Bournes Pond Inlet Opening Project
Background and Next Steps
Outline

– Project Background
  • Massachusetts Estuaries Project (MEP)
  • Comprehensive Wastewater Management Plan (CWMP)
  • Additional modeling and cost evaluations to evaluate a larger opening for Bournes Pond (Technical Memorandum BP-1)
  • Town decision-making and appropriation

– Next Steps
Massachusetts Estuaries Project (MEP)

- Evaluated Bournes Pond Nitrogen limits that became Nitrogen Total Maximum Daily Loads (TMDLs) as set by USEPA and MassDEP
- Identified that the amount of nitrogen mitigation for Bournes Pond and the costs to do that mitigation could be reduced if the inlet was enlarged
Falmouth Comprehensive Wastewater Management Plan (CWMP)
Detailed Modeling and Bridge Type Evaluations

- Hydrodynamic modeling identified an optimal opening size of 90 feet
- Water quality modeling estimated an effective nitrogen removal of 1,995 kg/year with the 90-foot opening
- Further evaluations were completed to identify the desired and lowest cost bridge type
Capital Cost Evaluations

<table>
<thead>
<tr>
<th>Capital Costs</th>
<th>Scenario 2: Double-Span Bridge</th>
<th>Scenario 4: Multiple Culvert Bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge and Road Work</td>
<td>2,500,000</td>
<td>2,600,000</td>
</tr>
<tr>
<td>Jetty Modifications and armoring</td>
<td>800,000</td>
<td>720,000</td>
</tr>
<tr>
<td>Dredging and Beach Nourishment</td>
<td>75,000</td>
<td>80,000</td>
</tr>
<tr>
<td>Permitting Allowance</td>
<td>300,000</td>
<td>300,000</td>
</tr>
<tr>
<td>Design</td>
<td>400,000</td>
<td>400,000</td>
</tr>
<tr>
<td>Engineering during Construction</td>
<td>520,000</td>
<td>520,000</td>
</tr>
<tr>
<td>Contingency (25%)</td>
<td>920,000</td>
<td>930,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5,520,000</strong></td>
<td><strong>5,550,000</strong></td>
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</tbody>
</table>
Cost Comparisons to Conventional Wastewater Nitrogen Management

– Evaluations indicated 273 to 407 houses would need wastewater management to remove 1,995 kg/yr. of nitrogen from the watershed
– This equals a capital cost of $12.8 to $19.1 M
– This is 2.3 to 3.4 times the cost of the new bridge at $5.52 M
Town Decision-Making and Appropriation, and Regulatory Approvals

- The Town approved the CWMP and the next steps for the Bournes Pond inlet opening
- The Spring 2014 Town Meeting appropriated (and the ballot vote supported) funds to proceed with CWMP recommendations including next steps for the Bournes Pond inlet opening project
- MEPA and CCC approved the CWMP and indicated that the Bournes Pond inlet opening should be reviewed as a Notice of Project Change (NPC) to the MEPA certificate

The first next step is to complete the Bournes Pond Inlet Opening Flooding and Coastal Erosion Analysis
Bournes Pond Inlet Widening

Hydrodynamics, Water Quality, Tidal Flooding, Coastal Erosion, and Relative Sea-Level Rise
Nonquitt Marsh, Dartmouth, MA
New culvert installed in Fall 2013

Before (2011)

After (2014)
Great South Bay, Fire Island, NY
Breached during Hurricane Sandy (2012)

Breach resulted in increased flushing of the bay and reduced brown tides (algal bloom).

Pleasant Bay, Orleans, MA
Breached in April 2007

Reduction in concentration of dissolved inorganic nitrogen after inlet breach
Selection of Bournes Pond
Selection of Bournes Pond

Tidal Restriction of the Inlet
- Reduced tide range
- Delay in tide phase
Refined Bathymetry Survey
Updated Tides

- Reduced tide range
- Delay in tide phase
MEP Model Grid

Improvements focused on inlet

Refined bathymetry

Updated tidal information
Modeled Currents

Max Flood Currents  Max Ebb Currents
Modeled Alternatives

Bournes Pond Inlet Velocities

Average Peak Inlet Velocities (ft/s)

Inlet Width (feet)

Sediment Movement Threshold

Flood Tide
Ebb Tide
Table 4-3. Average high, mid and low tide volumes, with mean tide prism for Bournes Pond, for existing inlet conditions, and for the proposed 90 ft-wide double span bridge inlet modification.

<table>
<thead>
<tr>
<th></th>
<th>existing inlet</th>
<th>90 ft-wide inlet</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean High Tide Volume</td>
<td>26,495,012 ft³</td>
<td>26,760,038 ft³</td>
<td>1.0%</td>
</tr>
<tr>
<td>Mean Tide Volume</td>
<td>20,628,030 ft³</td>
<td>20,290,713 ft³</td>
<td>-1.6%</td>
</tr>
<tr>
<td>Mean Low Tide Volume</td>
<td>14,761,049 ft³</td>
<td>13,821,388 ft³</td>
<td>-6.4%</td>
</tr>
<tr>
<td>Mean Prism Volume</td>
<td>11,733,963 ft³</td>
<td>12,938,650 ft³</td>
<td>10.3%</td>
</tr>
</tbody>
</table>
Existing

Widened Inlet

Northward Migration of Higher Quality Water
Reduction in Load = 1995 kg/year

Table 5-2. Comparison of sub-embayment watershed loads used for modeling of Present, Present with a 93-ft Double Span Bridge, and existing inlet with equivalent loading reduction to equal the widened inlet scenario of the Bournes systems. These loads do not include direct atmospheric deposition (onto the sub-embayment surface) or benthic flux loading terms.

<table>
<thead>
<tr>
<th>sub-embayment</th>
<th>present load (kg/day)</th>
<th>Widened Inlet (kg/day)</th>
<th>Widened Inlet % Change</th>
<th>Equivalent Load (kg/day)</th>
<th>% Change in Watershed Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bournes Pond</td>
<td>9.61</td>
<td>9.61</td>
<td>0.0%</td>
<td>4.14</td>
<td>-56.9%</td>
</tr>
<tr>
<td>Israels Cove</td>
<td>2.05</td>
<td>2.05</td>
<td>0.0%</td>
<td>2.05</td>
<td>0.0%</td>
</tr>
<tr>
<td>Surface Water Sources</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bournes Brook</td>
<td>3.29</td>
<td>3.29</td>
<td>0.0%</td>
<td>3.29</td>
<td>0.0%</td>
</tr>
</tbody>
</table>
Other Engineering Considerations

- Sea Level Rise
- Storms
- Flooding
- Coastal Erosion
Historical Sea-Level Trends - Woods Hole, MA

2.82 mm/year or 8.3 inches over 75-year design life
Relative Sea-Level Rise – Woods Hole
IPCC 2007 plus ice melt contribution

Relative Sea Level Rise at Woods Hole

- **IPCC (2007) low best estimate**
- **IPCC (2007) high best estimate**
- **IPCC with Rignot (2011)**

**Graph Details:**
- **Y-axis:** change from present MSL (feet)
- **X-axis:** Year

The graph shows the predicted relative sea-level rise at Woods Hole from 2010 to 2100, with different lines representing varying estimates and contributions from ice melt.
IPCC AR5 (2013) – “No Consensus” on the semi-empirical models...

Projections of 21st-century GMSLR under RCPs

*Medium confidence in likely ranges*

- **SPM Fig 9**
  - **RCP8.5**
    - 0.53–0.98 m by 2100
    - 8–16 mm yr\(^{-1}\) during 2081–2100
  - **RCP2.6**
    - 0.28–0.61 m by 2100

Mean over 2081–2100
The IPCC low and high best estimate predictions indicate that relative sea-level rise at Falmouth will be between 0.80 and 1.3 ft by 2090.
Storm Surge

Wave Action/Erosion
Last Major Hurricane 60+ Years Ago

Some scientists suggest that with continued warming, storm intensity is likely to increase while frequency may stay the same or decrease for the Atlantic region.
FEMA
Stillwater Flood Elevations
LiDAR Data
Developing the Coastal Flood Curve

Computed Surge from HEC-25

- $D = R/D =$ Half storm duration = 6 hours
- $Sp =$ Peak Surge Elevation = 3.1 feet
- $to =$ Time of peak surge or landfall = 00 hours

Constituent based Tidal Signal

Tide and Surge
Development of Flood Hydrograph Model Results
Rate of Shoreline Change

July 1938 (Pre-Storm) – September 2014
Contemporary Surveyed Shoreline Change
2004-2014
Number of years before the high water shoreline will migrate to the south edge of the roadway based on historical shoreline erosion rates between 2004 and 2014.
Vulnerable Coastlines

In Falmouth…
Woods Hole is the Most Vulnerable
Is the Erosion Manageable?

The Difference – 120,000 cubic yard of Nourishment in 1959
Conclusions

- Widening inlet from 50' to 90' does not increase flooding of residential properties.
- Regardless of width of inlet, during a 100 year storm surge, the entire barrier beach and adjacent upland areas are inundated.
- Any storm surge greater than 4.5' NAVD will overtop Menauhant Road.
- Broad range and uncertainty in sea level rise projections indicate that this issue may not be critical during the 75 year life of this project.
- Existing shoreline erosion west of the inlet threatens the stability of Menauhant Road in about 40 years.
- Beach nourishment can mitigate erosion.
Next Steps

– Additional Town presentation(s) and decision-making
– MEPA review of a Notice of Project Change to the CWMP
– Expected permitting to be requested in a MEPA approval:
  • Notice of Intent and Order of Conditions through the Falmouth Conservation Commission and MassDEP.
  • 401 Water Quality Certification through MassDEP.
  • Chapter 91 licensing through MassDEP.
  • 404 permitting through U.S. Army Corps of Engineers.
  • Coastal zone consistency reviews through Massachusetts Coastal Zone Management (CZM).
  • Massachusetts Endangered Species Act (MESA) permitting through the Massachusetts Natural Heritage and Endangered Species Program (NHESP).
– Design
– Construction
– Continued water quality monitoring