Elevating Roadway Improvements and Dune/Beach Nourishment along North Humarock for Improved Coastal Resiliency

Town of Scituate Public Informational Meeting

March 28, 2017
Study Purpose

To develop a conceptual plan for elevating a portion of Central Avenue along northern Humarock Beach and optimizing a dune/beach nourishment design to provide storm damage protection for repetitively damaged public and private infrastructure.
Task 1
- Kick-off Meeting

Task 2
- Initial Engineering Analysis to Screen Potential Alternatives
- Public Informational Meeting #1

Task 3
- Conceptual Design of Recommended Alternative

Task 4
- Develop Design Report
- Public Informational Meeting #2
- Educational Pamphlet
FEMA Flood Map
Effective November 4, 2016

All homes along North Humarock are located in VE zones.

VE Zones are coastal high hazard areas where wave action and/or high-velocity water can cause structural damage during the 1%-annual-chance (100-year) flood.
FEMA Flood Map

The purpose of the Flood Insurance Rate Maps (FIRMs) are for assessing flood risk for insurance.

Town is in process of developing a Letter of Map Revision (LOMR).

They provide a general guide for flood risk, but should be utilized in conjunction with other site-specific information for other purposes.
Storm Damage History

Jason Burtner, March 7, 2013

Nancy Durfee, January 24, 2017

William Schmid, January 24, 2016
### Storm Damage History

<table>
<thead>
<tr>
<th>Storm Date</th>
<th>Repetitive Loss Claims</th>
<th>Total Claims ($)</th>
<th>Return Period (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/6/1978</td>
<td></td>
<td></td>
<td>158</td>
</tr>
<tr>
<td>1/24/1979</td>
<td>4</td>
<td>$30,112</td>
<td>19</td>
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<tr>
<td>3/29/1984</td>
<td>2</td>
<td>$7,927</td>
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<tr>
<td>1/2/1987</td>
<td>10</td>
<td>$102,794</td>
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<tr>
<td>10/28/1991</td>
<td>38</td>
<td>$3,197,631</td>
<td>30</td>
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<tr>
<td>12/10/1992</td>
<td>32</td>
<td>$591,563</td>
<td>22</td>
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<tr>
<td>3/5/2001</td>
<td>11</td>
<td>$338,139</td>
<td>3</td>
</tr>
<tr>
<td>1/1/2003</td>
<td>4</td>
<td>$51,508</td>
<td>8</td>
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<tr>
<td>12/5/2003</td>
<td>2</td>
<td>$29,598</td>
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<tr>
<td>1/22/2005</td>
<td>2</td>
<td>$74,573</td>
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<tr>
<td>5/22/2005</td>
<td>3</td>
<td>$20,535</td>
<td>11</td>
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<td>4/15/2007</td>
<td>8</td>
<td>$49,587</td>
<td>15</td>
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<tr>
<td>2/23/2010</td>
<td>1</td>
<td>$36,204</td>
<td>2</td>
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<tr>
<td>12/16/2010</td>
<td>11</td>
<td>$236,165</td>
<td>13</td>
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<tr>
<td>2/7/2013</td>
<td>13</td>
<td>$445,427</td>
<td>4</td>
</tr>
<tr>
<td>3/4/2013</td>
<td>5</td>
<td>$154,052</td>
<td>3</td>
</tr>
<tr>
<td>1/2/2014</td>
<td>4</td>
<td>$90,609</td>
<td>17</td>
</tr>
<tr>
<td>1/26/2015</td>
<td>7</td>
<td>$509,160</td>
<td>11</td>
</tr>
</tbody>
</table>

**Blizzard of 1978**

**1991 No-Name Storm**

**Winter Storm Nemo**

**Winter Storm Juno**
Humarock Beach – Historical Inlet Positions (Breaching)  
Portland Gale - 1898
Likely range of global mean sea level rise by 2100:
- Low estimate 0.85 to 1.8 feet
- High estimate 1.5 to 2.7 feet

Boston Data: 2.81 mm/year = 0.92 feet in 100 years

IPCC, 2014
Extreme Water Levels

Approx. Water Elevation: 6.5 feet NAVD88
Jason Burtner, March 31, 2014

Legend
Ground Elevation
- Below 10-yr SWL
- Above 10-yr SWL
- Above 100-yr SWL

Water Elevation Return Period (years)
Sediment Sampling

- Sediment sampling completed by UMass on September 10, 2015 (summer) and March 23, 2016 (winter) along the entire beach.
- Additional samples collected by Applied Coastal on February 2, 2017 found mean sediment sizes of 36 mm and 26 mm for North Humarock.
Recommended Shore Protection Approaches

“The recommended shore protection approach for Humarock North is to **elevate Central Avenue**, construct dunes along the Humarock North, and nourish the beach along the entire Humarock North and South.”

**Dune/Beach Nourishment**
- Increase storm protection
- Reduce wave overtopping and overwash
- Reduce the need for post-storm roadway clearing
- Reduce overwash of sediment to the marsh
- Prevent breach between Humarock and Fourth Cliff

**Elevating Central Avenue**
- Maintain emergency egress during flood events
- Prevent still water flooding from the marsh side
- Prevent breach between Humarock and Fourth Cliff
Beach Nourishment
Beach Nourishment

Beach nourishment creates a wider beach to dissipate wave energy, thereby increasing protection to infrastructure and property currently threatened by overtopping and storm damage.
## Beach Nourishment

### Pros
- Restoration of the lost aerial and sub-tidal beach
- **Nourishment will provide wave dissipation and storm protection**
- **Nourishment will re-establish sediment supply to adjacent beaches**
- Creation of a recreational resource
- Repairs and maintenance funds may be provided by FEMA if nourishment is monitored

### Cons
- Impacts from covering of inter-tidal and sub-tidal habitats, benthic communities, and nearshore resources areas
- **Regular and episodic maintenance and re-nourishment required**
- Impacts to the community during construction

### Challenges
- Easements required if publicly funded
- Permitting concerns due to large project area footprint
- Significant cost – especially if upland source needed
Beach Nourishment – Winthrop Beach Example

Pre-nourishment
Beach Nourishment – Winthrop Beach Example

Before Nourishment

After Nourishment

Photo taken after Winter Storm Juno
Beach Nourishment – Winthrop Beach Example

April 2008

August 2013

March 2015
Nourishment Design – Influence of Project Length

- 1000 ft beach fill
- 2000 ft beach fill

Percentage of fill remaining vs. Time (years)

- 1000 ft beach fill
- 2000 ft beach fill

Time (years)
- 0
- 3
- 6
- 9
- 12
- 15

Percentage of fill remaining
- 100
- 75
- 50
- 25
- 0
Proposed Beach Nourishment Profile

**Graph Information:**
- **Proposed Nourishment (75 foot berm)**
- **LiDAR Profile**
- **Mean High Water**
- **10-year SWEL**
- **100-year SWEL**

**Key Points:**
- 75 ft
- 14 ft NAVD88
- 100 foot increase in high water beach width

**Graph Details:**
- Elevation (feet, NAVD88)
- Distance (feet)
Beach Nourishment Longevity

To nourish along North Humarock:
- Approximately 85 CY per foot of shoreline
- 5,000 feet of shoreline
- 425,000 CY of sediment
- Estimated construction cost: $14.5M
- Renourishment required every ~6 years
Beach nourishment is recommended if the nourishment length can be extended further south to increase the renourishment interval and area of storm protection.

<table>
<thead>
<tr>
<th>50-Year Lifecycle Cost Estimate</th>
<th>Beach Nourishment along North Humarock (5,000 ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Cost</td>
<td>$14,450,000</td>
</tr>
<tr>
<td>Renourishment Cost</td>
<td>$10,115,000</td>
</tr>
<tr>
<td>Renourishment Interval</td>
<td>6 years</td>
</tr>
<tr>
<td>Life Cycle</td>
<td>50 years</td>
</tr>
<tr>
<td>Inflation Rate</td>
<td>3%</td>
</tr>
<tr>
<td>Money Spent over 50 Years</td>
<td>$209,401,745</td>
</tr>
</tbody>
</table>
Constructed Dunes
## Constructed Dunes

Constructed dunes can provide storm damage protection by reducing flooding and overwash into the marsh. Regular maintenance and re-nourishment is required to maintain sufficient volume.

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Storm damage reduction during smaller storms</td>
<td>• Regular maintenance and re-nourishment required</td>
</tr>
<tr>
<td>• Reduced flooding and overtopping</td>
<td>• Dune alone may not provide enough protection from larger storms</td>
</tr>
<tr>
<td>• Dune nourishment life can be enhanced by adjacent beach nourishment</td>
<td></td>
</tr>
</tbody>
</table>

## Challenges

- Easements required if publicly funded
- Education of the public required to keep people off dunes
Cobble Dunes at Mann Hill Beach/Egypt Beach

Applied Coastal, May 10, 2016

Kevin Ham
The minimum dune volume required to prevent dune overtopping during a storm is estimated using FEMA’s “540 rule”. The “540 rule” states that dune volume is sufficient to protect against a 100-year storm when the volume seaward of the dune crest and above the 100-year still water elevation is greater than 540 square feet per linear foot of dune.
1994 Sacrificial Dune Project

- Designed for a 5-year storm (water levels of approximately 8 feet NAVD88)
- Sand placed from south end of Fourth Cliff to the Marshfield town line
- 49,000 cubic yards of nourishment
- Most of sand lost during Labor Day Storm (September 5, 1994, maximum water level of 5.5 feet NAVD88)
1994 Sacrificial Dune Project

Dune Volume = 134 sf
(does not satisfy 540 rule)
Proposed Constructed Dune Profiles

Top of wall

8 to 10 cubic yards/ft (designed)

50 cubic yards/ft

100 cubic yards/ft

75 to 125 foot increase in high water beach width
Reshaped profile based on Powell equations (1990) during a 10-year storm
Constructed dunes are recommended to reduce wave overtopping and overwash along North Humarock. At a minimum, the volume of the dune will adhere to FEMA’s “540 rule”. The dune can be redesigned during the project life to account for sea level rise.

Summary: Constructed Dunes

<table>
<thead>
<tr>
<th>50-Year Lifecycle Cost Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constructed Dunes along North Humarock (540 sf)</strong></td>
</tr>
<tr>
<td>First Cost</td>
</tr>
<tr>
<td>Maintenance Cost</td>
</tr>
<tr>
<td>Maintenance Cost Reoccurrence</td>
</tr>
<tr>
<td>Reconstruction Cost</td>
</tr>
<tr>
<td>Reconstruction Cost Reoccurrence</td>
</tr>
<tr>
<td>Life Cycle</td>
</tr>
<tr>
<td>Inflation Rate</td>
</tr>
<tr>
<td>Money Spent over 50 Years</td>
</tr>
</tbody>
</table>

1/3 of the cost for beach nourishment
Elevate Central Avenue
Elevate Central Avenue

Elevating flood-prone roads can improve emergency egress, reduce overwash and the need for debris clearing, and may also offer improved protection from breaching.

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Improves emergency egress during flood events</td>
<td>• Utilities must also be raised with the road (water, gas, electric, etc.)</td>
</tr>
<tr>
<td>• Reduces wave overwash and the need for debris clearing</td>
<td>• Impacts to the community from construction</td>
</tr>
<tr>
<td>• May offer improved protection from breaching</td>
<td></td>
</tr>
</tbody>
</table>

**Challenges**

• Some paved driveways may need to be filled to meet the new road elevation
Existing Elevation of Central Avenue
Issue #1: Existing Paved Driveways

- 32 out of 92 homes have paved/landscaped driveways
- In most cases, the driveways will need to be filled (partially or in entirety) in order to meet the new road elevation
Issue #2: New Driveways Sloping towards Homes

- Ideally, the road and driveway elevation would be the same in order to reduce still water flooding around the houses
- First floor living spaces, garages, non-elevated homes, and paved driveways may require that the driveway slope towards the house

Homes on the ocean side (east side of Central Avenue):
- Generally not an issue unless the new driveway slope is excessively steep (>6%)
Issue #2: New Driveways Sloping towards Homes

Homes on the river side (west side of Central Avenue):

Waves may overtop the road and rush down the driveways towards the marsh-side homes.

263 Central Avenue
Mostly elevated homes
10 Cliff Road South to 266 Central Ave

Homes on both sides of the road
265 Central Ave to 238 Central Ave

Mix of elevated and non-elevated homes
236 Central Ave to 178 Central Ave

Mix of elevated and non-elevated homes that are set close to road
176 Central Ave to 128 Central Ave
# Raise Road to 8.5 feet NAVD88

<table>
<thead>
<tr>
<th>Homes Affected</th>
<th>Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No issues</td>
</tr>
<tr>
<td>10</td>
<td>Paved driveways filled</td>
</tr>
<tr>
<td>7</td>
<td>Paved driveways filled</td>
</tr>
<tr>
<td>15</td>
<td>Paved driveways filled</td>
</tr>
</tbody>
</table>
Raise Road to 9.5 feet NAVD88

<table>
<thead>
<tr>
<th>Homes Affected</th>
<th>Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No issues</td>
</tr>
<tr>
<td>10</td>
<td>Paved driveways filled</td>
</tr>
<tr>
<td>7</td>
<td>Paved driveways filled</td>
</tr>
<tr>
<td>15</td>
<td>Paved driveways filled, Steep sloping driveways</td>
</tr>
<tr>
<td>Homes Affected</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
</tr>
<tr>
<td>0</td>
<td>No issues</td>
</tr>
</tbody>
</table>
| 10            | Paved driveways filled  
Steep sloping driveways |
| 7             | Paved driveways filled |
| 15            | Paved driveways filled  
Steep sloping driveways |
Raise Road to 11 feet NAVD88

<table>
<thead>
<tr>
<th>Homes Affected</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No issues</td>
</tr>
<tr>
<td>10</td>
<td>Paved driveways filled</td>
</tr>
<tr>
<td></td>
<td>Sloping driveways towards homes</td>
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<tr>
<td>9</td>
<td>Paved driveways filled</td>
</tr>
<tr>
<td></td>
<td>Steep sloping driveways</td>
</tr>
<tr>
<td>17</td>
<td>Paved driveways filled</td>
</tr>
<tr>
<td></td>
<td>Steep sloping driveways</td>
</tr>
</tbody>
</table>
Proposed Road Elevation Increase
Summary: Elevate Central Avenue

Elevating Central Avenue is recommended to maintain emergency egress during still water flooding events. Because portions of the existing road are extremely low, the maximum proposed elevation is recommended to compensate for future sea level rise. At a minimum, the road should be elevated above the existing 10-year still water elevation (8.3 feet NAVD88).

Cost estimate to be determined during conceptual design.
Next Steps

• A **conceptual design** will be developed for constructed dunes and elevating Central Avenue
  - Conceptual level plans will be developed as the basis for preliminary discussions with stakeholders, regulatory agencies, and financial considerations
  - The design will include a more detailed breakdown of project costs
  • **Mid-May 2017**

• **Public presentation** to present the conceptual design efforts
  - An educational pamphlet will be developed to highlight design elements and why they are needed to address long-term sustainability goals for the beach
  • **Early-June 2017**

• **Technical report** that includes a description of the methods, appropriate tables and figures of analysis results, and recommendations for the conceptual design
  • **Mid-June 2017**