Town of Orleans

Community Resilience Building Workshop Summary of Findings

June 2019

Contents

Town of Orleans
Community Resilience Building Workshop
Summary of Findings

Overview:

The need for municipalities, regional planning organizations, states and federal agencies to increase resilience and adapt to extreme weather events and mounting natural hazards is strikingly evident amongst the communities of coastal Massachusetts. Recent events such as successive March 2018 nor'easters, and heavy rain and wind events during the summer of 2018 have reinforced this urgency and compelled communities like the Town of Orleans to proactively plan and mitigate potential risks through a community driven process. Ultimately, these efforts will reduce the vulnerability of Orleans' citizens, facilities and ecosystems, and serve as a model for other Massachusetts communities.

In the fall of 2018, with funding from the Executive Office of Energy and Environmental Affairs Massachusetts Municipal Vulnerability Preparedness Program, the Town of Orleans contracted with the Woods Hole Group to implement the Community Resilience Building (CRB) process while also using components of the CRB process to update the Town's Multi-Hazard Mitigation Plan. A municipal-based core team was established to organize and implement an 8-hour CRB Workshop on February 8, 2019. The goal of this workshop was to engage and educate community stakeholders to facilitate the development, planning and ultimately, the implementation of priority adaptation actions. The list of workshop invitees and workshop content was guided by input from the municipal core team and consultants from Woods Hole Group. The Workshop's central objectives were to:

- Define top local natural and climate-related hazards of concern;
- Identify existing and future strengths and vulnerabilities;
- Develop prioritized actions for the Community; and
- Identify immediate opportunities to collaboratively advance actions to increase resilience.

Twenty-nine (29) participants from town departments/committees/boards, community organizations, local businesses, and regional transportation and energy companies were in attendance for the workshop, which employed a community-driven workshop process following the Community Resilience Building (CRB) framework (www.CommunityResilienceBuilding.com). The CRB's Risk Matrix format, large-scale maps of Town (Appendix A & B), and various datasets on natural hazards (Appendix C & D) were integrated into the workshop process to provide both decision support and risk visualization for workshop participants. The workshop included a combination of large group presentations and small group discussions. The large group presentations outlined the workshop process and goals, presented relevant hazard and community data, and shared example actions. Participants also had an opportunity to work together in small groups consisting of 7 to 8 people with different roles, responsibilities and expertise to foster an exchange of ideas and perspectives. Spokespersons from the small groups then reported their findings back to the larger group. This workshop process, rich with information and experiences shared amongst the participants, produced the findings detailed in this summary report. This report provides an overview of the top hazards, current concerns and challenges, strengths and vulnerabilities, and recommended actions to improve the Town of Orleans' resilience to natural and climate-related hazards today and in the future.

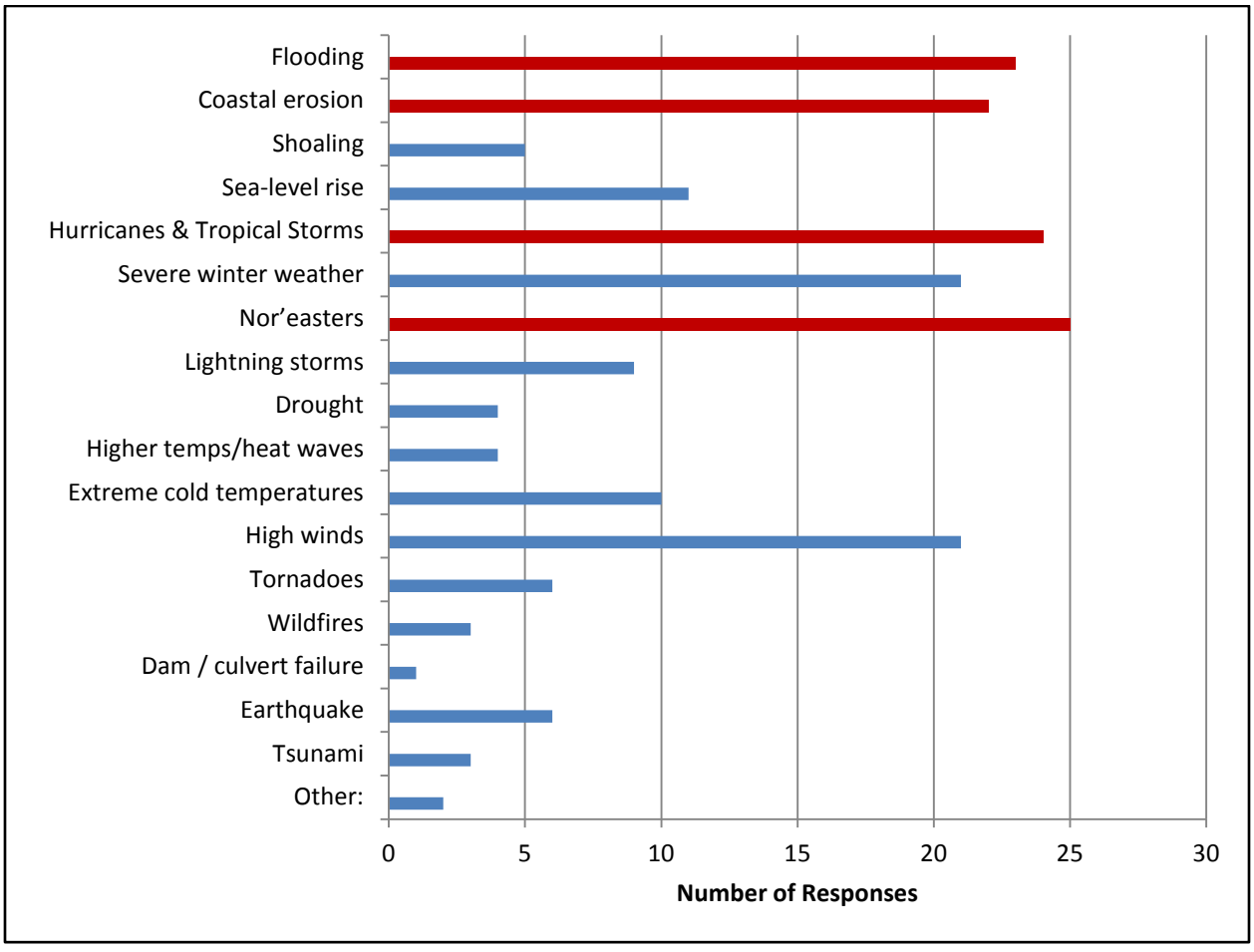
Workshop participants and other interested stakeholders are encouraged to provide comments, corrections and updates on the summary of findings described in this report. The Town of Orleans' ongoing community resilience will benefit from the participation of all those concerned.

Top Hazards and Vulnerable Areas

Prior to the Community Resilience Building Workshop held on February 8, 2019, invited workshop participants were asked to identify the top natural hazards for the Town of Orleans as part of a pre-workshop online survey. Nor'easters, hurricanes and tropical storms, flooding, and coastal erosion were identified as the hazards of greatest concern. Severe winter weather and high winds were also identified as major concerns for the Town. Although these hazards were not specifically addressed as "top hazards" during the CRB Workshop process, the impacts from these hazards overlap with hazards that were specifically addressed (i.e., Nor'easters and Hurricanes and Tropical Storms).

Top Hazards

- Nor'easters
- Hurricanes & Tropical Storms
- Flooding
- Coastal Erosion



Vulnerable Areas

Populations and Neighborhoods: Areas of subsidizing and public housing (Rock Harbor Village, Tonset Woods, etc.), concentrations of elderly populations (nursing home, senior housing, etc.), other vulnerable populations (mobility impaired, health risks, homeless, etc.), and neighborhoods that can be isolated during a flood event (Rock Harbor Village, Mayflower Point).

Ecosystems: Nauset Beach, which has been experiencing severe erosion, Skaket Beach, large estuaries in Town (Nauset Estuary and Pleasant Bay), shoaling that is occurring near the inlets and within the estuaries, mature trees resulting in large limbs overhanging powerlines, and aquaculture and shellfish beds.

Infrastructure and Transportation: Low-lying coastal roadways (Herring Brook Way, Main Street, River Road, Rock Harbor Road, Bridge Road, Quanset Road and Route 28 along Pleasant Bay), Orleans/Eastham rotary, septic systems, the electrical distribution system, including overhead electricity and utility wires, inadequate stormwater drainage systems and boat landings (Mill Pond Road and Sparrowhawk Road landings) and marine fuel storage depots (Arey's Boat Yard, Goose Hummock, Rock Harbor, Paw Wah).

Facilities: Snow Library, Community of Jesus, Senior Center, the schools (Orleans Elementary and Middle School), and the lack of local emergency shelter.

Current Concerns and Challenges Presented by Hazards

The Town of Orleans has many concerns and faces multiple challenges related to the impacts of natural hazards. In recent years, Orleans has experienced a series of highly disruptive and damaging weather events, including three successive nor'easters in March 2018, as well as significant rainfall events, such as the >4 inches of rain that fell within a few hours in August 2018. The impacts from recent nor'easters included significant coastal erosion at Nauset Beach, resulting in the loss of more than 50 feet of coastal dune and irreparable damage to Liam's snack shack, as well as coastal flooding and high winds resulting in many downed trees blocking roads and disrupting the electrical supply to many areas of Town. The frequency of these storms in March 2018 exacerbated the impacts, as the Town was still recovering from the last storm when the next one arrived. The magnitude and severity of the impacts of these storms produced a heightened level of awareness in Town and provided additional motivation to comprehensively improve resilience and reduce local vulnerabilities to natural hazards.

This series of extreme weather events highlighted that impacts from hazards are felt differently across the Town from the low-lying coastal areas to the forested uplands to the more developed downtown area. The barrier beaches separating Pleasant Bay and Nauset Estuary from the Atlantic Ocean are exposed to the full force of wave action, storm surge and high winds. During a major storm event, these barrier systems experience significant erosion, areas of over wash, shifting inlets, and excessive shoaling in the estuaries. The forested inland areas experience the effects of tree damage from wind, snow and ice, as well as hazards from inland flooding along roads due to poor drainage. The combination of these issues presents a challenge to emergency preparedness and response, and requires comprehensive yet tailored actions for establishing mitigation priorities for different areas of Town.

The workshop participants were generally in agreement that the Town of Orleans is experiencing more intense and frequent storms. The impacts, particularly during the series of March 2018 nor'easters, affected the daily activities of every resident. Low lying coastal roads are experiencing greater impact from major storms, and increases in severe rain events are resulting in routine flooding of certain major roadways where stormwater systems are inadequate to effectively divert rainwater. Additionally, there was a general concern that a long-range plan needed to be developed for how to manage the marine fuel depots, to minimize the risk of spills and pollution during flood and storm events.

Specific Categories of Concerns and Challenges

Vulnerability of Marine Fuel Depots and Landings

One of the primary concerns expressed by participants was the vulnerability of marine fuel storage facilities at various marinas and landings. Given the increasing hazards presented by flooding, sea-level rise and storm surge, participants felt that action should be taken to mitigate risk from these potential pollution sources. Concern was also expressed about the extremely low elevation and ongoing erosion occurring at some of the landings, specifically Mill Pond Road and Sparrowhawk Road Landings.

Utility (Electrical and Water) Distribution Systems

Electric service outages can be caused by a number of different natural hazard types, but most notably by high winds and heavy snow. The power distribution system was cited as one of the most critical pieces of infrastructure in Town, which can impact all residents regardless of where they live. Mature trees and overhanging limbs along roadways are a primary culprit because they can bring down power lines if they are toppled by high winds. Power interruptions due to storms can cause outages to heating or cooling systems, prohibit proper food storage and refrigeration, and generally disrupt daily life. Workshop participants identified elderly populations, the mobility impaired and low income residents as being particularly at risk during electric service outages.

The Town has a large watershed management area, which contains a wellfield that provides residents in the Town with drinking water. There was a concern from multiple groups about the longevity and security of these wells as a source of drinking water given the threat of salt water intrusion as sea-level rises. Participants also expressed concerns about access to the Town wells during storms due to downed trees or fire, and the fact that private wells do not function without electricity.

Roadway Flooding

Coastal flooding (e.g., standing flood waters, storm surge, and resulting erosion) presents a major threat to the Town's low-lying coastal roadways, including Herring Brook Way, Main Street, River Road, Rock Harbor Road, Bridge Road, Quanset Road and Route 28 along Pleasant Bay. Recent flooding events prompted participants to consider the future impact of coastal flooding if the extent or frequency of this hazard were exacerbated by sea-level rise, and to consider mitigation actions that would allow usable transportation corridors during flood events. Of particular concern is that coastal flooding has and will continue to inundate roads and neighborhoods, isolating certain areas from the rest of Town, and making it difficult for first responders and other services to access those areas during emergencies.

In addition to coastal flooding, key roadway areas in Town also experience significant flooding during heavy rainfall events. Stormwater systems are currently inadequate to handle the volume of precipitation produced by these large rain events, resulting in impassible roadways, inaccessible parking lots and businesses, and stranded vehicles.

Beach and Coastal Erosion

All small working groups also identified ongoing erosion along Orleans' Atlantic coastline as a point of concern. Nauset Beach, the Town's only ocean-facing public beach, was noted as a location of particular concern. Orleans' coastline is not only vital to the character of the Town, but this barrier beach system also provides valuable tourism and recreation benefits, vital habitat for threatened and endangered species, such as piping plovers and other nesting shorebirds, and provides the first line of defense for the Town against coastal storms, flooding, wave action and storm surge. Participants expressed concern about the ongoing erosion occurring at Skaket Beach along Cape Cod Bay and at a number of the smaller landings (e.g., Mill Pond Road) as well.

Lack of a Local Shelter

Should the need arise, residents of Orleans are currently directed to the regional emergency shelter located at Nauset High School in Eastham. There was a general concern expressed by the participants about the lack of an overnight shelter facility located within Orleans itself. This concern revolved around the uncertainty about whether roadways to Eastham would be passable and/or if the regional shelter would be have adequate capacity in the case of a severe event.

Current Strengths and Assets

As a result of Orleans' recent experiences with extreme weather, the Town is well acquainted with its existing strengths. Reinforcing and expanding these supportive practices and assets will improve resilience against future storms, with greater frequencies and intensities. Additional planning will help the Town address anticipated increases in storm surge, sea-level rise and precipitation.

- Orleans' first responders and emergency personnel have proven to be key assets during recent natural hazards. Participants highlighted effective interdepartmental coordination as a key strength. Responsive and committed Town leadership and staff are an important asset to Orleans, both in day-to-day operations, as well as during and immediately following a natural hazard or an emergency event.
- Piers and landings were considered a strength. In a Town that includes so much coastline along various waterbodies and embayments, multiple piers and landings are important to provide emergency responders with ready access to various locations.
- The Town's solar farm is a key strength by allowing the Town to draw from renewable energy sources, reduce its carbon footprint and move towards energy independence.
- Town well field is a local, reliable source of drinking water.
- Barrier beaches, marshes and estuaries along Orleans' coasts were recognized as an important buffer, offering the first line of defense against storms through storm surge attenuation and reduction of wave energy. Without these natural resources in place, the Town's coastal and inland infrastructure and homes would suffer greater damage during storm events.
- The presence of the Cape Cod National Seashore in portions of Orleans, means that the natural resources have been well protected and are therefore more resilient to be able to respond to natural hazards and climate change impacts. In addition, the National Seashore can provide aid to Orleans during an emergency, including federal staff and equipment resources.
- Key facilities in Town have proven to be important strengths. The Council on Aging, Snow Library, the Community of Jesus can all serve as gathering places during a natural hazard event.

Top Recommendations to Improve Resilience

A common thread throughout the Workshop discussions was the recognition that the Town and residents need to be better prepared through longer-term, community-based, contingency planning across key areas of concern. This and additional core highlights are addressed below. The following were the top five actions selected by workshop participants.

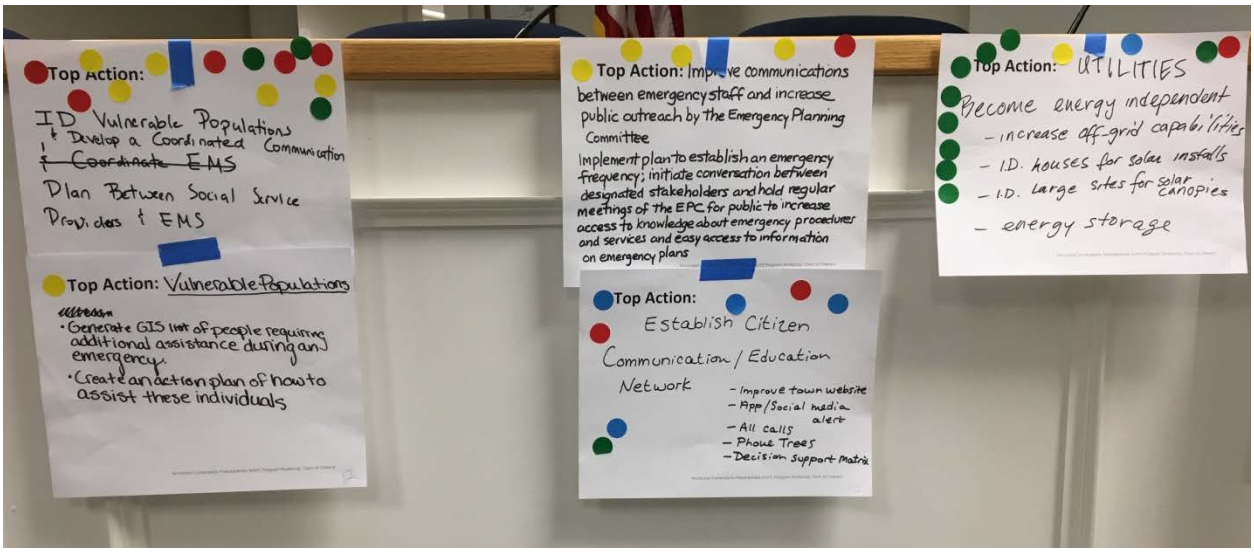
1. **Vulnerability Assessment of Coastal Fuel Depots & Implement Spill Prevention Measures**:
   Conduct a vulnerability assessment of fuel depots, town landings, and hazardous materials storage facilities in coastal areas. This may include an alternatives assessment for the best marine fueling and storage options to minimize spill and pollution risks. Based on the results of the assessment, develop and implement plans to address storm surge and wave impacts, sea-level rise, and potential spill risks. The Town has already identified the most vulnerable bulkheads. Actions may include replacement and repair of priority bulkheads (i.e., bulk heads found to be essential to the safe storage of marine fuel depots).

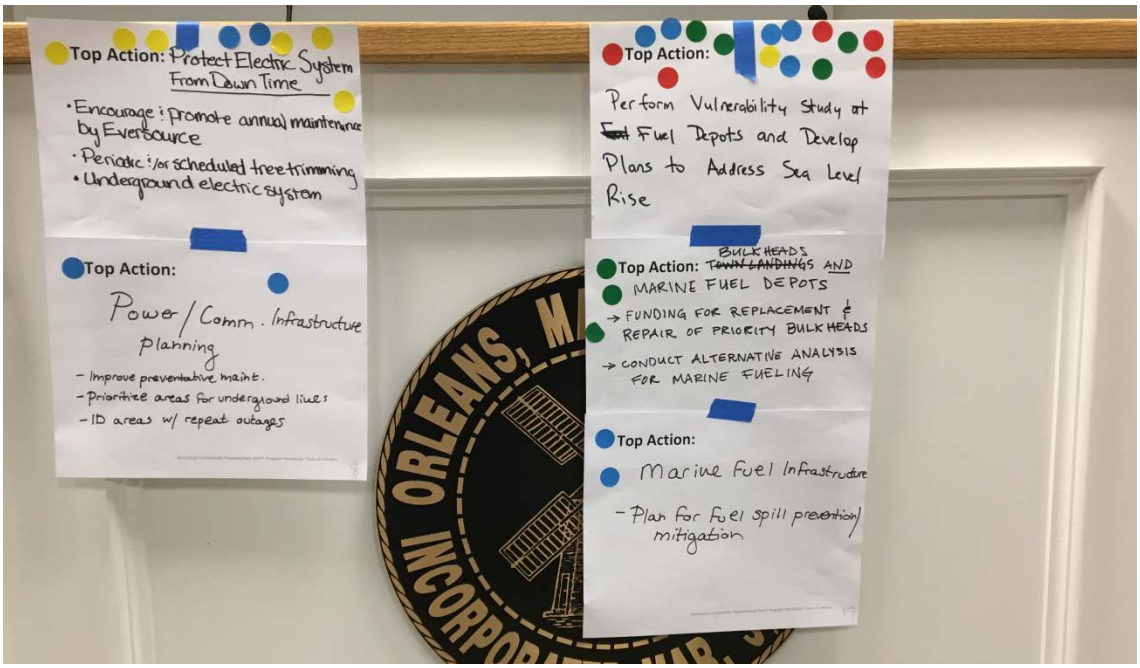
2. **Identify Vulnerable Populations to Aid in Emergency Response:**
   Generate a spatial database of people requiring additional assistance during an emergency, including contact information, details on potential needs and restrictions, as well as an action plan for how to assist these individuals. This may involve the development of a coordinated communication and action plan between social service providers and emergency responders.

3. **Become Energy Independent:**
   Orleans should work towards increasing its off-grid capabilities. Actions could include identifying houses that would be suitable for solar installations and large sites that would be suitable for solar canopies, as well as developing energy storage capabilities for existing solar facilities.

4. **Improve Public Outreach and Communication:**
   This could include the establishment of a citizen communication and/or education network, improvements to the Town website, development and posting of social media alerts, all calls, phone trees and/or a decision support matrix. The Emergency Planning Committee (EPC) could take the lead on public outreach related to emergency response. Dissemination of information could be initiated from the EPC to designated stakeholders. EPC meetings could also be held with more frequency and be open to the public to increase general knowledge about emergency procedures and services, as well as what emergency plans are already in place.

5. **Evaluate and Address Flood Risks to Low Lying Roads:**
   Conduct a coastal roads vulnerability assessment to determine the risks from flooding and wave impacts and to identify priority areas. Design and implement (perhaps using a phased approach) flood mitigation measures. Solutions may include updates or repairs to culverts, installation of tide gates, or elevation of roadways. Roadways of particular concern include Skaket Beach Rd, Mayflower Pt, Rock Harbor Rd, Quanset Rd, Jeremiah's Gutter, and the Intersection of Rt 28 and Tar Kiln Rd. The Town should also seek outside funding for implementing these actions.


Top Action:
ID Vulnerable Populations & Develop a Coordinated Communication & ~~Coordinate EMS~~ Plan Between Social Service Providers & EMS
Top Action: Vulnerable Populations
Actions
• Generate GIS list of people requiring additional assistance during an emergency.
• Create an action plan of how to assist these individuals
Top Action: Improve communications between emergency staff and increase public outreach by the Emergency Planning Committee
Implement plan to establish an emergency frequency; initiate conversation between designated stakeholders and hold regular meetings of the EPC for public to increase access to knowledge about emergency procedures and services and easy access to information on emergency plans
Top Action:
Establish Citizen Communication / Education Network
- Improve town website
- App/Social media alert
- All calls
- Phone Trees
- Decision Support Matrix
Top Action: UTILITIES
Become energy independent
- increase off-grid capabilities
- I.D. houses for solar installs
- I.D. large sites for solar canopies
- energy storage


Top Action: Protect Electric System From Down Time
• Encourage : promote annual maintenance by Eversource
• Periodic : or scheduled tree trimming
• Underground electric system
Top Action:
Power / Comm. Infrastructure Planning
- Improve preventative maint.
- Prioritize areas for underground lines
- ID areas w/ repeat outages
Top Action:
Perform Vulnerability Study at ~~Fuel~~ Fuel Depots and Develop Plans to Address Sea Level Rise
Top Action: ~~TOWN LANDINGS~~ BULK HEADS AND MARINE FUEL DEPOTS
→ FUNDING FOR REPLACEMENT & REPAIR OF PRIORITY BULK HEADS
→ CONDUCT ALTERNATIVE ANALYSIS FOR MARINE FUELING
Top Action:
Marine Fuel Infrastructure
- Plan for fuel spill prevention/ mitigation
ORLEANS, MA
INCORPORATED

In addition to the top five priority actions chosen by the workshop participants, the participants also developed a larger series of recommended actions, which they prioritized into "high", "medium" and "low" priority actions:

Other high priority actions:

- Implement the Phased Nauset Beach Retreat Plan, evaluating and updating the plan as needed to incorporate updated data. Implementation of the plan may include, but is not limited to, dune nourishment, land acquisition for future parking and facilities locations, design, permitting and construction of various aspects of the project, and generally enhancing the overall resiliency of the barrier system.
- Develop a local sheltering network and plan, which may include identifying potential facilities and the necessary services that would need to be provided, and formalizing the "shelter-in-place" plan.
- Protect utility infrastructure. This may take the form of preventative maintenance to the utility infrastructure itself, which would involve additional communication with Eversource to encourage and promote annual maintenance, periodic and/or scheduled tree pruning, prioritizing areas for moving powerlines underground, and/or identifying areas of Town with repeat power outages. The Town could request annual reporting from Eversource to improve understanding of what actions they have taken in the past year and what actions they are planning to take in the coming year.
- Address the flood risk in the vicinity of the Orleans-Eastham Rotary. The rotary, and the main roads connecting to the rotary, not only serve as regional transportation corridors and evacuation routes, but also provide vital access to major commercial areas. A flood vulnerability assessment should be performed for the rotary and the nearby drainage areas known as Jeremiah's Gutter. Solutions should address a regional approach and raise awareness of the risks, with the goal of providing a reliable evacuation route, even during a flood event, and the increased likelihood of this risk in the future given climate change and sea-level rise.
- Address inadequate stormwater handling resulting in roadway flooding. Design and install an adequate drainage system to remediate stormwater flooding that currently results in impassible roadways and inaccessible parking areas.
- Work on getting generators for areas of concentration housing. Create provisions for generator installation for densely concentrated neighborhoods and/or areas of public housing. Target areas could include RH Village, Tonset Woods and Old Colony.
- Create a Personal Care Center that could serve as a charging station, warming center, and provide key amenities (i.e., a place to cook, shower, etc.) that residents can go to during the day when a natural hazard event results in power outages.
- Revisit the countywide EMS plan to address sub-regional needs, including standardized communications and instituting a post-storm action report.
- Conduct a tree inventory, which would identify at risk trees and recommend where to plant new ones. This may require the purchase of a new inventory mapping software.
- Monitor the potential of salt water intrusion to Well #7.

- Address flooding and coastal erosion at town landings. Ongoing coastal erosion at Mill Pond Road landing is currently undermining the roadway, water main and other infrastructure. Additionally, the low existing elevations at Mill Pond Road and Sparrowhawk Road landings result in frequent flooding of these assets, prohibiting use during certain tides.

Other medium priority actions:

- Revise local building and design standards to provide increased resiliency under future SLR scenarios.
- Ensure continued service at key businesses (i.e., grocery stores, hardware stores, etc.) during a hazard event. Access to vital resources allows neighborhoods to provide for themselves if access out of Town is blocked, and allows for faster recovery. Food security was raised as an important concern.
- Assess the need for backup power sources (i.e., generators) at municipal facilities that serve the public (i.e. schools, library, etc.).
- Identify coastal areas that could serve as zones of transition around Pleasant Bay and Nauset Estuary and to manage those areas to increase resiliency of the salt marsh and estuarine ecosystem to sea-level rise.
- Obtain permits for dredging in Pleasant Bay and Nauset Estuary, and implement dredging work. Emphasis should be placed on beneficial reuse within the system as appropriate.

Other low priority actions:

- Build a Town of Orleans Community Center. The Town currently lacks a centralized location for community engagement, youth and adult recreational programs, and, most for a local emergency shelter location. There are existing locations in Town that could serve as warming or charging stations during the day in the event of an emergency, but due to the extensive Red Cross requirements to establish a full overnight emergency shelter facility, the Town would need to establish an entirely new site to serve as a local emergency shelter. When not in use during an emergency, it could serve the community in other ways listed above.
- Conduct thorough site plan reviews during redevelopment, reduce construction of impervious surfaces, and initiate guidelines for new development and redesigns.

CRB Workshop Participants

Below is a table of workshop participants.

Name	Department/Affiliation
Lynn Bruneau	Orleans Finance Committee
Bob Rich	Orleans Water & Sewer Commissioner
Lee Andre	Community of Jesus
Len Short	Orleans Water & Sewer Board
Mefford Runyon	Orleans Board of Selectmen
Kevin Higgins	Orleans Police Department
Lauren McKean	Cape Cod National Seashore
David Light	Agricultural Advisory Committee
Tony Pike	Orleans Fire Department
George Meservey	Orleans Planning Department
Kristen Boyd	Cape Cod Regional Transit Authority
John Kennedy	Cape Cod Regional Transit Authority
Jeffrey Soares	Senator Julian Cyr's Office
Kevin Galligan	Orleans Board of Selectmen
Mike Brink	Orleans Conservation Commission
Geof Deering	Orleans Fire Department
Brian Junkins	Friends Market
John Jannell	Orleans Conservation Department
Nate Sears	Orleans Natural Resources Department / DPW
Terri Smith	Center for Coastal Studies
Brenda Halliday	The Learning Garden
Bill Ciucca	National Grid
Mon Cochran	Friends of Pleasant Bay / Orleans Open Space Committee
Bob Canning	Orleans Health Department
Tavi Prugno	Orleans Snow Library
Judi Wilson	Orleans Council on Aging
Alan McClennen	Orleans Board of Selectmen
Sims McGrath	Orleans Board of Health
Andrea Reed	Orleans Planning Board

Below is a table of additional entities that were invited but were unable to attend.

Department/Affiliation	Department/Affiliation
Town Administrator's Office	Eversource
Orleans Building Department	Verizon
Orleans School Department	Comcast
Orleans Water Department	MassDOT
Orleans Historical Commission	Orleans Inn
Orleans Housing Authority	Snows Home & Garden
Pleasant Bay Resource Management Alliance	Nauset Marine
Orleans Conservation Trust	Arey's Pond Boat Yard
Orleans Pond Coalition	Goose Hummock Marina
Terraces Orleans	

Recommended Citation

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CRB Workshop Project Team

Town of Orleans:

George Meservey, Planning Department Director (Project Lead – Principal Contact)
Nate Sears, Department of Natural Resources (Core Team Member)
John Jannel, Conservation Department (Core Team Member)
Tom Daley, DPW (Core Team Member)
Sue Brown, Water Department (Core Team Member)
Scott MacDonald, Police Department (Core Team Member)
Tony Pike, Fire Department (Core Team Member)

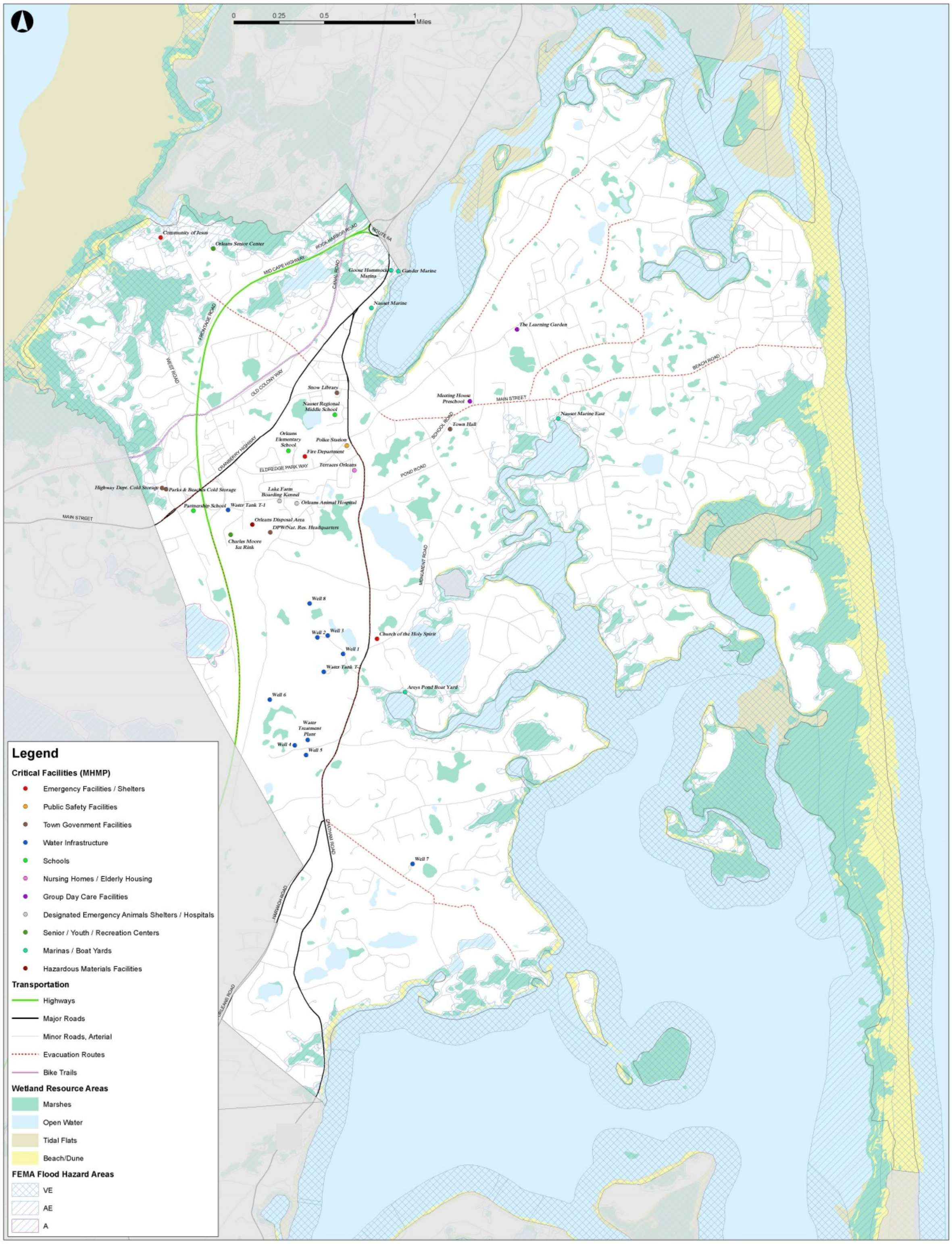
Woods Hole Group:

Elise Leduc (Lead Facilitator)
Leslie Fields (Small Group Facilitator)
Adam Finkle (Small Group Facilitator)
Brittany Hoffnagle (Small Group Facilitator)
Kalinda Roberts (Small Group Facilitator)

Acknowledgements

Special thanks to the Town of Orleans for their willingness to embrace this process and engage a good cross section of workshop participants, in particular George Meservey and the rest of the municipal staff that comprised the core team. This project was made possible through funding from the Executive Office of Energy and Environmental Affairs' Municipal Vulnerability Preparedness (MVP) Grant Program.

Appendix A: Workshop Base Map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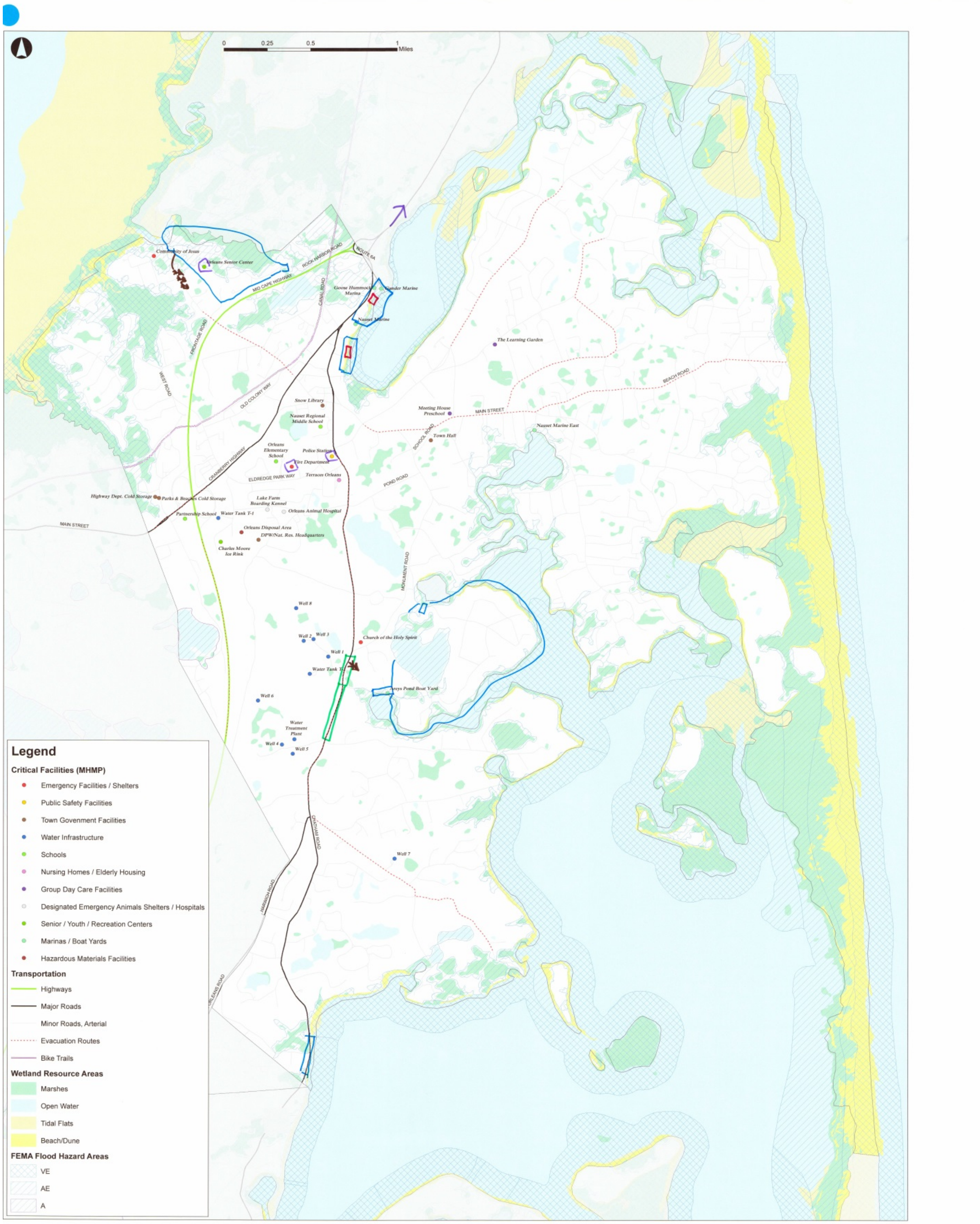
Miles
Community of Jesus
Orleans Senior Center
MID CAPE HIGHWAY
ROCK HARBOR ROAD
ROUTE 6A
CANAL ROAD
Goose Hummock Marina
Gander Marine
Nauset Marine
The Learning Garden
FRONTAGE ROAD
WEST ROAD
OLD COLONY WAY
BEACH ROAD
Snow Library
Nauset Regional Middle School
Meeting House Preschool
MAIN STREET
Nauset Marine East
SCHOOL ROAD
Town Hall
Orleans Elementary School
Police Station
Fire Department
CRANBERRY HIGHWAY
ELDREDGE PARK WAY
Terraces Orleans
POND ROAD
Highway Dept. Cold Storage
Parks & Beaches Cold Storage
Lake Farm Boarding Kennel
Orleans Animal Hospital
Partnership School
Water Tank T-1
MAIN STREET
Orleans Disposal Area
DPW/Nat. Res. Headquarters
Charles Moore Ice Rink
MONUMENT ROAD
Well 8
Well 2
Well 3
Church of the Holy Spirit
Well 1
Water Tank T-2
Areys Pond Boat Yard
Well 6
Water Treatment Plant
Well 4
Well 5
CHATHAM ROAD
Well 7
HARWICH ROAD
Legend
Critical Facilities (MHMP)
Emergency Facilities / Shelters
Public Safety Facilities
Town Govenment Facilities
Water Infrastructure
Schools
Nursing Homes / Elderly Housing
Group Day Care Facilities
Designated Emergency Animals Shelters / Hospitals
Senior / Youth / Recreation Centers
Marinas / Boat Yards
Hazardous Materials Facilities
Transportation
Highways
Major Roads
Minor Roads, Arterial
Evacuation Routes
Bike Trails
Wetland Resource Areas
Marshes
Open Water
Tidal Flats
Beach/Dune
FEMA Flood Hazard Areas
VE
AE
A

Appendix B: Participatory Mapping Results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Gander Marine
Nauset Marine
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Frontage Road
West Road
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Meeting House Preschool
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Nauset Marine East
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School Road
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Harwich Road
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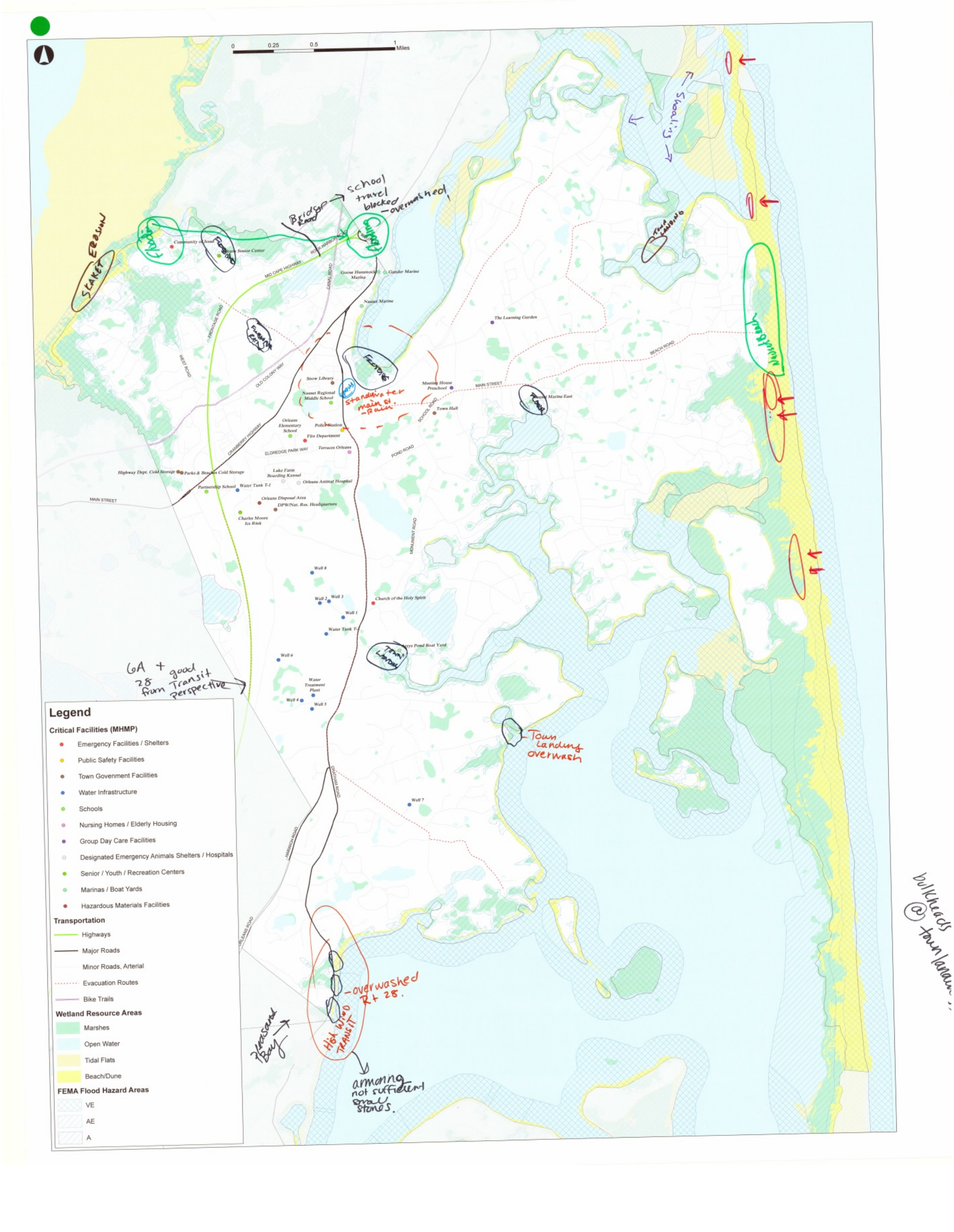
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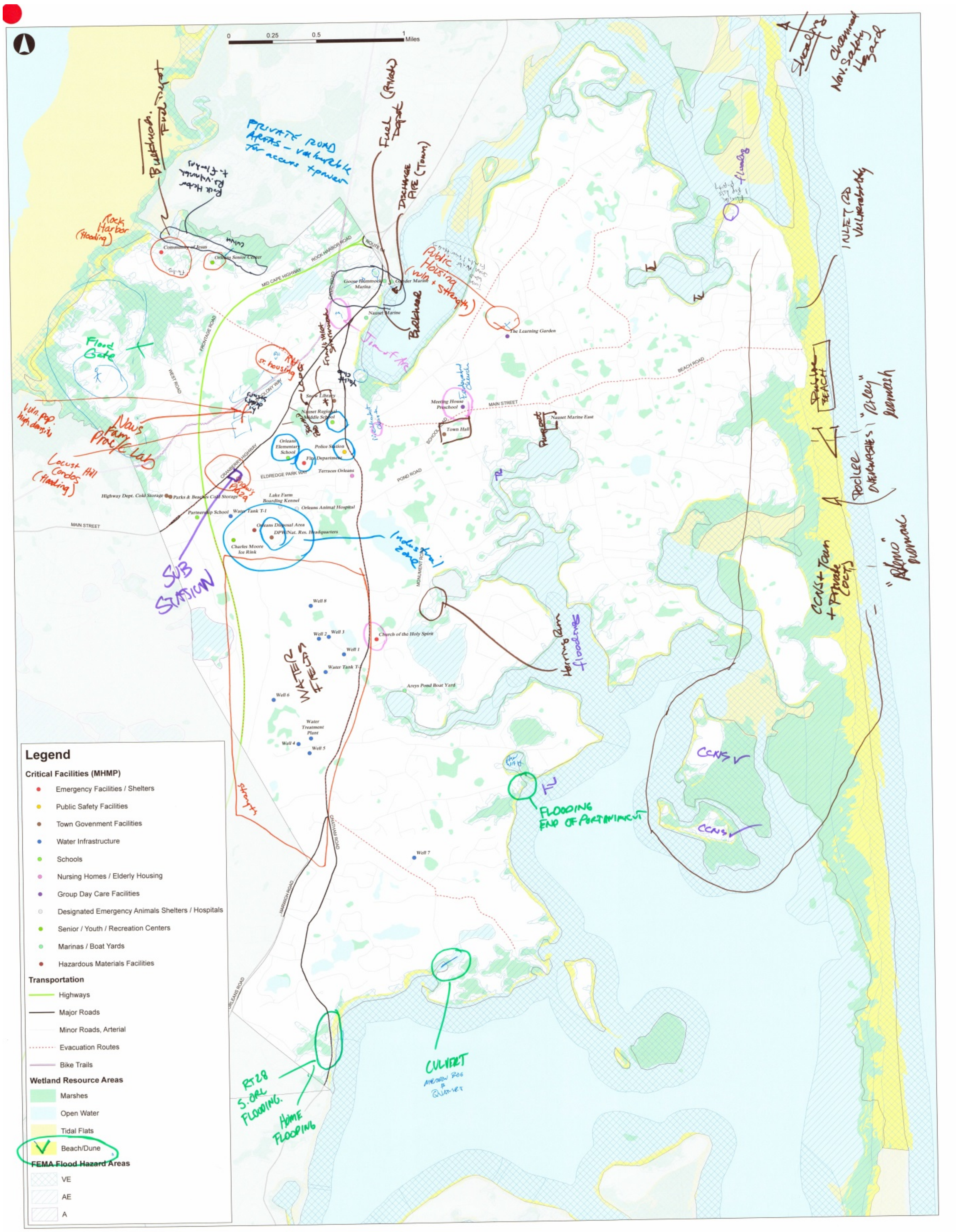
Beach/Dune
FEMA Flood Hazard Areas
VE
AE
A
0 0.25 0.5 1 Miles
School travel blocked - overwashed
Bridge Road
6A + 28 good from Transit perspective
Town Landing overwash
- overwashed Rt 28.
bulkheads @ town landing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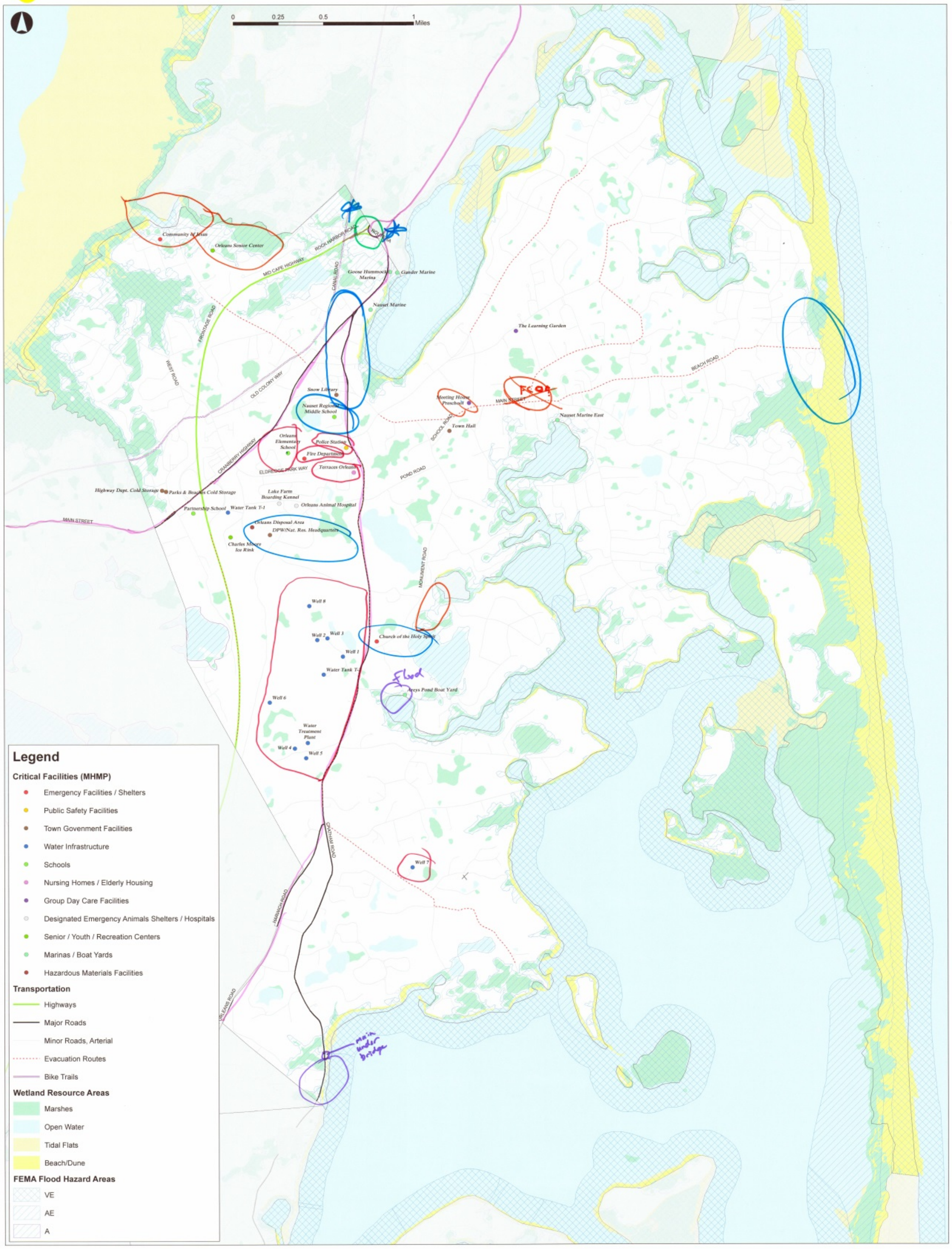
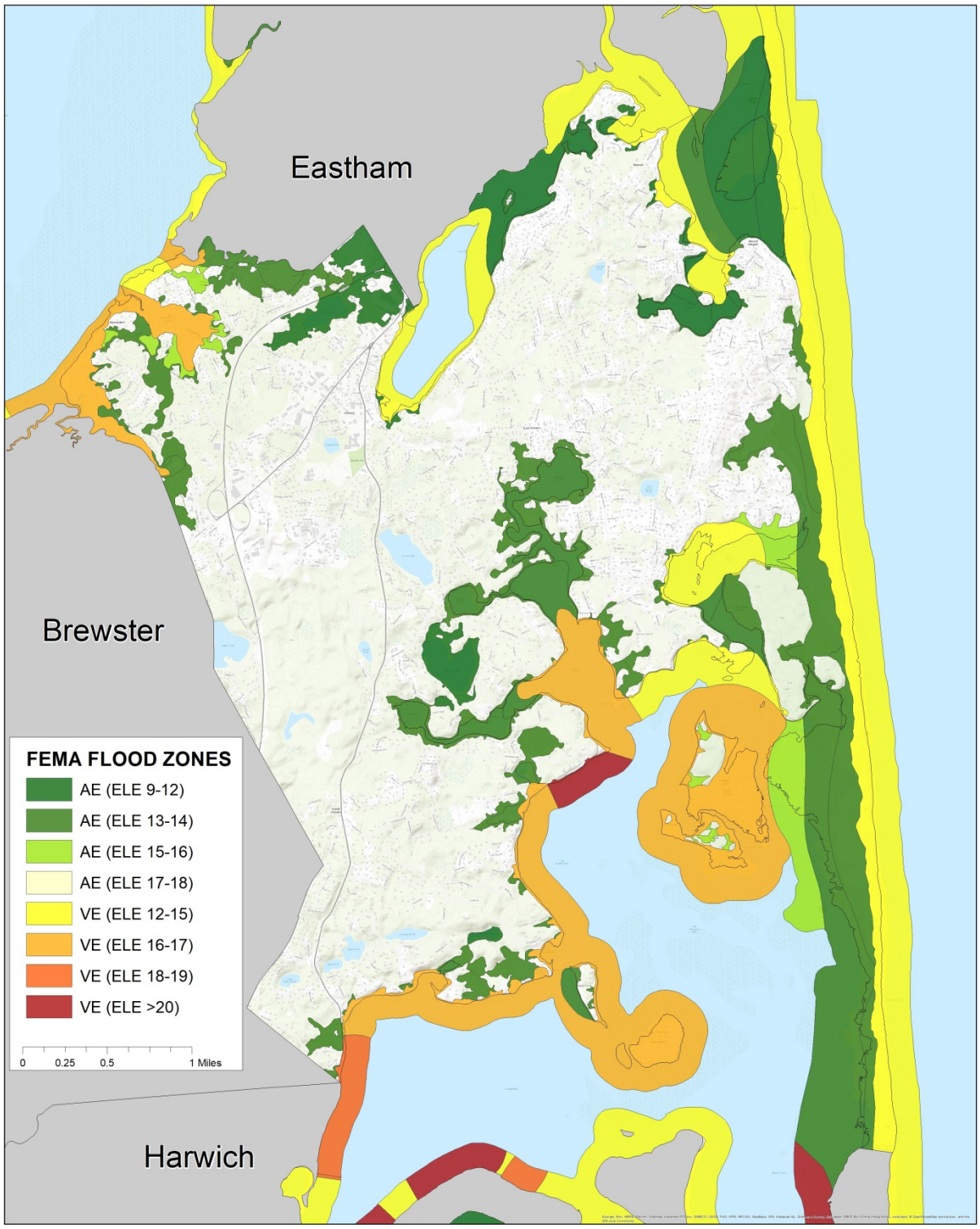
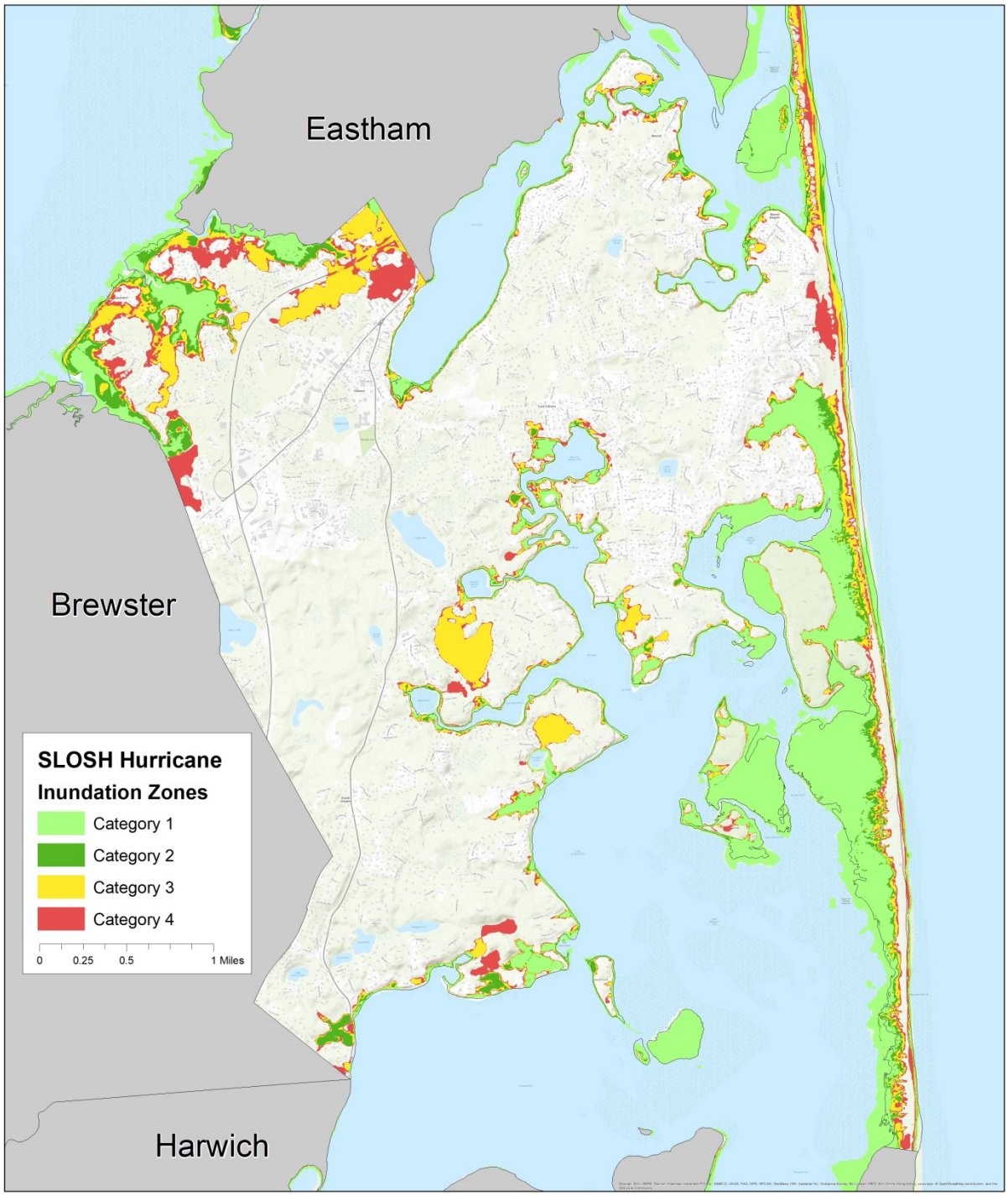
Bike Trails
Wetland Resource Areas
Marshes
Open Water
Tidal Flats
Beach/Dune
FEMA Flood Hazard Areas
VE
AE
A
MID CAPE HIGHWAY
MAIN STREET
BEACH ROAD
POND ROAD
ELDREDGE PARK WAY
Town Hall
Police Station
Fire Department
Orleans Elementary School
Nauset Regional Middle School
Orleans Senior Center
Community of Jesus
Goose Hummock Marina
Nauset Marine
The Learning Garden
Nauset Marine East
Meeting House Preschool
Terraces Orleans
Lake Farm Boarding Kennel
Orleans Animal Hospital
Partnership School
Water Tank T-1
Water Tank T-2
Orleans Disposal Area
DPW/Nat. Res. Headquarters
Charles Moore Ice Rink
Highway Dept. Cold Storage
Church of the Holy Spirit
Areys Pond Boat Yard
Well 1
Well 3
Well 4
Well 5
Well 6
Well 7
Well 8
Water Treatment Plant

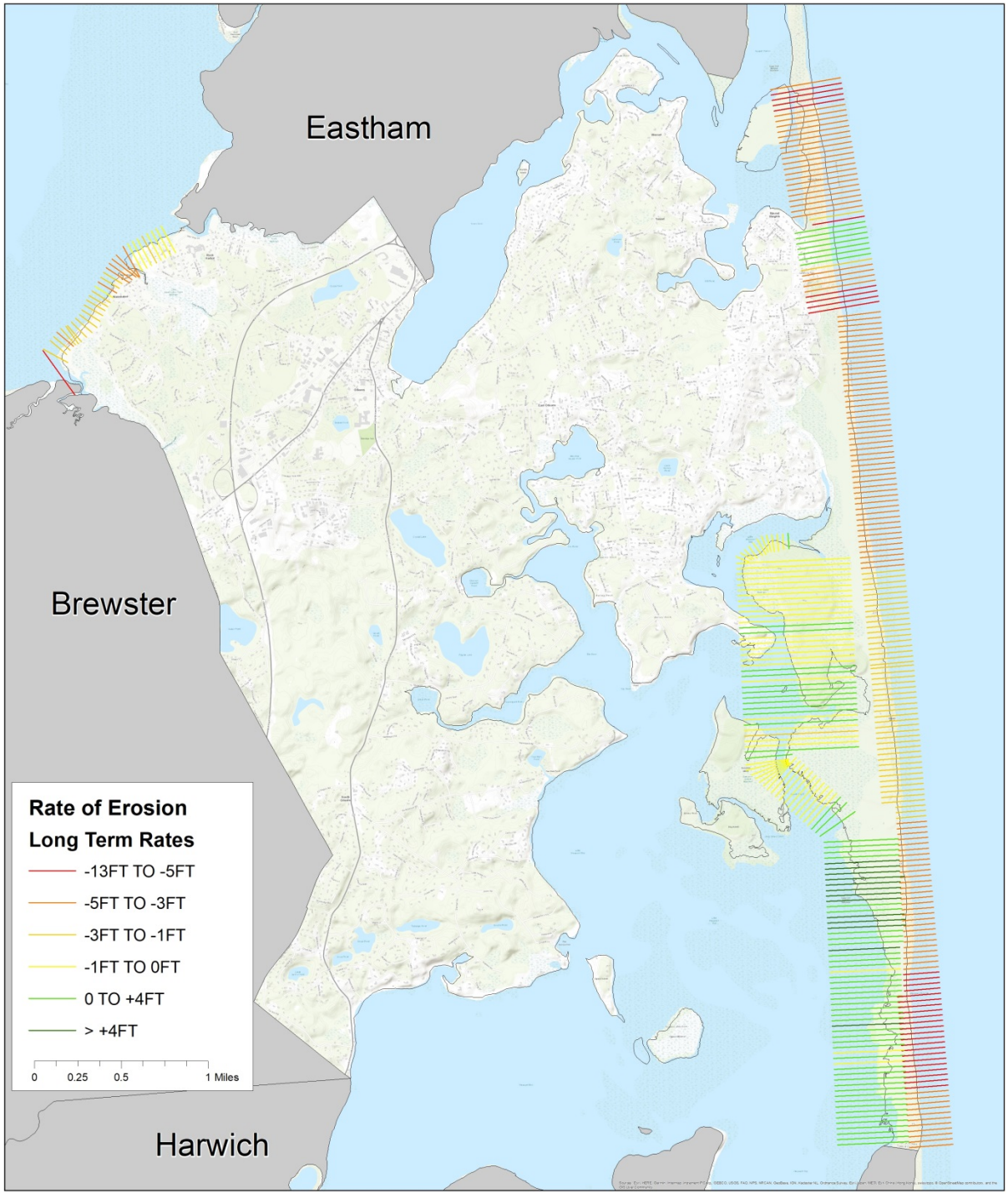

0
0.25
0.5
1
Miles
Community of Jesus
Orleans Senior Center
MID CAPE HIGHWAY
ROCK HARBOR ROAD
CANAL ROAD
Goose Hummock Marina
Gander Marine
Nauset Marine
FRONTAGE ROAD
WEST ROAD
OLD COLONY WAY
The Learning Garden
BEACH ROAD
Snow Library
Nauset Regional Middle School
Meeting House Preschool
MAIN STREET
Nauset Marine East
SCHOOL ROAD
Town Hall
Orleans Elementary School
Police Station
Fire Department
Terraces Orleans
ELDREDGE PARK WAY
CRANBERRY HIGHWAY
POND ROAD
Highway Dept. Cold Storage
Parks & Beaches Cold Storage
Lake Farm Boarding Kennel
Orleans Animal Hospital
Partnership School
Water Tank T-1
MAIN STREET
Orleans Disposal Area
DPW/Nat. Res. Headquarters
Charles Moore Ice Rink
MONUMENT ROAD
Well 8
Well 2
Well 3
Church of the Holy Spirit
Well 1
Flood
Areys Pond Boat Yard
Well 6
Water Treatment Plant
Well 4
Well 5
CHATHAM ROAD
Well 7
Legend
Critical Facilities (MHMP)
Emergency Facilities / Shelters
Public Safety Facilities
Town Govenment Facilities
Water Infrastructure
Schools
Nursing Homes / Elderly Housing
Group Day Care Facilities
Designated Emergency Animals Shelters / Hospitals
Senior / Youth / Recreation Centers
Marinas / Boat Yards
Hazardous Materials Facilities
Transportation
Highways
Major Roads
Minor Roads, Arterial
Evacuation Routes
Bike Trails
Wetland Resource Areas
Marshes
Open Water
Tidal Flats
Beach/Dune
FEMA Flood Hazard Areas
VE
AE
A

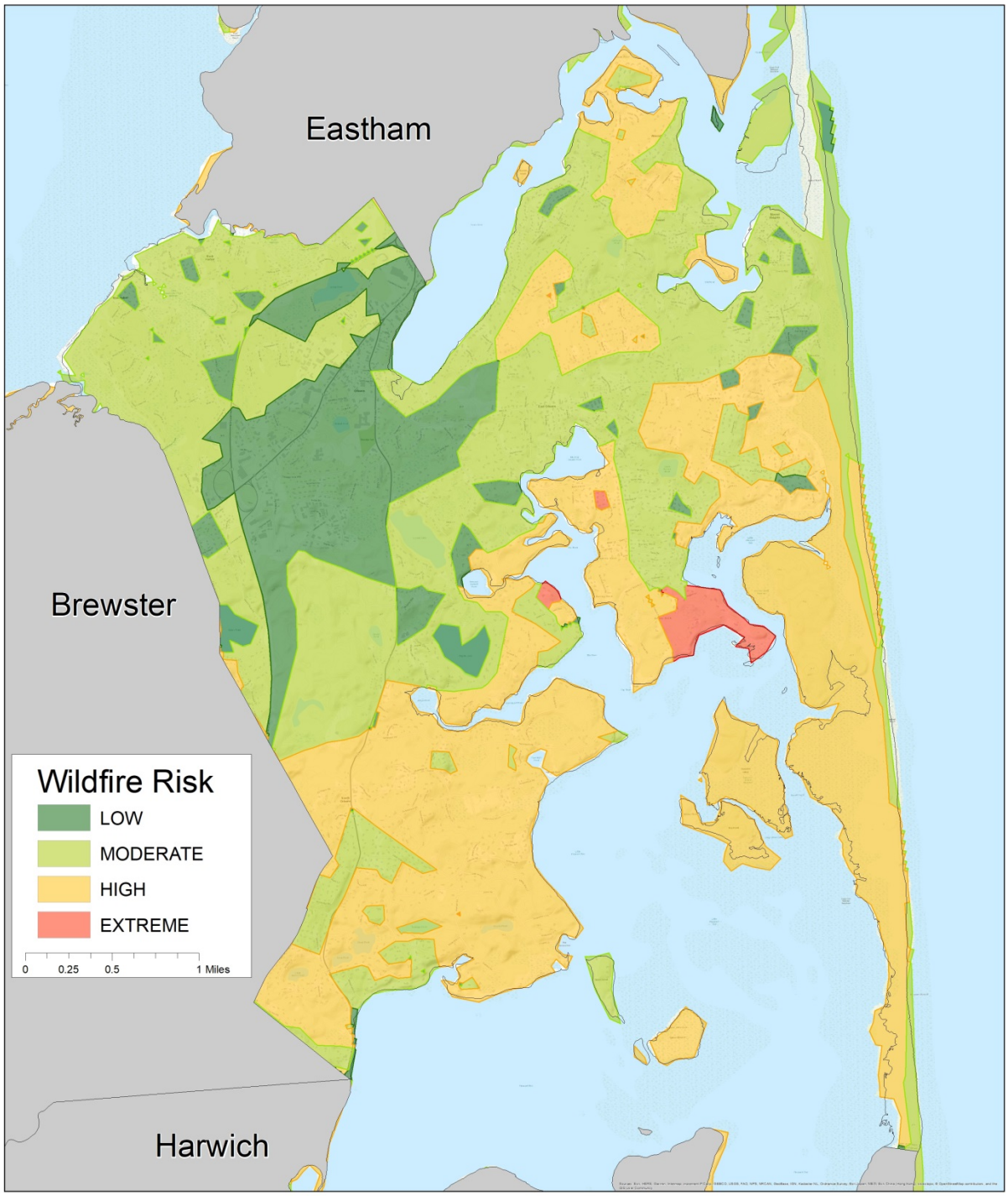
Appendix C: Orleans Risk Maps Used During Workshop

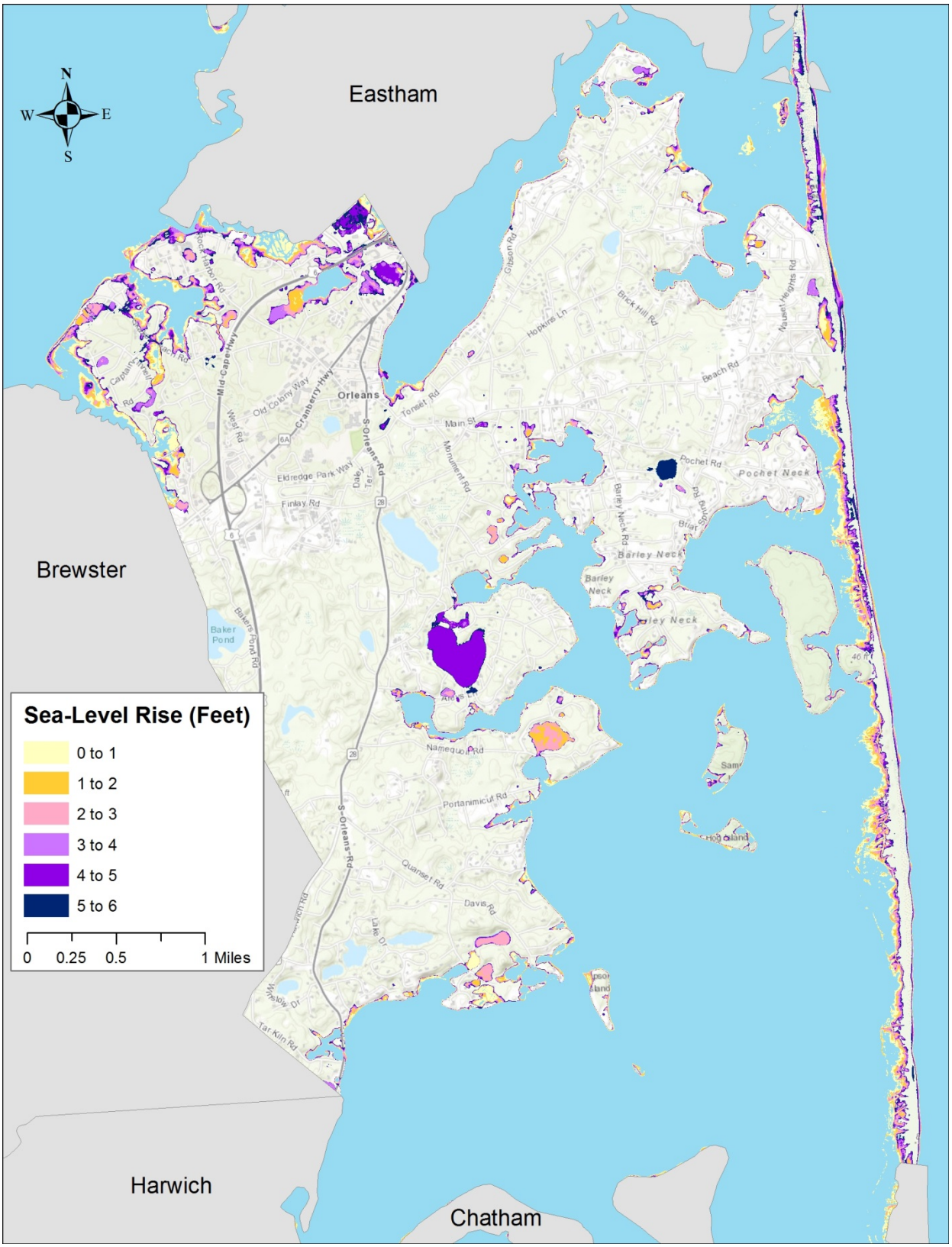
(Given as workshop handouts)

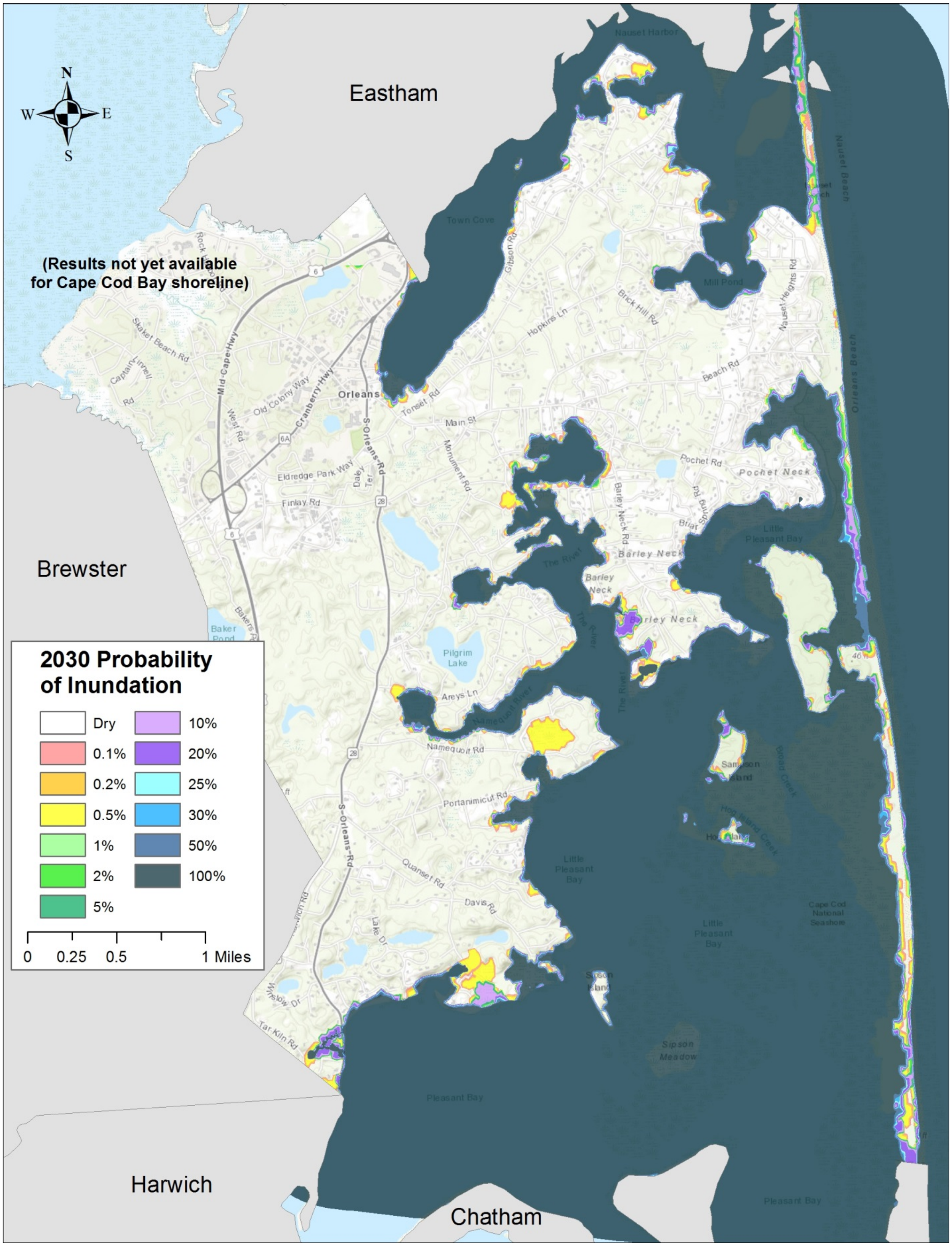

Eastham
Brewster
Harwich
FEMA FLOOD ZONES
AE (ELE 9-12)
AE (ELE 13-14)
AE (ELE 15-16)
AE (ELE 17-18)
VE (ELE 12-15)
VE (ELE 16-17)
VE (ELE 18-19)
VE (ELE >20)
0
0.25
0.5
1 Miles

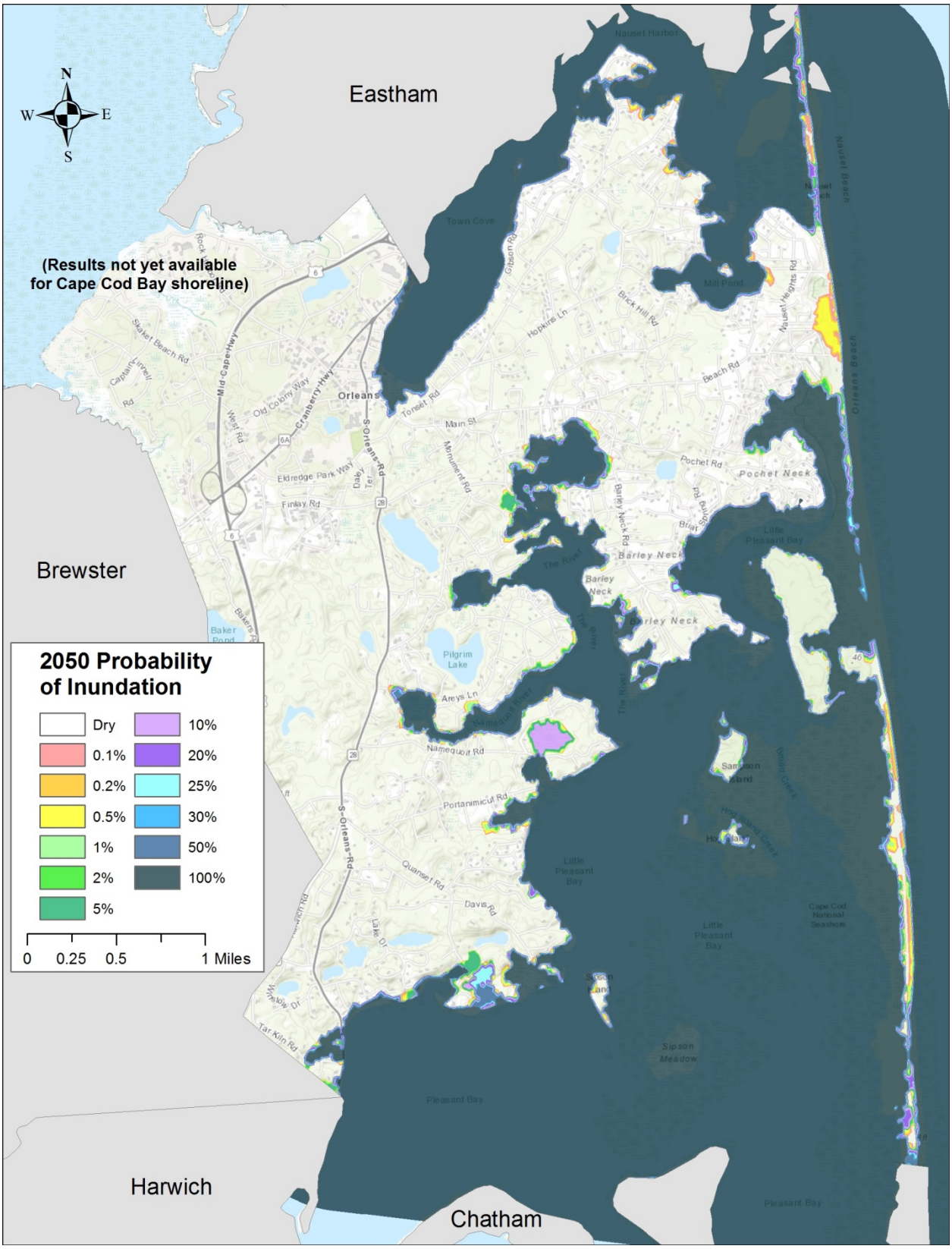

Eastham
Brewster
Harwich
SLOSH Hurricane
Inundation Zones
Category 1
Category 2
Category 3
Category 4
0
0.25
0.5
1 Miles

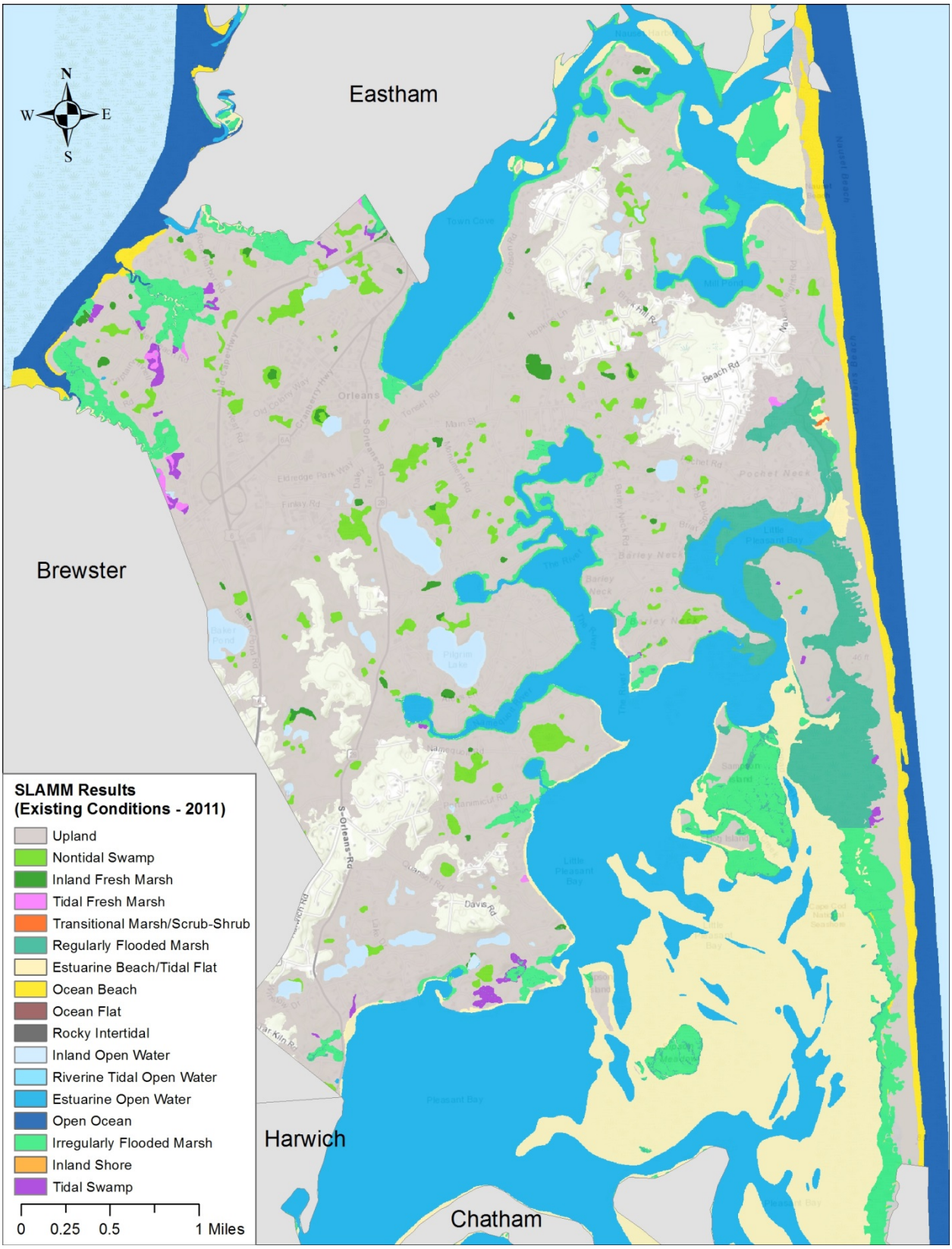

Eastham
Brewster
Harwich
Rate of Erosion
Long Term Rates
-13FT TO -5FT
-5FT TO -3FT
-3FT TO -1FT
-1FT TO 0FT
0 TO +4FT
> +4FT
0
0.25
0.5
1 Miles

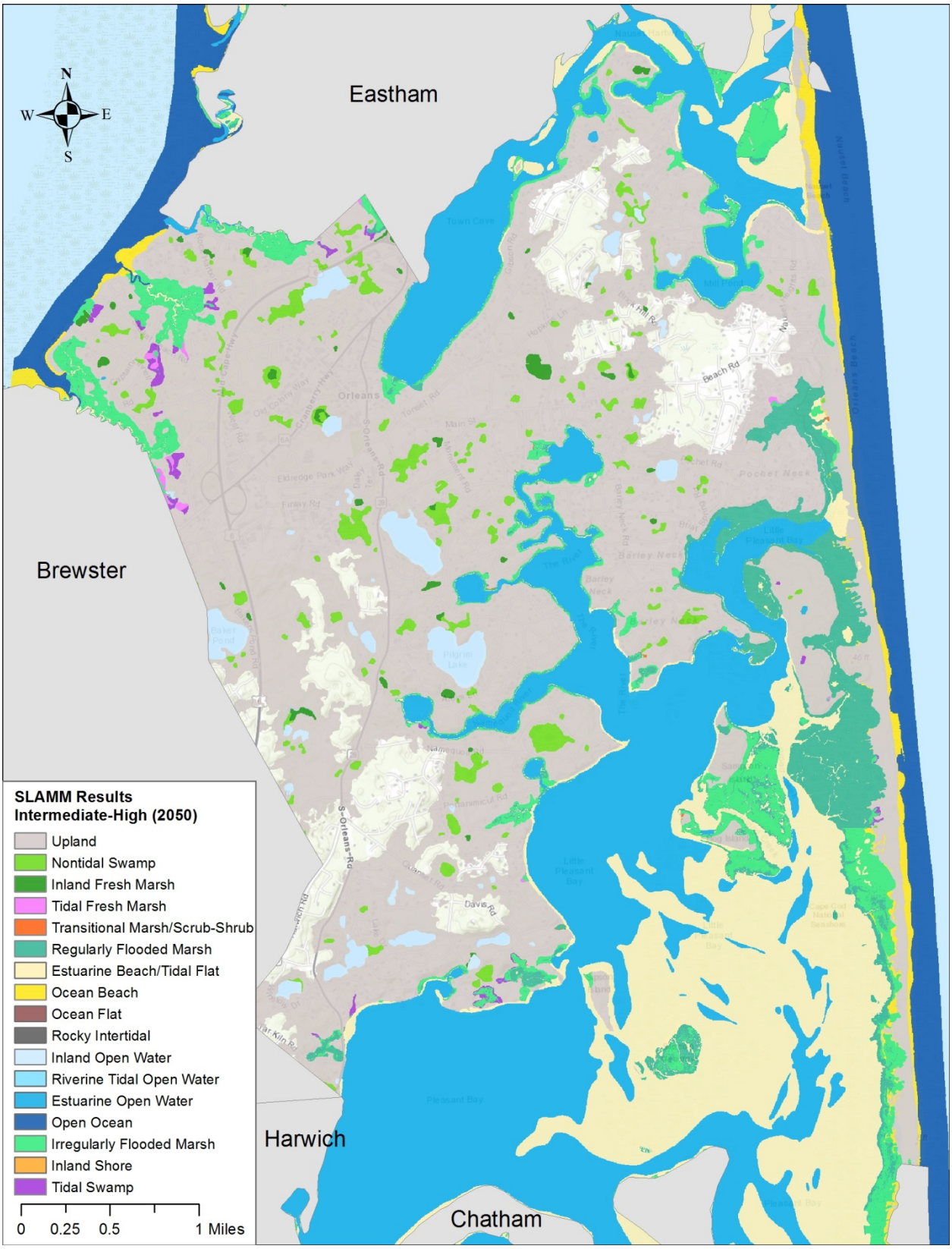

Eastham
Brewster
Harwich
Wildfire Risk
LOW
MODERATE
HIGH
EXTREME
0
0.25
0.5
1 Miles

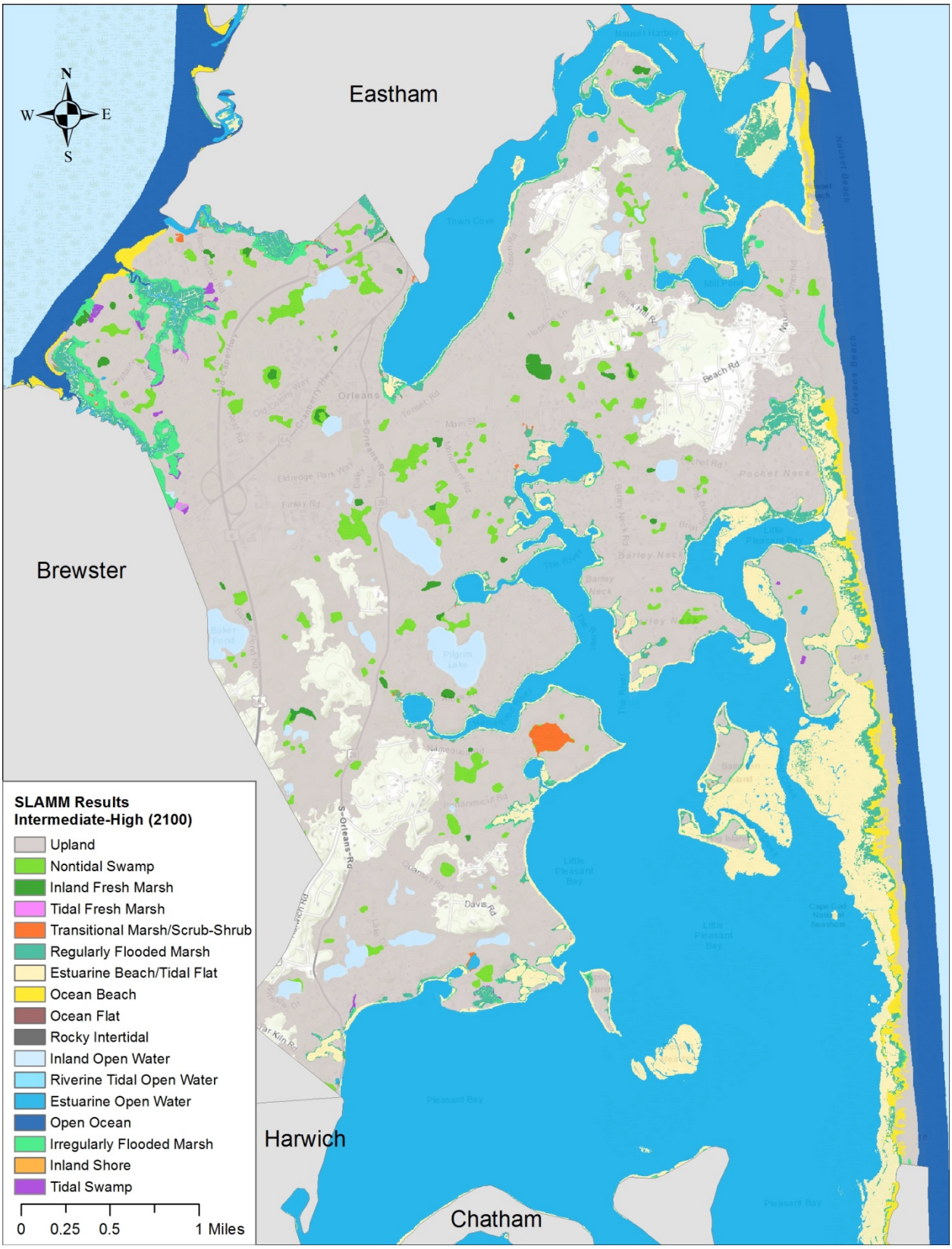

N
W
E
S
Eastham
Brewster
Orleans
Harwich
Chatham
Sea-Level Rise (Feet)
0 to 1
1 to 2
2 to 3
3 to 4
4 to 5
5 to 6
0
0.25
0.5
1 Miles
Cranberry Hwy
Mid-Cape Hwy
S Orleans Rd
Old Colony Way
Eldredge Park Way
Finlay Rd
Main St
Monument Rd
Tonset Rd
Gibson Rd
Hopkins Ln
Beach Rd
Pochet Rd
Pochet Neck
Barley Neck Rd
Barley Neck
Briar Rd
Baker Pond
Baker's Pond Rd
Namequoit Rd
Portanimicut Rd
Quanset Rd
Davis Rd
Lake Dr
Tar Kiln Rd
Holiday Rd


Eastham
Brewster
Harwich
Chatham
(Results not yet available
for Cape Cod Bay shoreline)
N
S
W
E
2030 Probability
of Inundation
Dry
0.1%
0.2%
0.5%
1%
2%
5%
10%
20%
25%
30%
50%
100%
0
0.25
0.5
1 Miles
Orleans
Pochet Neck
Barley Neck
Little Pleasant Bay
Pleasant Bay
Nauset Beach
Orleans Beach
Mill Pond
Town Cove
Pilgrim Lake
Main St


N
W
E
S
Eastham
(Results not yet available
for Cape Cod Bay shoreline)
Brewster
Orleans
Harwich
Chatham
Nauset Harbor
Town Cove
Mill Pond
Nauset Heights Rd
Brick Hill Rd
Hopkins Ln
Gibson Rd
Nauset Beach
Orleans Beach
Beach Rd
Tonset Rd
Main St
Monument Rd
Old Colony Way
Cranberry Hwy
Mid-Cape Hwy
Skaket Beach Rd
Captain Linnell Rd
West Rd
Eldredge Park Way
Finlay Rd
Daley Ter
S Orleans Rd
Pochet Rd
Pochet Neck
Barley Neck Rd
Barley Neck
Little Pleasant Bay
The River
The Sawer
Baker Pond
Pilgrim Lake
Areys Ln
Namequoit Rd
Portanimicut Rd
Quanset Rd
Davis Rd
Lake Dr
Tar Kiln Rd
Sipson Meadow
Pleasant Bay
Cape Cod National Seashore
2050 Probability of Inundation
Dry
0.1%
0.2%
0.5%
1%
2%
5%
10%
20%
25%
30%
50%
100%
0
0.25
0.5
1 Miles


N
W
E
S
Eastham
Brewster
Orleans
Harwich
Chatham
SLAMM Results
(Existing Conditions - 2011)
Upland
Nontidal Swamp
Inland Fresh Marsh
Tidal Fresh Marsh
Transitional Marsh/Scrub-Shrub
Regularly Flooded Marsh
Estuarine Beach/Tidal Flat
Ocean Beach
Ocean Flat
Rocky Intertidal
Inland Open Water
Riverine Tidal Open Water
Estuarine Open Water
Open Ocean
Irregularly Flooded Marsh
Inland Shore
Tidal Swamp
0 0.25 0.5 1 Miles


N
W
E
S
Eastham
Brewster
Orleans
Harwich
Chatham
SLAMM Results
Intermediate-High (2050)
Upland
Nontidal Swamp
Inland Fresh Marsh
Tidal Fresh Marsh
Transitional Marsh/Scrub-Shrub
Regularly Flooded Marsh
Estuarine Beach/Tidal Flat
Ocean Beach
Ocean Flat
Rocky Intertidal
Inland Open Water
Riverine Tidal Open Water
Estuarine Open Water
Open Ocean
Irregularly Flooded Marsh
Inland Shore
Tidal Swamp
0
0.25
0.5
1 Miles


N
W
E
S
Eastham
Brewster
Harwich
Chatham
Orleans
Beach Rd
Pochet Neck
Barley Neck
Davis Rd
S Orleans Rd
Pleasant Bay
Little Pleasant Bay
SLAMM Results
Intermediate-High (2100)
Upland
Nontidal Swamp
Inland Fresh Marsh
Tidal Fresh Marsh
Transitional Marsh/Scrub-Shrub
Regularly Flooded Marsh
Estuarine Beach/Tidal Flat
Ocean Beach
Ocean Flat
Rocky Intertidal
Inland Open Water
Riverine Tidal Open Water
Estuarine Open Water
Open Ocean
Irregularly Flooded Marsh
Inland Shore
Tidal Swamp
0
0.25
0.5
1 Miles

Appendix D: Massachusetts Updated Climate Projections

(Given as workshop handouts)

CAPE COD BASIN

MUNICIPALITIES WITHIN CAPE COD BASIN:

Barnstable, Bourne, Brewster, Chatham, Dennis, Eastham, Falmouth, Harwich, Mashpee, Orleans, Provincetown, Sandwich, Truro, Wellfleet, Yarmouth

Many municipalities fall within more than one basin, so it is advised to use the climate projections for the basin that contains the majority of the land area of the municipality.

CAPE COD BASIN

Cape Cod Basin		Observed Baseline 1971-2000 (°F)	Projected Change in 2030s (°F)	Mid-Century Projected Change in 2050s (°F)	Projected Change in 2070s (°F)	End of Century Projected Change in 2090s (°F)
Average Temperature	Annual	49.92	+1.78 to +3.41	+2.41 to +5.39	+2.74 to +7.78	+3.11 to +9.52
	Winter	31.92	+1.76 to +3.72	+2.50 to +5.70	+3.07 to +7.69	+3.35 to +9.20
	Spring	45.98	+1.73 to +3.23	+2.16 to +5.04	+2.59 to +6.74	+2.94 to +7.69
	Summer	68.15	+1.50 to +3.62	+2.08 to +5.66	+2.45 to +8.58	+3.03 to +10.43
	Fall	53.32	+1.92 to +3.83	+3.03 to +5.86	+2.85 to +8.29	+3.35 to +10.06
Maximum Temperature	Annual	57.74	+1.63 to +3.38	+2.19 to +5.23	+2.43 to +7.73	+2.82 to +9.26
	Winter	39.76	+1.52 to +3.60	+2.10 to +5.27	+2.60 to +7.27	+3.01 to +8.65
	Spring	53.74	+1.44 to +3.11	+1.92 to +4.80	+2.30 to +6.54	+2.62 to +7.55
	Summer	75.95	+1.35 to +3.48	+1.95 to +5.60	+2.29 to +8.47	+2.68 to +10.27
	Fall	61.24	+1.84 to +3.80	+2.81 to +5.83	+2.76 to +8.00	+3.08 to +9.97
Minimum Temperature	Annual	42.09	+1.92 to +3.53	+2.67 to +5.50	+3.06 to +7.84	+3.42 to +9.67
	Winter	24.08	+2.06 to +3.97	+2.90 to +6.16	+3.53 to +8.34	+3.81 to +9.85
	Spring	38.23	+1.74 to +3.47	+2.51 to +5.28	+2.71 to +6.93	+3.19 to +7.83
	Summer	60.35	+1.65 to +3.75	+2.23 to +5.72	+2.61 to +8.66	+3.32 to +10.64
	Fall	45.41	+1.92 to +4.01	+3.14 to +5.88	+2.96 to +8.49	+3.63 to +10.28

- The Cape Cod basin is expected to experience increased average temperatures throughout the 21st century. Maximum and minimum temperatures are also expected to increase throughout the end of the century. These increased temperature trends are expected for annual and seasonal projections.
- Seasonally, maximum summer and fall temperatures are expected to see the highest projected increase throughout the 21st century.
    - Summer mid-century increase of 2 °F to 5.6 °F (3-7% increase); end of century increase of 2.7 °F to 10.3 °F (4-14% increase).
    - Fall mid-century increase of 2.8°F to 5.8°F (5-10% increase); end of century increase by and 2.8 °F to 5.8 °F (5-16% increase).
- Seasonally, minimum winter and fall temperatures are expected to see increases throughout the 21st century.
    - Winter mid-century increase of 2.9 °F to 6.2 °F (12-26% increase); end of century increase by 3.8 °F to 9.9 °F (16-41% increase).
    - Fall mid-century of 3.1 °F to 5.9 °F (7-13% increase); end of century increase of 3.6 °F to 10.3 °F (8-23% increase).

CAPE COD BASIN

Cape Cod Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)	Mid-Century Projected Change in 2050s (Days)	Projected Change in 2070s (Days)	End of Century Projected Change in 2090s (Days)
Days with Maximum Temperature Over 90°F	Annual	0.76	+1.17 to +3.89	+1.93 to +9.25	+2.46 to +21.33	+3.23 to +33.89
	Winter	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00
	Spring	0.01	-0.02 to +0.09	-0.02 to +0.13	+0.00 to +0.20	+0.00 to +0.29
	Summer	0.73	+1.06 to +3.58	+1.79 to +8.62	+2.34 to +19.96	+3.04 to +31.61
	Fall	0.01	+0.06 to +0.28	+0.10 to +0.68	+0.13 to +1.26	+0.19 to +2.26
Days with Maximum Temperature Over 95°F	Annual	0.06	+0.08 to +0.63	+0.19 to +1.88	+0.25 to +4.51	+0.26 to +9.49
	Winter	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00
	Spring	0.00	+0.00 to +0.01	-0.00 to +0.02	+0.00 to +0.05	+0.00 to +0.08
	Summer	0.06	+0.07 to +0.61	+0.18 to +1.85	+0.25 to +4.32	+0.26 to +9.11
	Fall	0.00	+0.00 to +0.03	+0.00 to +0.06	+0.00 to +0.17	+0.00 to +0.42
Days with Maximum Temperature Over 100°F	Annual	0.00	+0.00 to +0.07	+0.00 to +0.31	+0.01 to +0.80	+0.03 to +1.71
	Winter	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00
	Spring	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.01
	Summer	0.00	+0.00 to +0.07	+0.00 to +0.31	+0.01 to +0.80	+0.02 to +1.69
	Fall	0.00	+0.00 to +0.00	+0.00 to +0.00	+0.00 to +0.01	+0.00 to +0.04

- Due to projected increases in average and maximum temperatures throughout the end of the century, the Cape Cod basin is also expected to experience an increase in days with daily maximum temperatures over 90 °F, 95 °F, and 100 °F.
    - Annually, the Cape Cod basin is expected to see days with daily maximum temperatures over 90 °F increase by 2 to 9 more days by mid-century, and 3 to 34 more days by the end of the century.
    - Seasonally, summer is expected to see an increase of 2 to 9 more days with daily maximums over 90 °F by mid-century.
    - By end of century, the Cape Cod basin is expected to have 3 to 32 more days.

CAPE COD BASIN

Cape Cod Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)	Mid-Century Projected Change in 2050s (Days)	Projected Change in 2070s (Days)	End of Century Projected Change in 2090s (Days)
Days with Minimum Temperature Below 0°F	Annual	0.79	-0.08 to -0.37	-0.09 to -0.39	-0.14 to -0.4	-0.15 to -0.4
	Winter	0.79	-0.08 to -0.37	-0.09 to -0.39	-0.14 to -0.4	-0.15 to -0.4
	Spring	0.00	-0.01 to -0.00	-0.01 to -0.00	-0.01 to -0.00	-0.01 to -0.00
	Summer	0.00	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00
	Fall	0.00	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00	-0.00 to -0.00
Days with Minimum Temperature Below 32°F	Annual	104.75	-13.60 to -27.72	-19.29 to -41.91	-23.29 to -54.38	-24.54 to -66.71
	Winter	70.7	-5.68 to -12.20	-7.00 to -20.22	-10.21 to -29.71	-11.46 to -38.36
	Spring	23.8	-5.16 to -11.14	-7.22 to -14.64	-7.87 to -17.32	-9.50 to -18.96
	Summer	0.00	-0.05 to -0.00	-0.04 to -0.00	-0.04 to -0.00	-0.05 to -0.00
	Fall	10.16	-3.40 to -6.37	-4.69 to -8.2	-5.09 to -9.62	-5.34 to -10.71

- Due to projected increases in average and minimum temperatures throughout the end of the century, the Cape Cod basin is expected to experience a decrease in days with daily minimum temperatures below 32 °F and 0 °F.
- Seasonally, winter, spring and fall are expected to see the largest decreases in days with daily minimum temperatures below 32 °F.
    - Winter is expected to have 7 to 20 fewer days by mid-century, and 11 to 38 fewer days by end of century.
    - Spring is expected to have 7 to 15 fewer days by mid-century, and 10 to 19 fewer days by end of century.
    - Fall is expected to have 5 to 8 fewer days by mid-century, and 5 to 11 fewer days by end of century.

CAPE COD BASIN

Cape Cod Basin		Observed Baseline 1971-2000 (Degree-Days)	Projected Change in 2030s (Degree-Days)	Mid-Century Projected Change in 2050s (Degree-Days)	Projected Change in 2070s (Degree-Days)	End of Century Projected Change in 2090s (Degree-Days)
Heating Degree-Days (Base 65°F)	Annual	5956.64	-475.48 to -913.39	-685.90 to -1374.26	-773.67 to -1828.23	-854.04 to -2171.56
	Winter	2996.33	-164.51 to -347.77	-220.16 to -520.87	-277.06 to -697.53	-304.13 to -831.96
	Spring	1753.89	-152.01 to -285.19	-190.19 to -444.68	-229.91 to -584.74	-267.48 to -649.94
	Summer	94.49	-30.02 to -57.56	-41.95 to -69.89	-44.65 to -80.65	-44.99 to -85.45
	Fall	1105.61	-131.82 to -268.87	-226.73 to -393.30	-215.14 to -547.22	-242.01 to -619.87
Cooling Degree-Days (Base 65°F)	Annual	435.71	+144.74 to +364.43	+224.26 to +601.17	+250.48 to +965.18	+314.49 to +1226.21
	Winter	nan	+0.13 to +1.43	+0.38 to +3.50	+0.92 to +3.19	-0.34 to +3.91
	Spring	7.08	+3.48 to +9.44	+4.94 to +20.08	+5.86 to +34.34	+7.02 to +52.03
	Summer	384.03	+107.28 to +279.41	+148.81 to +457.16	+184.27 to +701.82	+229.32 to +875.35
	Fall	43.77	+30.85 to +80.41	+41.77 to +138.18	+48.96 to +224.33	+71.67 to +296.72
Growing Degree-Days (Base 50°F)	Annual	2421.38	+343.19 to +690.79	+460.30 to +1078.12	+519.05 to +1678.13	+617.96 to +2104.38
	Winter	4.84	+0.24 to +9.74	+0.28 to +15.26	+2.10 to +25.74	+4.23 to +35.89
	Spring	197.63	+50.56 to +105.22	+69.23 to +195.43	+77.64 to +277.13	+77.88 to +342.92
	Summer	1669.64	+137.95 to +332.36	+190.73 to +520.48	+224.93 to +789.31	+278.12 to +958.80
	Fall	546.41	+107.92 to +248.13	+174.67 to +396.65	+168.86 to +571.84	+215.05 to +716.85

- Due to projected increases in average, maximum, and minimum temperatures throughout the end of the century, the Cape Cod basin is expected to experience a decrease in heating degree-days, and increases in both cooling degree-days and growing degree-days.
- Seasonally, winter historically exhibits the highest number of heating degree-days and is expected to see the largest decrease of any season, but spring and fall are also expected to see significant change.
    - The winter season is expected to see a decrease of 220-521 degree-days by mid-century (a decrease of 7-17%), and a decrease of 304-832 degree-days by the end of century (a decrease of 10-28%).
    - The spring season is expected to decrease in heating degree-days by 11-25% (190-445 degree-days) by mid-century, and by 15-37% (267-650 degree-days) by the end of century.
    - The fall season is expected to decreases in heating degree-days by 21-36% (227-393 degree-days) by mid-century, and by and 22-56% (242-620 degree-days) by the end of century.
- Conversely, due to projected increasing temperatures, summer cooling degree-days are expected to increase by 39-119% (149-457 degree-days) by mid-century, and by 60-228% (229-875 degree-days) by end of century.

- Seasonally, summer historically exhibits the highest number of growing degree-days and is expected to see the largest decrease of any season, but the shoulder seasons of spring and fall are also expected to see an increase in growing degree-days.
    - The summer season is projected to increase by 11-31% (190.73-520.48 degree-days) by mid-century, and by 17-57% (278-959 degree-days) by end of century.
    - Spring is expected to see an increase by 35-99% (69-195 degree-days) by mid-century and 39-174% (78-343 degree-days) by end of century.
    - Fall is expected to see an increase by 32-73% (175-397 degree-days) by mid-century and 39-131% (215-717 degree-days) by end of century.

CAPE COD BASIN

Cape Cod Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)	Mid-Century Projected Change in 2050s (Days)	Projected Change in 2070s (Days)	End of Century Projected Change in 2090s (Days)
Days with Precipitation Over 1”	Annual	7.02	+0.16 to +1.76	+0.66 to +2.66	+0.45 to +2.92	+0.55 to +3.41
	Winter	1.45	-0.10 to +0.62	+0.08 to +0.67	+0.02 to +1.04	+0.09 to +1.35
	Spring	1.65	+0.08 to +0.65	+0.08 to +0.90	+0.22 to +1.05	+0.29 to +1.20
	Summer	1.92	-0.18 to +0.55	-0.13 to +0.78	-0.40 to +0.66	-0.46 to +0.58
	Fall	2.01	-0.23 to +0.62	-0.13 to +0.85	-0.31 to +0.94	-0.35 to +1.11
Days with Precipitation Over 2”	Annual	0.75	-0.04 to +0.43	+0.07 to +0.52	+0.08 to +0.71	+0.05 to +0.74
	Winter	0.09	-0.05 to +0.16	-0.02 to +0.15	-0.02 to +0.20	-0.02 to +0.27
	Spring	0.05	-0.03 to +0.13	+0.01 to +0.18	+0.02 to +0.19	-0.01 to +0.25
	Summer	0.33	-0.07 to +0.15	-0.05 to +0.23	-0.05 to +0.20	-0.05 to +0.22
	Fall	0.28	-0.04 to +0.13	-0.01 to +0.20	-0.01 to +0.23	-0.07 to +0.31
Days with Precipitation Over 4”	Annual	0.01	+0.00 to +0.03	+0.00 to +0.03	-0.01 to +0.05	-0.01 to +0.05
	Winter	0.00	+0.00 to +0.00	+0.00 to +0.01	-0.00 to +0.00	+0.00 to +0.00
	Spring	0.00	+0.00 to +0.01	+0.00 to +0.00	+0.00 to +0.01	+0.00 to +0.00
	Summer	0.00	-0.01 to +0.02	-0.01 to +0.02	-0.01 to +0.03	-0.01 to +0.03
	Fall	0.01	-0.00 to +0.02	+0.00 to +0.01	+0.00 to +0.02	+0.00 to +0.03

- The projections for expected number of days receiving precipitation over one inch are variable for the Cape Cod basin, fluctuating between loss and gain of days.
    - Seasonally, the winter season is generally expected to see the highest projected increase.
    - The winter season is expected to see an increase in days with precipitation over one inch of 0-1 days by mid-century, and by 0-1 days by the end of century.
    - The spring season is expected to see an increase in days with precipitation over one inch of 0-1 days by mid-century, and by 0-1 days by the end of century.

CAPE COD BASIN

Cape Cod Basin		Observed Baseline 1971-2000 (Inches)	Projected Change in 2030s (Inches)	Mid-Century Projected Change in 2050s (Inches)	Projected Change in 2070s (Inches)	End of Century Projected Change in 2090s (Inches)
Total Precipitation	Annual	44.94	-1.08 to +3.47	-0.38 to +4.54	-0.78 to +5.79	-0.83 to +5.45
	Winter	11.63	-0.40 to +1.24	-0.22 to +1.59	-0.05 to +2.10	-0.04 to +3.13
	Spring	11.51	-0.04 to +1.48	-0.26 to +1.67	-0.21 to +2.08	+0.08 to +2.45
	Summer	10.24	-0.95 to +1.19	-1.05 to +1.73	-1.64 to +2.00	-2.22 to +1.66
	Fall	11.62	-0.96 to +0.90	-0.99 to +1.09	-1.40 to +1.64	-1.52 to +1.26

- Similar to projections for number of days receiving precipitation over a specified threshold, seasonal projections for total precipitation are also variable for the Cape Cod basin.
    - The winter season is expected to experience the greatest change with a decrease of 2% to an increase of 14% by mid-century, and an increase of 0-27% by end of century.
    - Projections for the summer and fall seasons are more variable, and could see either a drop or increase in total precipitation throughout the 21st century.
        - The summer season projections for the Cape Cod or basin could see a decrease of 1.1 to an increase of 1.7 inches by mid-century (decrease of 10% to increase of 17%), and a decrease of 2.2 to an increase of 1.7 inches by the end of the century (decrease of 22% to increase of 16%).
        - The fall season projections for the Cape Cod basin could see a decrease of -1 to an increase of 1.1 inches by mid-century (decrease of 9% to increase of 9%), and a decrease of 1.5 to an increase of 1.3 inches by the end of the century (decrease of 13% to increase of 11%).

Cape Cod Basin		Observed Baseline 1971-2000 (Days)	Projected Change in 2030s (Days)	Mid-Century Projected Change in 2050s (Days)	Projected Change in 2070s (Days)	End of Century Projected Change in 2090s (Days)
Consecutive Dry Days	Annual	18.72	-1.06 to +1.99	-0.56 to +2.62	-0.34 to +3.63	-0.26 to +4.65
	Winter	10.19	-0.52 to +1.53	-0.44 to +1.46	-0.31 to +1.83	-0.94 to +1.97
	Spring	11.59	-0.99 to +1.21	-0.86 to +1.50	-1.00 to +1.48	-1.34 to +1.58
	Summer	15.38	-1.00 to +2.02	-0.83 to +2.61	-0.89 to +4.38	-1.03 to +5.26
	Fall	13.05	-0.57 to +2.45	-0.04 to +2.29	+0.17 to +2.82	+0.04 to +3.45

- Annual and seasonal projections for consecutive dry days, or for a given period, the largest number of consecutive days with precipitation less than 1 mm (~0.04 inches), are variable throughout the 21st century.
    - For all the temporal parameters, the Cape Cod basin is expected to see a slight decrease to an increase in consecutive dry days throughout this century.
    - Seasonally, the fall and summer seasons are expected to continue to experience the highest number of consecutive dry days.
        - The summer season is expected to experience a decrease of 1 day to an increase of 5 days in consecutive dry days by the end of the century.

Appendix E: Listening Session Public Comments

Orleans MVP Listening Session (May 22, 2019) Public Comments

A public meeting on May 22, 2019 served as both the MVP Listening Session, as well as the final public presentation for the Multi-Hazard Mitigation Plan (MHMP) process.

Questions specifically related to the MHMP included:

Question 1: Is this version of the MHMP the first hazard mitigation plan for the Town of Orleans or if it was an update?

Answer 1: This 2019 MHMP is an update from the existing 2004 plan. Due to lack of funding, the 5-year update was not performed in 2009. Available funding, as well as new State requirements for Hazard Mitigation Plans were driving factors to complete this current update.

Question 2: Does the MHMP update break down each hazard individually?

Answer 2: Yes. The MHMP contains a separate section for 16 different hazards.

Question 3: Are the land use categories listed in the tables in Chapter 4 defined for the average reader?

Answer 3: Yes. Table 4-1 on page 4-4 provides a description of what types of parcels are included in each land use category.

Question 4: Was "loss of life" one of the criteria for prioritization of the mitigation actions?

Answer 4: Although there was no specific evaluation criterion called "loss of life", there was a criterion related to improving protection of the public. This criterion was intended to determine whether a particular action would provide improvements to protection of the people within the Town and/or improvements to emergency response that would help ensure public safety during and immediately after a hazard event.

Comments specifically related to the MHMP included:

- One participant suggested that another column to be added the Tropical Storm/Nor'easter/ Hurricane Table to indicate storm duration, noting that some storms blow by quickly, and some hang over an area for a longer period of time. This addition would be an interesting comparison and provoke thoughts regarding the amount of damage caused in relation to the storm duration. The duration of the storm can make all the difference when considering how quickly a town can respond or recover.

Questions specifically related to the MVP Summary and Findings report:

Question 1: What are the benefits of completing the MVP process as part of a regional strategy (i.e., Wellfleet and Truro)?

Answer 1: This approach makes sense if towns already share resources (e.g., schools, emergency response, etc.) and are impacted by similar hazards. In that case, neighboring communities could pool resources and develop a more regional strategy.

Question 2: Do the climate change projections used in the MVP presentations assume that there is no chance of reversal of CO2 emissions?

Answer 2: The climate change projections presented were based on two different modeled scenarios: RCP 4.5 and RCP 8.5. These are two of four main Representative Concentration Pathways (RCPs) that represent a range of greenhouse gas emissions scenarios. RCP 2.6 assumes that global annual GHG emissions (measured in CO_2-equivalents) peak between 2010–2020, with emissions declining substantially thereafter. Emissions in RCP 4.5 peak around 2040, then decline. In RCP 6, emissions peak around 2080, then decline. In RCP 8.5, emissions continue to rise throughout the 21st century. So, the two scenarios presented provide both a scenario where emissions are reduced following 2040 (RCP 4.5), as well as a scenario where emissions continue to increase (RCP 8.5).

Question 3: Is the 10 feet of projected sea level rise in the "high" scenario a projection for the state or is it specific to Cape Cod?

Answer 3: The values presented in the graph were predictions specific to Boston, but the magnitude of relative mean sea level rise change is very similar for other parts of the state, including Cape Cod, for the high sea level rise projection.

Comments specifically related to the MVP Summary and Findings report:

- On the discussion of emergency response on the town level and some of the outcomes of the workshop, one participant commented that it might not make sense for every town on Cape to have individualized emergency response or shelters because of the size of Cape Cod towns and their demographics.
- The slight increase in annual projected rainfall doesn't mean we won't have severe periods of drought. That is significant when linking increased temperatures and drought in terms of what people need to have to survive.
- In regards to sea level rise and flooding, one participant voiced concerns over the Rock Harbor and Orleans Rotary areas. Specifically, the Orleans Rotary is the access point to regional emergency facilities and the main exit point of everyone on the outer Cape. This will become even more complicated with sea level rise. Another area of concern is Bridge road. Historically, this area was navigable, but the bridge has not been raised. Flooding may prohibit people from being able to evacuate.

- Cape Cod was traditionally a place for summer cottages, but now many of these are being converting to year-round houses. To protect these homes from flooding (including "sunny day flooding"), there are a lot of resources being used to lift these coastal cottages up in order to respond to FEMA flood zone designations.
- One participant suggested that MVP Action grants should be sought in the future to address the public safety of two bulkheads located at Rock Harbor and Goose Hummock, both of which have fuel depots.
- One commenter mentioned that they weren't sure if current residents even know where the shelter is in Town. This comes down to education and disseminating information to Orleans residents. This comment sparked a conversation about the knowledge gap in residents, during which a number of different potential education and outreach methods were discussed:
    - The Orleans Pond Coalition has an event called Celebrate Our Waters. This could be a good platform to provide information regarding shelters and emergency services to residents.
    - Host a table at the Block party to provide emergency response information?
    - Consider targeting specific groups (e.g., faith based organizations) to help get the information out.
    - For residents in communities vulnerable to isolation due to flooding, potentially utilize technology or sensors tied to predictive models that can notify residents about flooding risks before they occur, so they can evacuate in time. Essentially, could a pre-flooding alert system be put in place?
- One commenter identified inter-agency collaboration as an important conversation to be had. For example, the loss of electric utility services like National Grid can have a large direct impact to us as a town. The Town is severely impacted if we lose power. National Grid is already implementing their own resiliency projects. We need to collaborate on a much larger scale than what we are doing currently. The Town has our own priorities, National Grid as theirs, and the State have their commitments but we need to stop wasting time and resources working individually. We need to create a better platform to work together.
- In regards to the way that actions were ranked in the MVP report, one commenter was concerned that the bulkheads will get the highest priority but the ability to evacuate and actions that take a large capital investment and time for planning will be pushed further down the list.
- One commenter noted that updating building standards, regulations, zoning and bylaws was ranked as a medium priority action, and was concerned that there would be a reluctance to go after these regulation changes because they can be difficult to pass. But stressed that we need to increase our resiliency because we have high density housing in areas that are vulnerable.
- One commenter noted that the rotary is really in Eastham and reiterated its vulnerability. The rotary and the implications of climate change to the rotary are prime examples of where the two towns will have to work together. The rotary is a multi-stakeholder project and would require the involvement of Orleans, Eastham, MassDOT, and the state.

- The area surrounding Willow St was noted as an area of major concern. This road is highly used and needs to be considered. There are rumors that the state highway department is considering some plans. It does not seem to be a priority, but it needs immediate action.
- One participant commented that current stormwater standards and designs are inadequate. We are seeing 100-year rain events every 4 to 5 years.

Following the Public Listening Session, no additional comments were received by the Town.