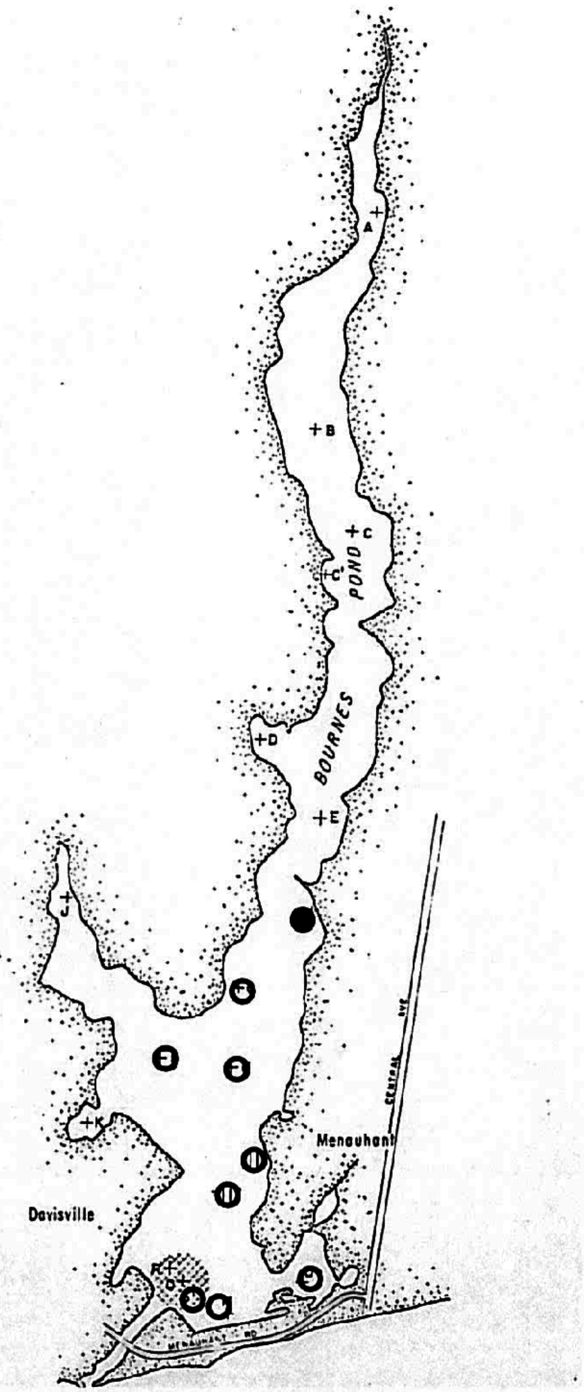



Figure VII-17. Map of eelgrass distribution in 1979 survey of sites A-R from Environmental Impact Statement by Weston and Sampson related to the new inlet/bridge which was installed in 1986. Eelgrass density is shown as: (+) no eelgrass, (open circles) sparse eelgrass, (hatched circle) moderate density eelgrass, and (full circle) dense eelgrass.

MASSACHUSETTS ESTUARIES PROJECT

## Department of Environmental Protection
## Eelgrass Mapping Program

### Bournes Pond Historical Eelgrass Distribution

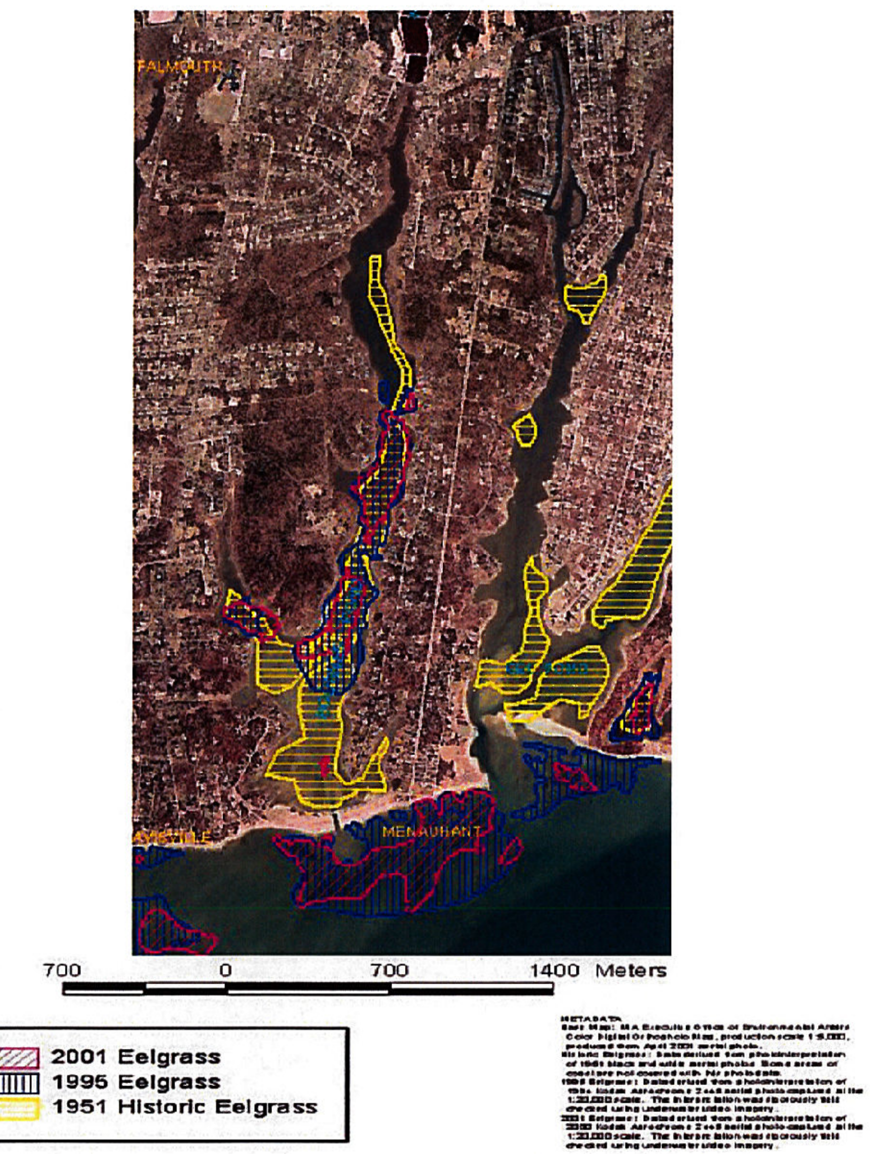



Figure VII-18b. Eelgrass bed distribution within Bournes Pond. The 1951 coverage is depicted by the yellow outline inside of which circumscribes the eelgrass beds. The blue (1995) and purple (2001) areas were mapped and ground-truthed by DEP.

Paper Size ANSI B

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WASTEWATER AND NUTRIENT MANAGEMENT

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FIGURES ON
EELGRASS DISTRIBUTION

Figure 09

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Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:jjobrien

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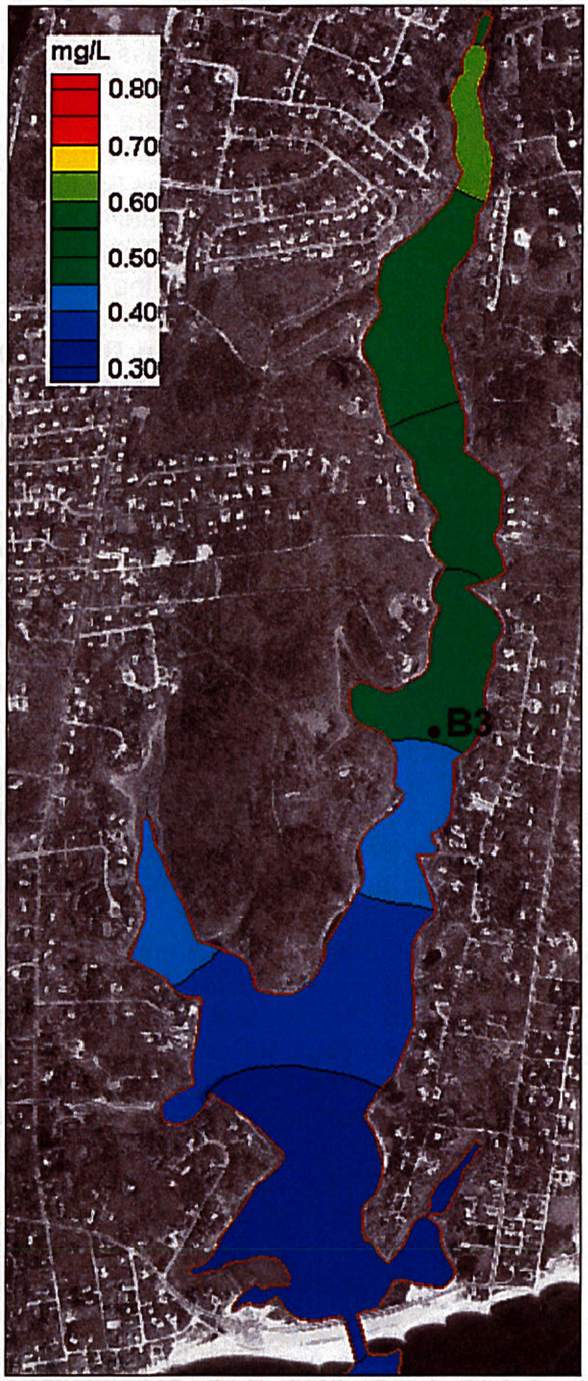


Figure VIII-3. Contour plot of modeled average total nitrogen concentrations (mg/L) in the Bournes Pond system, for threshold conditions (0.45 mg/L at water quality monitoring station B3). The approximate location of the sentinel threshold station for Bournes Pond (B3) is shown.

Paper Size 8x11

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TOWN OF FALMOUTH, MASSACHUSETTS
CWMP

MODELED THRESHOLD CONDITIONS FOR BOURNES POND

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Figure 10

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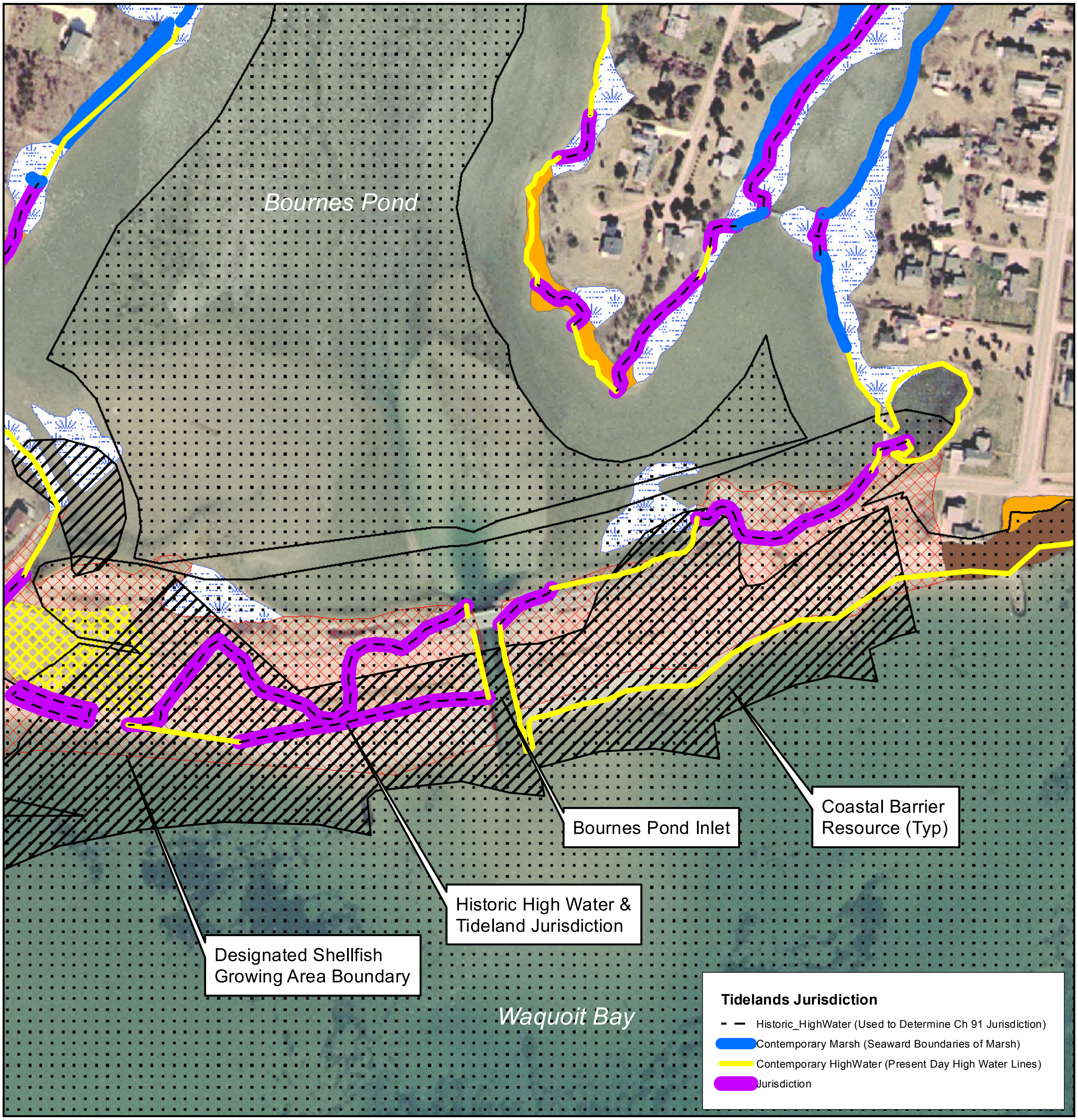


LEGEND

**Wetland Description**

- BARRIER BEACH-COASTAL BEACH
- BARRIER BEACH-COASTAL DUNE
- COASTAL BANK BLUFF OR SEA CLIFF
- COASTAL BEACH
- COASTAL DUNE
- SALT MARSH
- COASTAL BARRIER RESOURCE
- NHESP ESTIMATED & PRIORITY ENDANGERED SPECIES

*Note: For the purpose of this figure, the entire area inside Bournes Pond is designated as a Shellfish Growing Area.

Paper Size ANSI B

0 62.5 125 250 Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1927
Grid: NAD 1927 StatePlane Massachusetts Mainland FIPS 2001

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Town of Falmouth, Massachusetts
Wastewater and Nutrient Management

RESOURCE AREAS

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Figure 11

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LEGEND

**Flood Zone Designation**

- AE: 1% Annual Chance of Flooding, with BFE (Base Flood Elevation)
- VE: High Risk Coastal Area

Paper Size ANSI B

0 95 190 380 Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1927
Grid: NAD 1927 StatePlane Massachusetts Mainland FIPS 2001

N

Town of Falmouth, Massachusettes
Wastewater and Nutrient Management

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FLOOD ZONES

Figure 12

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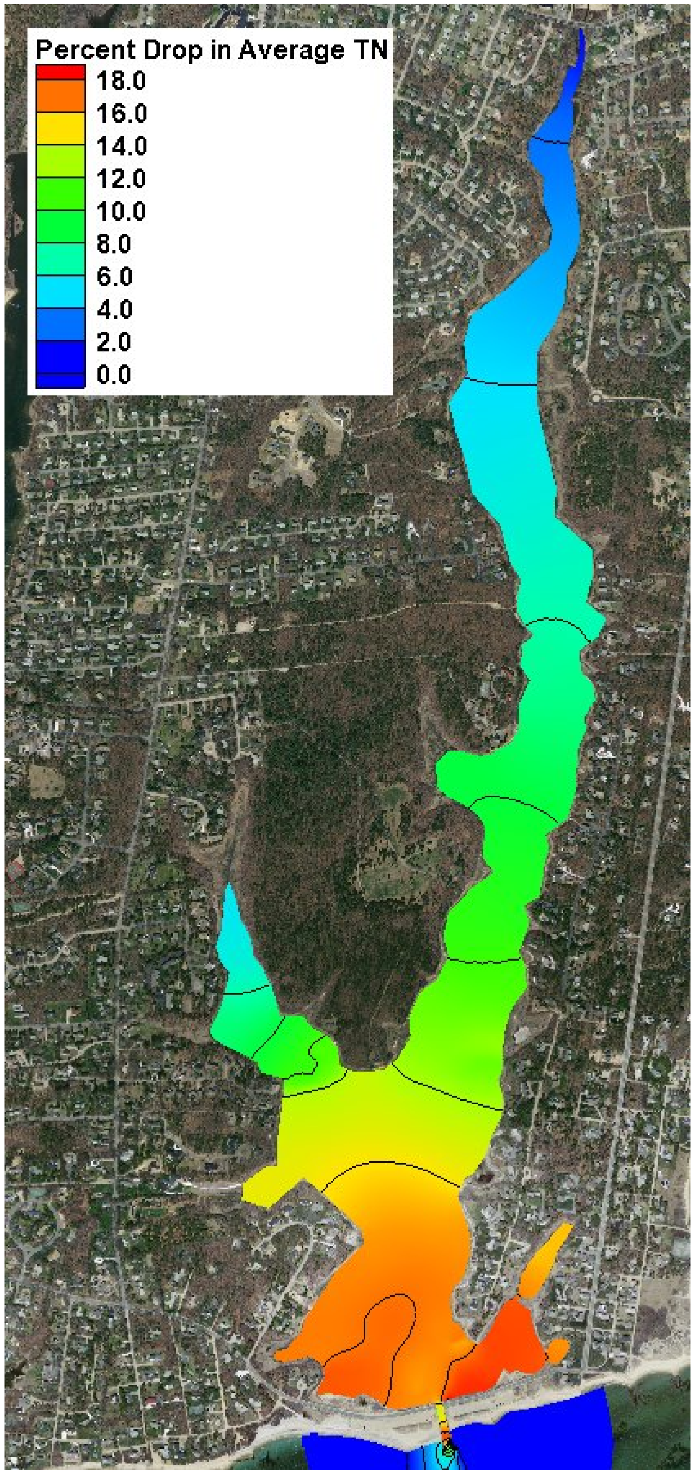


Figure 13. Modeled percent reduction in Total Nitrogen (TN) concentrations for Bournes Pond associated with the widened inlet relative to existing conditions. The largest reduction in TN and greatest improvement in water quality occurs in the proximity of the improved inlet.

Figure 14. Eelgrass coverage in Bournes Pond provided by Massachusetts DEP for 2001 (green) and 2015 (white). In 2001, 27.9 acres of eelgrass existed in Bournes Pond, which was reduced to 21.9 acres in 2015; a reduction of approximately 6.0 acres or 25%.

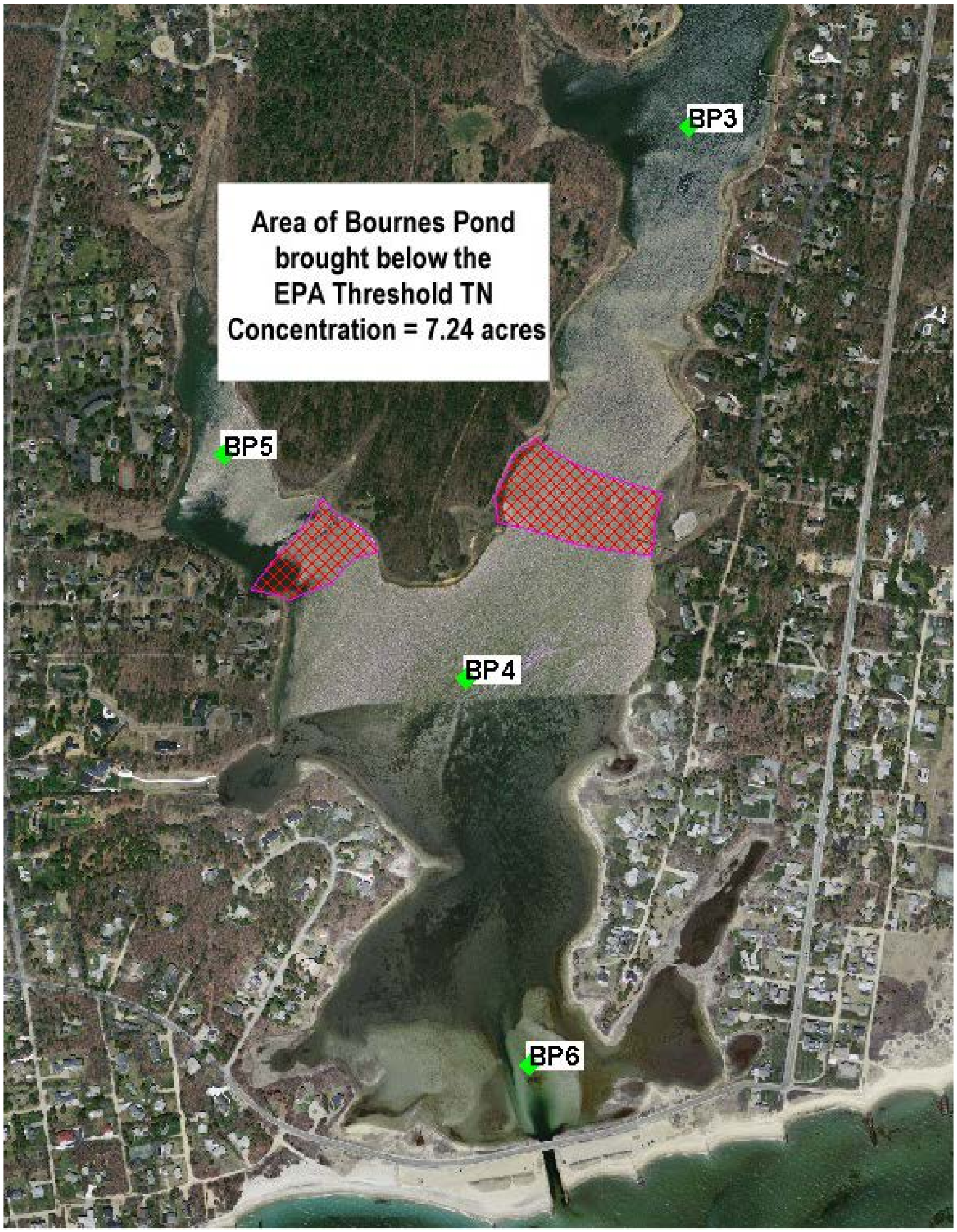


Figure 15. Anticipated expansion areas for eelgrass in Bournes Pond based on reduction of TN concentrations below the nitrogen threshold limit (0.45 mg/L) associated with the proposed widened inlet.

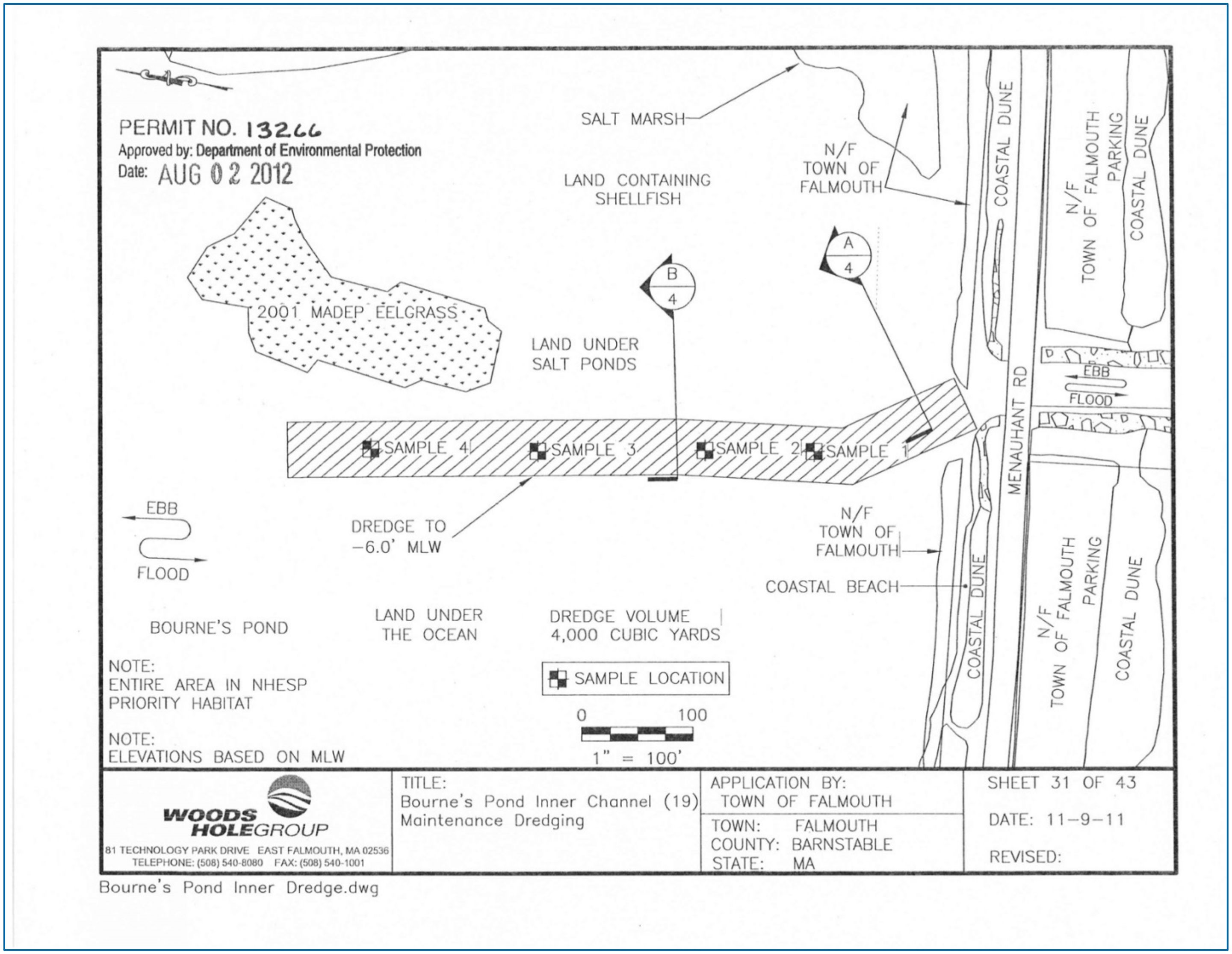


Figure 16. Permitted Bournes Pond channel north of the existing bridge.

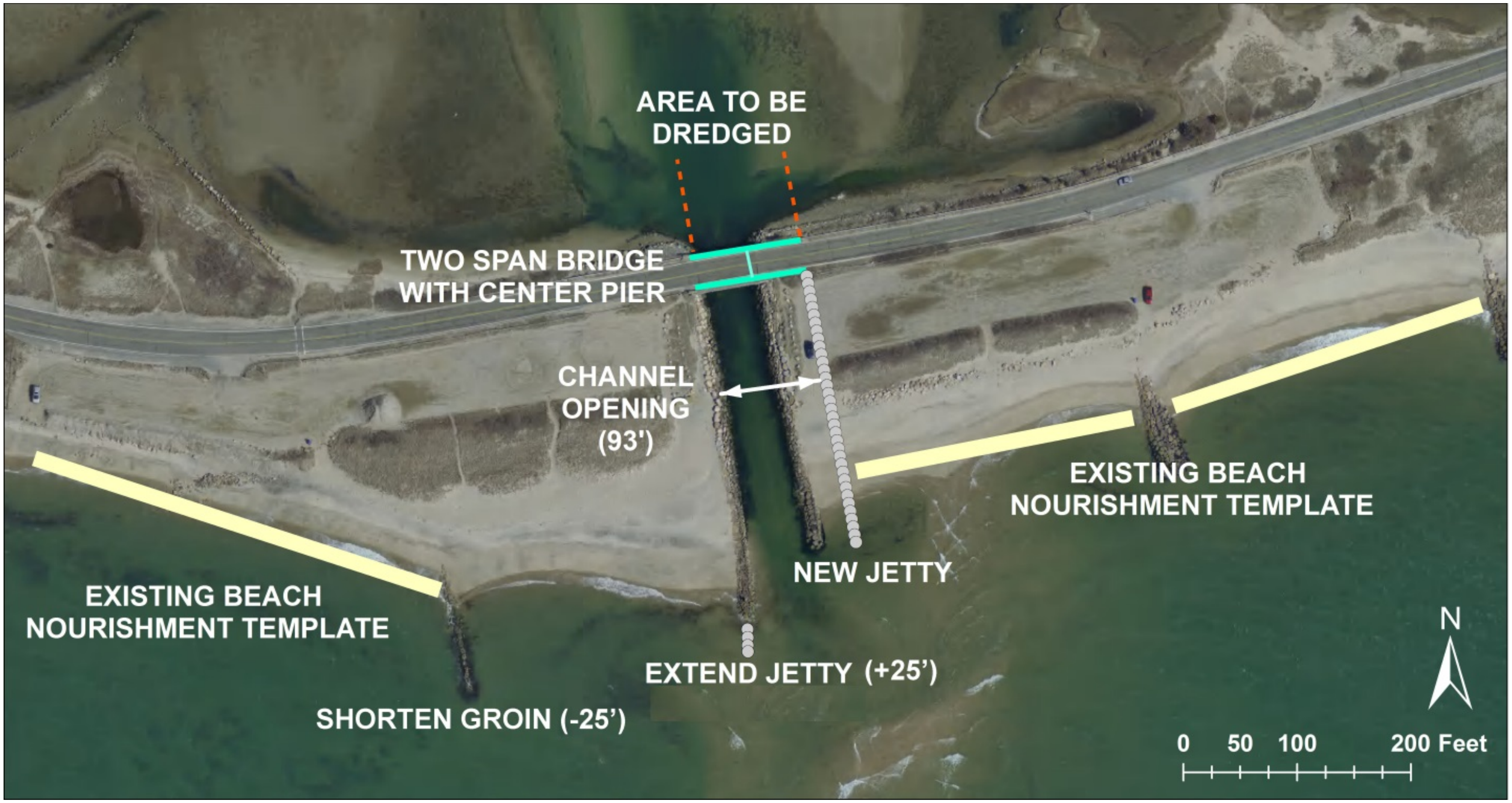


Figure 17. Proposed modifications to the channel and coastal engineering structures at Bournes Pond Inlet

# PRB at Sailfish Drive
# Flow Scenario #1:
# ~1000 kg
# ~1400 ft

# EPA-funded groundwater characterization in progress

Flow perpendicular to Sailfish Dr.

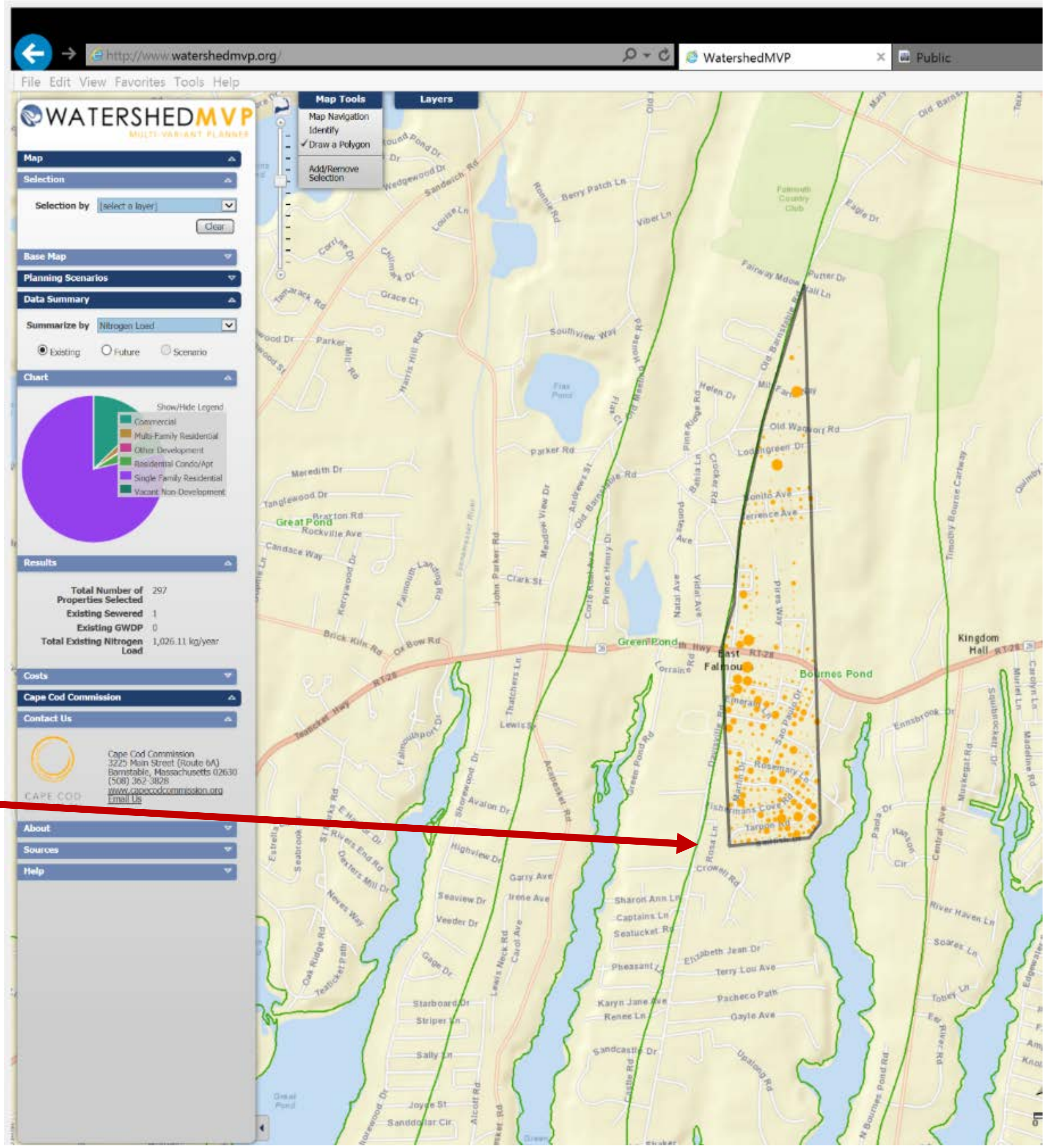


**Figure 18 - Potential PRB Locations in Fisherman's Cove**

# PRB at Sheila Way
# Flow Scenario #2:
# ~400 kg
# ~1400 ft

Flow perpendicular to shoreline

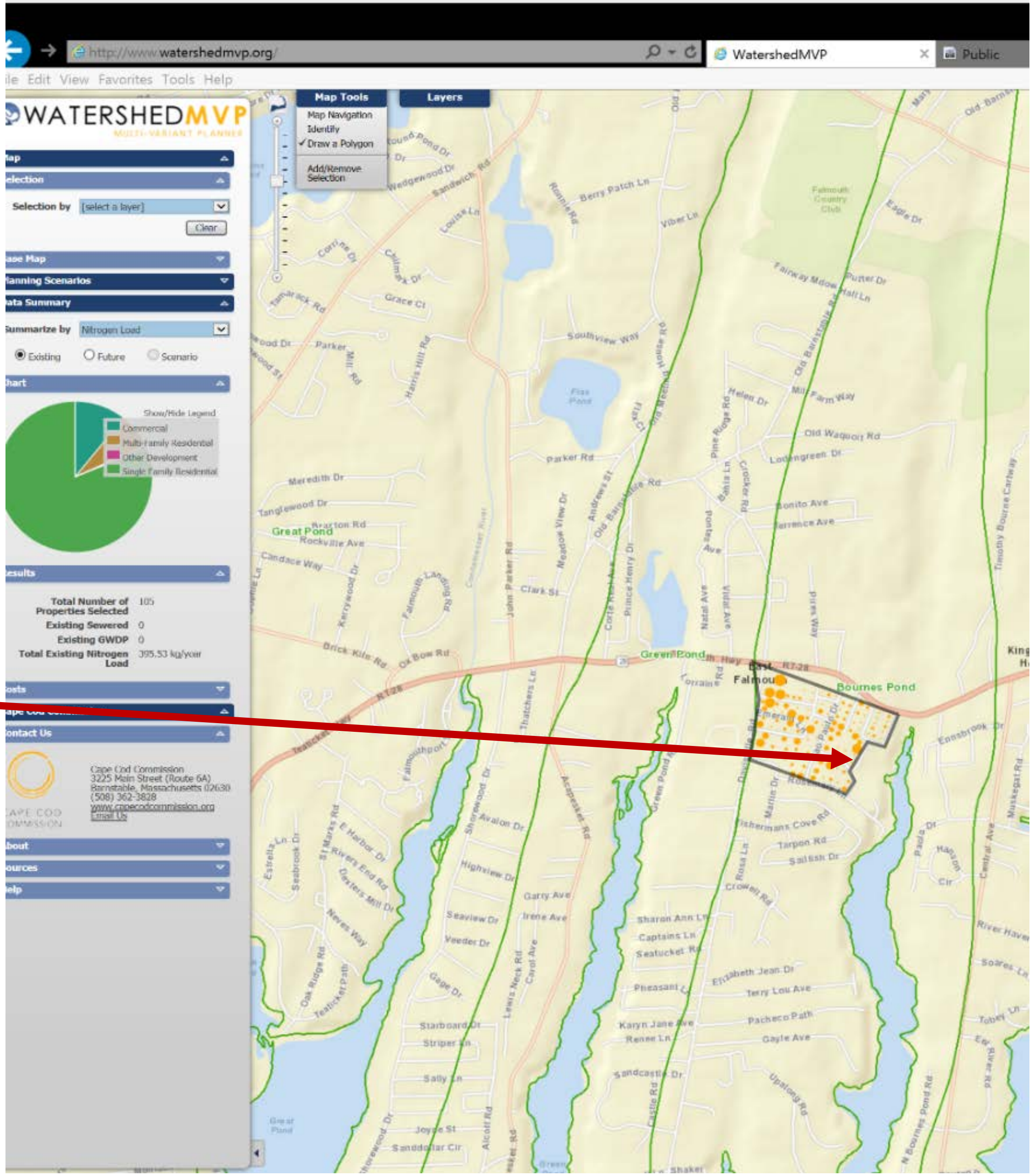


Figure 18 - Potential PRB Locations in Fisherman's Cove

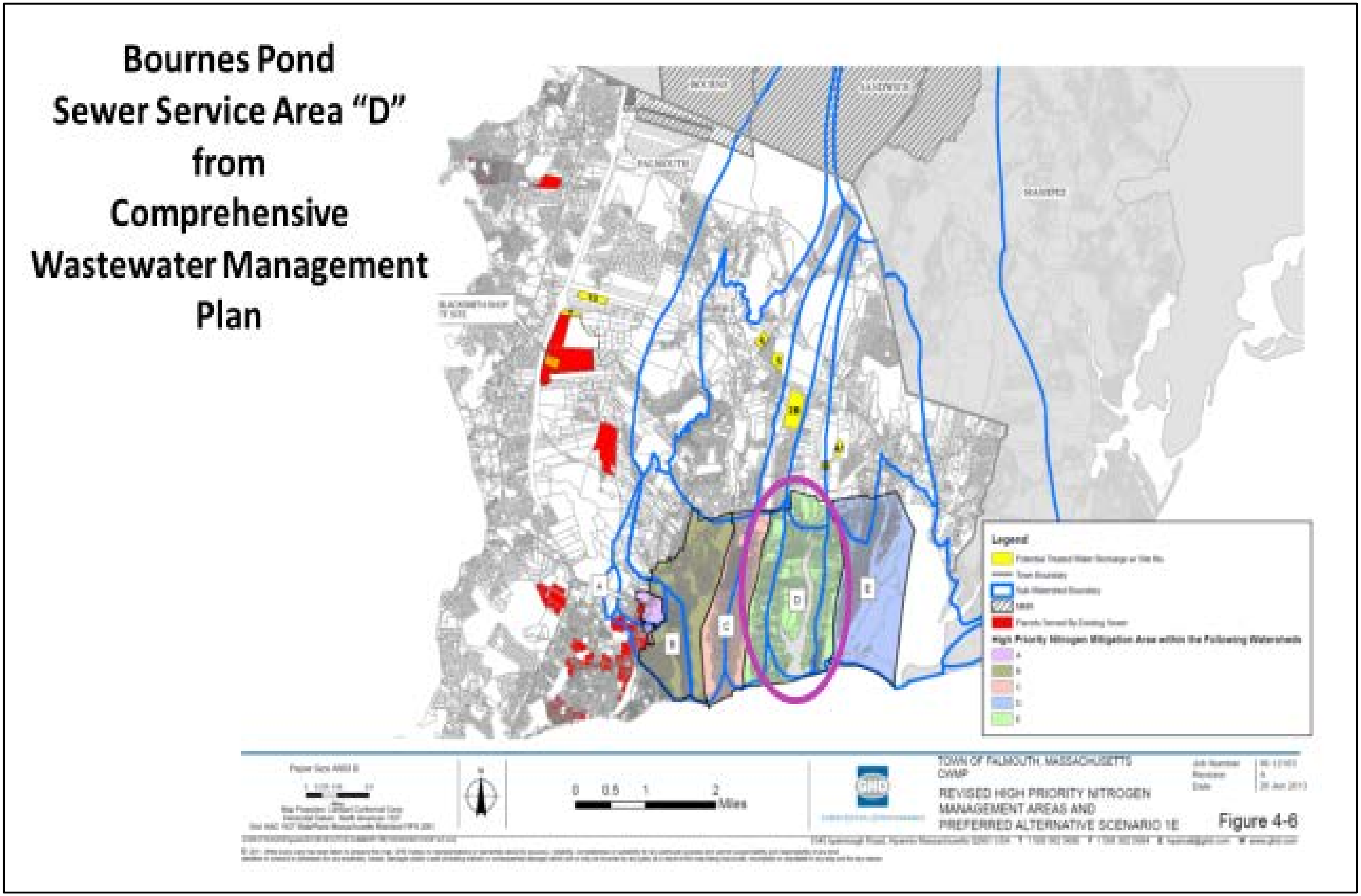


**Figure 19 – Bournes Pond Sewer Service Area "D" from Comprehensive Wastewater Management Plan**

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