

Community Resilience
Building Workshop

OAK BLUFFS, MA



SUMMARY OF FINDINGS

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Prepared For:
Massachusetts Executive Office of Energy and Environmental Affairs
3/7/19

1	OVERVIEW
3	COMMUNITY RESILIENCE BUILDING WORKSHOP
4	TOP HAZARDS AND VULNERABLE AREAS <ul style="list-style-type: none">• 2015 Hazard Mitigation Plan vulnerability summary• 2016 Coastal Vulnerability Assessment and Adaptation Plan summary
7	CURRENT CONCERNS AND CHALLENGES PRESENTED BY HAZARDS
9	SPECIFIC CATEGORIES OF CONCERNS AND CHALLENGES
10	CURRENT STRENGTHS AND ASSETS
11	TOP RECOMMENDATIONS TO IMPROVE RESILIENCE TO HAZARDS <ul style="list-style-type: none">• Infrastructural• Societal• Environmental
13	NEXT STEPS
16	RECOMMENDATIONS FROM PREVIOUS STUDIES
18	ACKNOWLEDGEMENTS
19	CRB WORKSHOP PARTICIPANTS
20	APPENDIX A: WORKSHOP GROUPS' ANNOTATED MAPS AND COMPLETED MATRICES
28	APPENDIX B: COMPILED MATRIX
34	APPENDIX C: CRB WORKSHOP INTRODUCTORY PRESENTATION (EXCERPTS)
51	APPENDIX D: WORKSHOP GROUPS' TOP ACTIONS WITH LARGE GROUP "DOT VOTES"

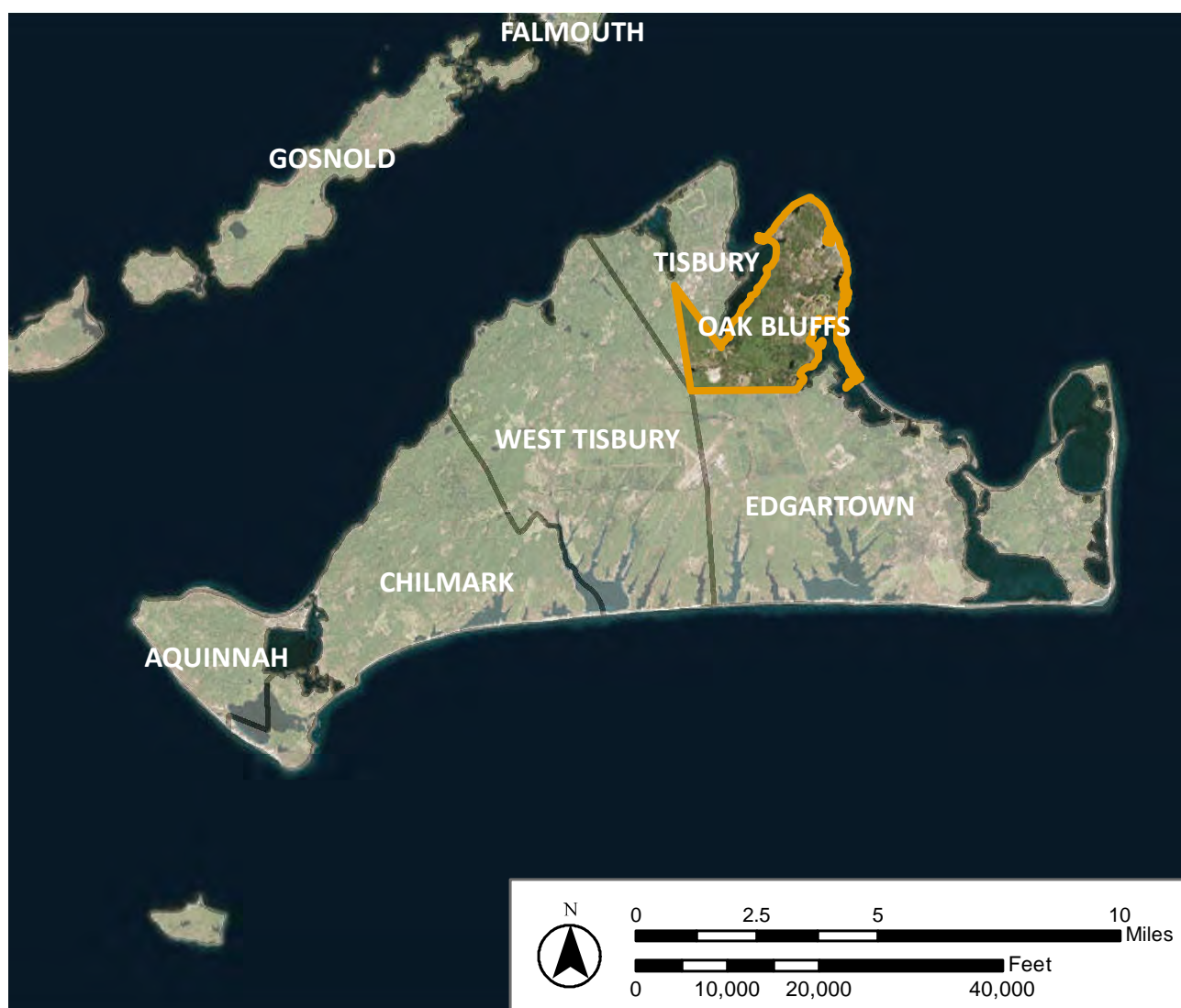
OVERVIEW

Oak Bluffs is no stranger to weather-related hazards. This is the most populated town on the island of Martha's Vineyard, and flooding and wind damage from coastal storms and hurricanes is a regular occurrence. The long-term effects of climate change will likely make severe weather events more frequent, and sea-level rise will increasingly impact Oak Bluffs' densely populated waterfront town center. With no direct road access to the mainland, residents have learned to be self-reliant, and the town has planned carefully to respond to severe weather and other emergencies.

In 2015, the Martha's Vineyard Commission drafted the Hazard Mitigation Plan (HMP) for Seven Towns in Duke's County. Emergency managers and stakehold-

ers from Edgartown, Oak Bluffs, Tisbury, West Tisbury, Chilmark, Aquinnah, and Gosnold identified vulnerabilities and priority action items to build resilience against key hazards in each town. The report had a strong focus on enhancing the resilience of the county's infrastructure, with recommendations for specific roads, bridges, beaches, stormwater systems, development regulations, and other elements of the built environment in each town.

In 2016, the engineering consulting firm Kleinfelder collaborated with the Woods Hole Group to produce the Coastal Vulnerability Assessment and Adaptation Plan for Oak Bluffs. Using current local sea level rise projection data, the report focused mostly on town owned infrastructure that's vulnerable to storm surge and sea level rise, and made recommendations for



Oak Bluffs is one of the island of Martha's Vineyard's more densely populated "down island" towns.



Lake Ave along Oak Bluffs Harbor is an important link through Oak Bluffs' town center. Its vulnerability to storm surge inundation will increase with sea level rise.

protection strategies for those specific elements.

The town of Oak Bluffs decided to build on these previous hazard mitigation planning efforts by working towards Municipal Vulnerability Preparedness (MVP) certification from the Massachusetts Office of Energy and Environmental Affairs (EOEEA). In 2018, the town successfully applied for funding under the MVP program to hold Community Resilience Building workshops and further develop its resilience strategies. While the previous Hazard Mitigation Plan and Coastal Vulnerability Assessment and Adaptation Plan both helped to identify key infrastructural vulnerabilities and priority action items that address part of the MVP requirements, the MVP process places additional emphasis on issues of social and environmental resilience, and takes advantage of the latest climate change data and projections.

As described in the following report, the town held Community Resilience Building workshops on November 1st and 7th, 2018. Facilitated by MVP-certified providers from Dodson & Flinker, the workshops involved stakeholders in developing a detailed Risk Matrix. The Risk Matrix outlined key hazards and the impacts of those hazards on vulnerable infrastructure, social and environmental resources. At the final workshop, participants identified potential actions the town can take to address these vulnerabilities, and set priorities for future action.

COMMUNITY RESILIENCE BUILDING WORKSHOP

The goal of the Community Resilience Building (CRB) Workshop was to build on the 2015 Hazard Mitigation Plan (HMP) and 2016 Coastal Vulnerability Assessment and Adaptation Plan (CVAAP), by identifying a broader range of the community's hazards and vulnerabilities in order to create an updated list of priorities and actions supported by the latest climate change projections.

Oak Bluffs received an MVP planning grant in 2018. The project was led by Liz Durkee (Conservation Agent, Oak Bluffs), supported by a core team which included John Rose (Fire Chief, Oak Bluffs), Tony Lima (Land Bank, Oak Bluffs Parks Commissioner), Kevin Johnson (Oak Bluffs Water District), Robert Whritenour (Town Administrator, Oak Bluffs), Wendy Brough (Assistant Town Administrator, Oak Bluffs), and Christine Flynn (Martha's Vineyard Commission). The Core Team selected MVP certified provider Dodson & Flinker to facilitate the process, which began with a kick-off meeting and tour of the town on September 11, 2018. The Core Team and consultants developed a schedule and agenda for a two-day workshop series, and over the following weeks recruited a group of invited stakeholders. The 28 participants included representatives from town departments, planning board, Martha's Vineyard Hospital, advocacy groups, Steamship Authority, Martha's Vineyard Land Bank, local businesses, and other organizations, institutions, and groups.

The Community Resilience Building (CRB) workshop was held between two sessions on November 1 and November 7, 2018. Following the structure of the CRB Workshop guide, Participants worked together to identify key hazards, infrastructural, societal, and environmental vulnerabilities, and prioritized action items to address climate change-related hazard preparedness for Oak Bluffs. Breakout groups were facilitated by consultants from Dodson & Flinker: Peter Flinker, Dan Shaw, Nate Burgess, and Allison Gramolini.

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
- Identify immediate opportunities to collaboratively advance actions to increase resilience.



Oak Bluffs' unique campground cottages are an important historical and cultural asset, and are vulnerable to flooding and fires.



Beach Road adjacent to Joseph Sylvia State Beach, a narrow barrier island in front of Sengekontacket Pond, is vulnerable to both flooding and coastal erosion.

TOP HAZARDS AND VULNERABLE AREAS

Top Hazards: At the beginning of the workshop, the consultants introduced the workshop process, along with an overview of Massachusetts' current climate change projections, both statewide and downscaled to Duke's county. The consultants also presented a brief summary of the findings from the 2015 HMP and 2016 CVAAP, reminding participants that today's CRB Workshop would add to this list of priority actions, rather than replace them.

Following this, workshop participants were asked to discuss hazards that Oak Bluffs may face now or in the future. The discussion began with the large group in order to generate a quick list of many possible hazards. A long list was quickly generated, and discussions then continued among the four tables, as each smaller group refined a list of their top four hazards.

Discussion about hazards focused on a few main themes, including hazard events that could pose a risk to the town's fairly dense coastal population (compared to other MV and MA towns), risks to the increasingly aging population, events that could dis-

rupt transportation to the mainland, and events that could disrupt power, communication, and access to infrastructure.

The majority of participants identified the following as top hazards which Oak Bluffs faces:

- Sea level rise
- Severe storms
- Flooding
- Erosion
- Drought and heat
- Wildfire
- Ocean acidification and ecosystem change
- Warming waters

2015 HAZARD MITIGATION PLAN FOR SEVEN TOWNS IN DUKES COUNTY

The Hazard Mitigation Plan (HMP) for Seven Towns in Duke's County identified hazards and vulnerabilities in Oak Bluffs along with the whole county. The most significant overall hazards include floods and wildfire. Floods are a frequent hazard caused by hurricanes, nor'easters and coastal storms. Hurricanes are rare but very serious, while nor'easters strike more frequently and have been responsible for more damage over time. Between 1864 and 1965 there were at least 24 fires over 1000 acres in size on Martha's Vineyard, though none of this scale have occurred since 1965. Wildfire is a significant threat as dried dead timber accumulates over time throughout all of the island's forested lands. With the steady accumulation of fuel coupled with a lack of a wildfire management plan outside the state forest, wildfire is a significant potential hazard.

For Oak Bluffs specifically, the top hazards identified were coastal flooding, severe wind and rain from hurricanes and nor'easters, coastal erosion, sea level rise, and wildfires.

A summary of Oak Bluff's vulnerability from the HMP is as follows:

- About 5,279 people (summer) live within areas considered at risk for wildfire. Vulnerable facilities in these areas include 1275 residential buildings; 33 commercial buildings; 12 municipal, public, or non-profit buildings including the fire department and town DPW barn.
- About 1,105 people (summer) live within 100 year flood zones.
- 1,519 people (summer) live within SLOSH category 4 (this could potentially increase to over 2000 people under buildout). Critical infrastructure potentially inundated by category 1 hurricanes includes the ferry terminals (Steamship Authority, Island Queen & Hy-Line), harbor master office, sewer substation, and electrical panel. The lagoon well and police station could be inundated by category 3 storm surge, and the state police station, day care facility, MV Hospital and Windemere Nursing Home could be inundated by a category 4 storm surge.
- 362 people live in areas directly inundated by 4' of sea level rise.



Electrical and sewer pump utilities along Lake Ave control important townwide infrastructure. These particular utilities are vulnerable to storm surge and flooding.



With sea level rise, some of Oak Bluffs' salt marshes may have room to expand inland where gradual enough topography allows, while others may disappear.

Areas of concern: Many of the specific vulnerabilities that were identified are located in the compact area surrounding Oak Bluffs Harbor. This is the town's historic and commercial center, and it includes low-lying flood-prone areas which contain much of the town's critical infrastructure, services, businesses, historical architecture and cultural identity. Another significant cluster of vulnerable features is located around the hospital and Lagoon Pond Bridge. Other vulnerable areas include much of Oak Bluffs' coastline, including roads, infrastructural elements, beaches, ponds, and marshes. Certain individual vulnerable features are scattered further inland.

At the workshops, discussion about vulnerable areas included:

- Oak Bluffs Harbor (downtown)
- Hospital area
- Coastal roads
- Utilities: town well, sewer pumps, electric panel
- Ponds and marshes
- Beaches

CURRENT CONCERNS AND CHALLENGES PRESENTED BY HAZARDS

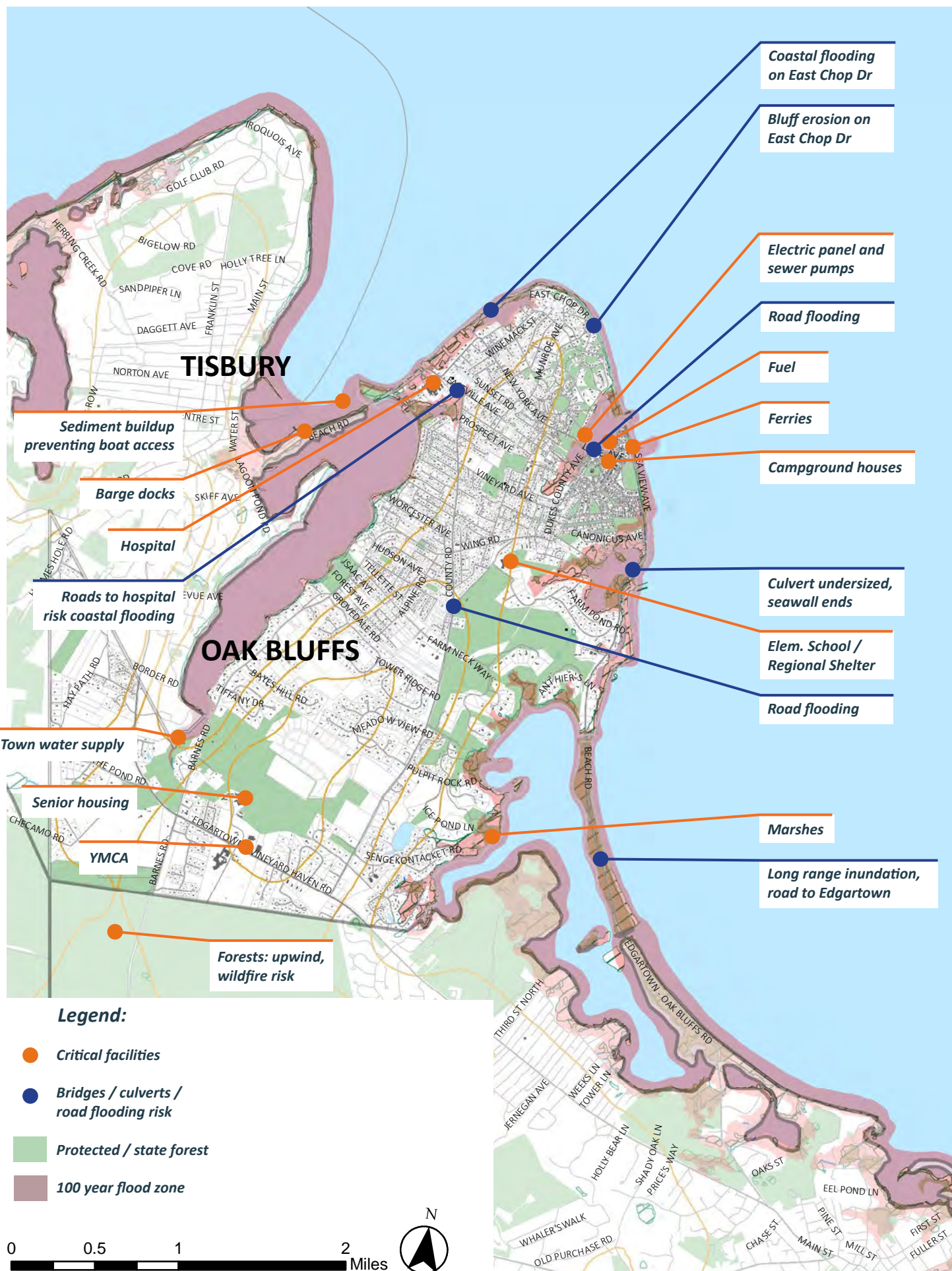
Sea level rise: Most groups made a distinction between coastal flooding from sea level rise and coastal flooding from severe storms. These represent two important but different time scales of planning and response, since sea level rise is a slow and steady baseline increase while severe storms are a sudden acute event that can happen in any given year. The latest models indicate that sea level around Oak Bluffs could rise by as much as a foot and a half by mid-century and up to 6 feet by the end of the 21st century. The low-lying portion of Oak Bluffs' downtown contains homes, businesses, ferry docks, electrical and sewer infrastructure, roads, and other critical assets that serve the town and in some cases the whole island. The Martha's Vineyard Hospital, west of downtown, is also on low lying ground and is accessed by roads which are very vulnerable to coastal flooding. Sea level rise will increase the risk of flooding in all

of these places. Sea level rise is also likely to cause environmental change around the towns' shoreline, as beaches continue to erode, freshwater bodies convert to saltwater, and marshes migrate inland or disappear.

Severe storms: Flooding from severe storms is a particularly urgent hazard in Oak Bluffs. Coastal flooding could cause widespread damage to homes, especially downtown. This includes immediate property damage as well as lingering after-effects like mold. Many of the assets identified above as being vulnerable to sea level rise in the long-term are also potentially vulnerable to coastal flooding from severe storms in the short-term. Effects of storms also include erosion of beaches and bluffs. Erosive wave energy is compounded where these sandy environments are backed by hard structures like seawalls or revetments. Storms also pose a threat to certain roads and wetlands inland, due to flooding from stormwater runoff. As with all 6 Martha's Vineyard towns, island-wide dependence on a small number of ferries and air transport for a majority of supply and transportation underscores the need to maintain reserves of emergency supplies, including food, water, and fuel, in case any of these facilities are disrupted by a severe storm.

Wildfires: Martha's Vineyard has not experienced a wildfire larger than 100 acres since a 1200-acre fire in 1965. Because of the homogenous forest structure and accumulation of fuel that has developed throughout the Island over the decades, the forested interior of the island south of Oak Bluffs poses a significant wildfire risk. Since the densely settled town of Oak Bluffs would be downwind of these forests during the summer, the impact of a large scale wildfire today could be much more catastrophic than in the past.

Water quality: General warming trends from climate change impact the waters of Martha's Vineyard, affecting the economy, environment, and way of life on the Island. As waters warm, important species like lobster gradually migrate northwards to colder waters. Ocean acidification is impacting the viability of shellfishing. Nitrogen from lawn fertilizer and from septic tanks accumulates in the ponds surrounding Oak Bluffs, causing algal blooms, further compromising the viability of shellfishing, and posing public health risks.



Aging population: by 2035, Oak Bluffs is projected to have a population that's 30% age 65 and older, a 30% increase from its 2010 age ratio¹. All hazards identified in Oak Bluffs will have to be considered in light of this aging population. Communication and emergency response are likely to be issues of key importance.

SPECIFIC CATEGORIES OF CONCERNS AND CHALLENGES

- Water supply by Upper Lagoon Pond is vulnerable to sea level rise, though there are plans underway to construct new wells further inland.
- Roads in need of short-term infrastructure improvements or raising included Eastville Ave and County Rd by the hospital, the portion of Seaview Ave by Inkwel Beach, and County Rd at Tradewinds Rd.
- The forests in the southern part of Oak Bluffs and the State Forests south of Oak Bluffs present a sig-

nificant risk of wildfire, especially since the heavily populated Oak Bluffs is downwind of this area during summer.

- The culvert at Farm Pond was identified as currently being too small for the volume of water that needs to pass through it during storm events.
- Roads whose long-term existence was called into question due to sea level rise included nearly all of East Chop Dr and the portion of Beach Road on Joseph Sylvia State Beach.
- The Martha's Vineyard Hospital and Windemere Nursing Home are vulnerable mainly due to the possibility of flooding on the roads leading to this area (Eastville Ave, County Rd).
- The area surrounding Oak Bluffs harbor is vulnerable to sea level rise, including buildings on the northwest edge of the harbor, sewer pump and electrical infrastructure, Lake Ave, and certain homes and businesses.

1 Oak Bluffs Housing Production Plan FY2018-2022. Prepared by JM Goldson with RKG Associates.

- Emergency supplies like food, water, and fuel are



Above: Town sewer pumps at Dukes County Ave and School St are in a low-lying area vulnerable to flooding.

Facing page: Key features identified by workshop participants are indicated on the townwide basemap.

potentially vulnerable due to Martha's Vineyard's limited connection with the mainland.

- The gas stations in Oak Bluffs are located on Oak Bluffs Harbor, on Lake Ave (cars) and Circuit Ave Extension (boats), and both are vulnerable to sea level rise.
- The barge docks, which are in Tisbury just past the Lagoon Pond Bridge from Oak Bluffs, are an important fuel supply point from the mainland to the Island, and could be vulnerable to storm surge and rising sea levels.
- The build up of sand in the Lagoon Pond Bridge channel prevents boats from entering Lagoon Pond, which could be an important protective harbor during storms.
- Campground houses are an important historical and cultural asset, but historic preservation restrictions can get in the way of upgrades that could make the buildings more floodproof and fireproof.
- The police station by Oak Bluffs Harbor is vulnerable to coastal flooding, especially its basement level archives.
- Harmful nitrogen levels in ponds like Sengekontacket Pond and Lagoon Pond, as well as general ocean acidification, threaten shellfishing.
- The causeway and herring run between saltwater Lagoon Pond and freshwater Upper Lagoon Pond serves an important ecological role for herring spawning habitat, and is vulnerable to saltwater inundation from sea level rise.
- Marshes in Brush Pond, Crystal Lake, Sengekontacket Pond and Farm Pond could disappear if rates of sediment accretion are outpaced by sea level rise.
- The wetlands south of Sunset Pond are vulnerable to regular flooding.

CURRENT STRENGTHS AND ASSETS

Emergency shelter: Oak Bluffs Elementary School, located inland and uphill enough to be protected from storm surge and sea level rise, serves as a regional emergency shelter.

Large-capacity venues: Martha's Vineyard Regional High School, Martha's Vineyard Ice Arena, and the YMCA of Martha's Vineyard are facilities which could accommodate large groups of people or large amounts of supplies in a hazard-response event or its aftermath.

Town barn and generators: Located at Pennsylvania Ave and County Rd, this facility is home to important town-owned infrastructure.

Town sewer: Much of Oak Bluffs is on town sewer, which helps to limit the concentration of nitrogen runoff from private septic systems into surrounding water bodies. Existing sewer areas have the potential for expansion.

Ferry docks: While the year-round ferry terminal is located in Tisbury, Oak Bluffs' seasonal ferry terminals bring cars, passengers, and supplies to and from the island during the summer. This link to the mainland is a critical asset to all of Martha's Vineyard, and is located at Oak Bluffs Harbor.

Fire and emergency medical services: Oak Bluffs benefits from a reliable, responsive fire department and emergency medical services, and from having the Island's hospital in town. Fire and EMS rely heavily on volunteer staffing from the community, and have a good communication network.

Vulnerable population plan: Emergency managers and hospitals in the area maintain a confidential list of priority residents to reach in the event of a power and communication outage. This is important considering the added vulnerability of Oak Bluffs' aging population.

Brazilian population: The Portuguese-speaking population in Oak Bluffs is a tight-knit and self-reliant part of the community. Brazilian churches are an important part of this population's communication network.

Social services: Organizations like First Stop MV and the Good Shepherd church make important social services available.

TOP RECOMMENDATIONS TO IMPROVE RESILIENCE TO HAZARDS

Participants in the Community Resilience Building workshop identified dozens of potential actions to address climate change, sea level rise, flooding and other challenges. These have been compiled into the following list, organized by the workshop's three categories of infrastructural, societal, and environmental action items. The list below is also supplemented by top recommendations from the 2015 Hazard Mitigation Plan (HMP) and 2016 Coastal Vulnerability Assessment and Adaptation Plan (CVAAP). All potential actions below were generated by workshop participants except where otherwise noted.

INFRASTRUCTURAL

- Raise Seaview Ave at Farm Pond and increase the culvert size, to protect against sea level rise.
 - Raise the intersection of Eastville Rd and County Rd including road segments leading up to this intersection, to help protect hospital access from sea level rise (Kleinfelder, CRB workshop).
 - Create an emergency supply of food, water, and fuel for the hospital.
 - Extend the existing seawall to Harthaven, and raise the wall to a total height of 12'; or construct a protective dune and beach east of Seaview Ave, to protect against sea level rise (CVAAP).
 - Planned retreat from East Chop Drive would greatly reduce the risk posed by erosion, sea level rise, and storm surge in this area. The low-lying section of East Chop Drive between Vineyard Sound and Crystal Lake is vulnerable to coastal flooding, while the section running along East Chop Bluff is at risk of damage due to erosion of the adjacent bluff. Planning for use of alternate routes would prevent either of these hazards from disrupting travel.
 - Protect Beach Road at Sengekontacket from erosion and flooding through the use of non-structural
- erosion control measures. While hard structures such as jetties and groins have commonly been used to protect infrastructure, the Massachusetts Office of Coastal Zone Management (CZM) notes that such structures increase scour and beach erosion (CZM Policy Guide, October 2011). Non-structural restorative measures such as beach nourishment and dune rebuilding are recommended to protect both the road and the adjacent natural resources.
- Relocate and rebuild public water supplies further inland and uphill to protect against sea level rise (already underway).
 - Raise the perimeter bulkhead around Oak Bluffs Harbor with a permanent barrier, and raise the dune on Jetty Beach and behind East Chop Beach Club to prevent flood water from reaching inland; accompanied by beach nourishment to further fortify the beaches and dunes in this area, and a possible glass sea wall along the bulkhead. Alternatively, a temporary flood barrier could be stored horizontally in the sidewalk and deployed in advance of a storm (CVAAP).
 - Construct a hurricane barrier outside of Oak Bluffs Harbor to protect against flooding around the harbor. This could be a seawall, gate at the end of the channel, or living breakwater.
 - Protect electrical infrastructure for sewer pumps by replacing the existing wooden building by the harbor with a waterproof structure with an electric panel above flood elevation; or relocate to another location. Dukes County Rd station was recommended at workshop (CVAAP, CRB).
 - Create a backup solar battery bank at the town landfill.
 - Conduct more regular tree trimming to protect above ground power lines from wind damage and resulting power outages during storms.
 - Protect the Vineyard Haven causeway to the ferry.
 - Create a town fund for ongoing dredging needs.

SOCIETAL

- Hire a full-time emergency response planner, to help coordinate shared problems among the Island towns and to reduce vulnerability from current dependence on volunteer emergency responders.
- Conduct voluntary buyouts for parcels vulnerable to sea level rise and storm surge.
- Designate a permanent building to house emergency supplies, particularly ensuring the hospital has access to food, water, and fuel.
- Create a text message alert system, particularly for the benefit of seniors.
- Create a cleanup plan for the aftermath of a flood event, to prevent public health impacts of mold and other resulting hazards.

ENVIRONMENTAL

- Implement green infrastructure on parcels vulnerable to sea level rise and storm surge; techniques including dune enhancement, beach nourishment, wetland restoration, thin layer marsh deposition.
- Install constructed oyster reefs to protect against storm surge and sea level rise, to double as shell-fishing enhancement, and to filter water.
- Update septic regulations in response to sea level rise and nitrogen contamination.
- Expand sewerage to further limit septic discharge to local waters.
- Update zoning to limit uses within potential storm surge and flood areas.
- Continue beach nourishment as long as feasible to maintain Oak Bluffs' tourism economy.
- Perform a detailed study of coastal processes to understand hydrologic and sediment transport systems in the area (CVAAP).
- Conduct thin layer marsh sediment deposition to help marshes keep up with sea level rise.



The herring run between saltwater Lagoon Pond and freshwater Upper Lagoon Pond serves an important ecological role for herring spawning habitat, and is vulnerable to saltwater inundation from sea level rise

- Conduct voluntary buyouts for vulnerable environmental sites, in order to build dunes, nourish beaches, and install other green infrastructure techniques.

Participants in the Community Resilience Building workshop identified dozens of potential actions to address climate change, sea level rise, flooding and other challenges. Each of the breakout groups presented its top priority actions to the whole group, and at the end of the session each person voted among the compiled top action items, using three green dot stickers per person which they could distribute any way they liked. The results of this exercise are documented in the appendix.

NEXT STEPS

The core team took the top priority actions from the workshop and developed a short list of the top projects for which Oak Bluffs could seek funding for implementation. These projects were conceived with the goal of achieving multiple priority actions from different categories simultaneously. The infrastructural priorities include protection of the harbor, downtown, historic neighborhoods, and vulnerable structures. The societal priorities include access to the MV Hospital, protection of fresh water supply, emergency preparedness and response to extreme weather events, and economic impacts. The environmental priorities include protection of fresh water supply and coastal natural resources such as beaches and salt ponds.

PROTECT OAK BLUFFS HARBOR

(Infrastructural/Societal)

Areas and features around Oak Bluffs Harbor to protect from flooding, storm surge and sea level rise include the recreational and economic value of the harbor, Lake Avenue, homes and businesses on the harbor, historic MV Camp Meeting Association homes, and Sunset Lake and wetlands area inland to Vineyard Avenue.

- Reconfigure jetties to protect the harbor in NE storms (planning underway).
- Consider the possibility of offshore breakwaters.
- Construct a hurricane barrier.
- Raise the harbor bulkhead to address sea level rise.

ACCESS TO MV HOSPITAL

(Infrastructural/Societal)

Three of the four access roads to the hospital are in the 100-year flood zone, making them impassable in storms (Beach Road, Eastville Avenue, County Road). The fourth access, Temahigan Avenue, would be inundated in a category 3 hurricane, eliminating all access to the hospital. By collaborating with MV Hospital, Tisbury and all Island towns, Dukes County

Emergency Management, and MA DOT, access to the hospital could be enhanced and protected.

- Raise County Rd and Eastville Ave to provide viable access to the hospital during flood and storm events and as sea level rise advances.
- Collaborate with MA DOT and Tisbury to further protect access via Beach Rd.

PROTECT FRESH WATER SUPPLY (WATER SECURITY)

(Infrastructural/Societal/Environmental)

The Lagoon Pond well is vulnerable to salt water intrusion if the causeway between Lagoon Pond (salt water) and Upper Lagoon Pond (fresh water) fails due to storm over wash and sea level rise. This well is currently the primary source of drinking water for most of the town. A town's inability to access or provide clean water to residents could have serious economic impacts; long term implications could include a decline in property values and tax base. Environmentally, the herring run at the causeway is vital to herring access to the Upper Lagoon Pond. The causeway protects the freshwater habitat of the Upper Lagoon to enable spawning success of the herring and other species.

- Raise the Lagoon Ponds causeway to protect Upper Lagoon Pond and the town well (collaborate with Tisbury), through a combination of hard and soft engineering.
- Improve the herring run design and construction to adapt to sea level rise and storm surge.
- Continue planning for wells in other locations.

EMERGENCY PREPAREDNESS

(Infrastructural/Societal)

The towns of Martha's Vineyard should create, fund, and fill the position for a professional Islandwide emergency planner. This same recommendation also came out of the West Tisbury and Chillmark MVP planning process. The planner's duties would include, but not be limited to: preparation for the impacts of

storms, hurricanes, and flooding; response training for wildfire and fire in highly compact, dense, historic downtown areas (including preparation for economic losses), water supply protection, storm and hurricane evacuation, shelters, elderly support, communication to the public, storm aftermath (clean-up, shelter, food, medical supplies, medical care), and emergency supplies.

- Create, fund, and fill the position of professional islandwide emergency planner.

SEA VIEW AVENUE ACCESS - STEAMSHIP AUTHORITY TO FARM POND

(Infrastructural/Societal/Environmental)

Sea View Avenue is a major transportation gateway and vital town asset, as well as an iconic and scenic coastal road. It provides access to in-town beaches, parks, coastal ponds, the Harthaven neighborhood, State Beach/Sengekontacket Pond, Edgartown, and destination points to all other Island towns. Seeking funding for infrastructural improvements along this corridor would yield multiple benefits. The Town and State would be the primary responsible parties.

- Protect the Steamship Authority (SSA) dock. Communicate with SSA on plans for docking facility renovations in response to sea level rise.
- Repair the seawall from SSA to Farm Pond (short-term repairs and long-term stabilization). Through coordination with MA DOT, the seawall could be extended (and possibly raised) south across from Farm Pond to protect emergency access to Harthaven, State Beach, and inland areas around Farm Pond, including Oak Bluffs school.
- Conduct beach nourishment (and groin rehabilitation) of Sea View Avenue beaches for as long as is economically and environmentally feasible, in order to protect recreational, cultural and storm damage protection values of in-town beaches. This should include North Bluff, Pay and Inkwell beaches.
- Enlarge the culvert to Farm Pond (including adding a storm gate to address storm surge) to help improve water quality.

- Protect the exposed road at Farm Pond for emergency access to Harthaven, State Beach, and Edgartown.
- Protect Oak Bluffs School (emergency shelter).
- Conduct an artificial reef / oyster reef pilot program to protect against storm surge and erosion.

ADDRESS CLIMATE RESILIENCY USING GREEN INFRASTRUCTURE WHERE POSSIBLE

(Infrastructural/Societal/Environmental)

While seawalls and hard infrastructure should be strengthened where necessary to protect downtown, the harbor, and emergency access, green infrastructure and living shorelines elsewhere can provide more nature-based climate resiliency. The town would play a leading role, in partnership with private landowners.

- Install green infrastructure such as rain gardens and bioswales to provide for storm water management (coastal and inland flooding), in places where existing infrastructure concentrates high volumes of stormwater.
- Install living shorelines to provide salt marsh protection in coordination with thin layer deposition to help protect salt marshes against sea level rise.
- Install vegetated dunes and conduct bank restoration to provide infrastructural protection while also enhancing Oak Bluffs' natural systems.
- Consider retreat options when adaptation options are no longer environmentally feasible. Conduct buy-outs of vulnerable structures by seeking federal and state funding, and return sites to natural conditions. Work with MV Land Bank on purchase and 'unbuilding' of vulnerable properties.



The causeway between Upper Lagoon Pond and Lower Lagoon Pond preserves Upper Lagoon Pond's freshwater environment from saltwater intrusion. Sea level rise could likely lead to high tides overtopping the causeway if it remains at its current elevation, which would wipe out this important freshwater habitat.

POSSIBLE FUNDING SOURCES

Funding for implementation from public sector sources could include:

- MVP Implementation grants from Massachusetts Executive Office of Energy and Environmental Affairs, ranging from \$10,000 - \$400,000 are available to municipalities upon completion of the MVP planning process
- Massachusetts Emergency Management Agency (MEMA) grants
- FEMA's Hazard Mitigation Grant Program (HMGP)
- MassWorks Infrastructure grants from Massachusetts Executive Office of Housing and Economic Development
- Massachusetts Division of Ecological Restoration's Culvert Replacement Municipal Assistance grants
- Massachusetts Seaport Economic Council grants
- Dam and Seawall Repair or Removal grants from
- Commonwealth Conservation Land Tax Credit (CLTC) might be able to be utilized as part of a planned retreat strategy if coastal landowners were willing to donate (with partial reimbursement) vulnerable land towards creating living shorelines, vegetated dunes, bank restoration, etc.
- Massachusetts Department of Environmental Protection 604b Water Quality Management Planning Grants
- Massachusetts Complete Streets Funding Program for improvements to key local roads as long as they will include bicycle, pedestrian, etc.
- Collaboration with land preservation organizations like Martha's Vineyard Land Bank and Trustees of the Reservation, for purchasing land as part of managed retreat
- Other state funds for land conservation
- EPA grants

Massachusetts Executive Office of Energy and Environmental Affairs

RECOMMENDATIONS FROM HAZARD MITIGATION PLAN¹

General recommendations for Dukes County towns overall included:

- Increase capacity in adaptation to climate change, by incorporating 25-year storm calculations rather than 10-year volume into regulations and public infrastructure planning. Establish management plans for state forests, to reduce fire risk, and participate in DCR Firewise program.
- Plan and build drought-resistant infrastructure for water supply.
- Continue mapping and estimates of structures within 100 year floodplain.

In addition to these overall recommendations, specific recommendations were made for individual towns. For Oak Bluffs, recommendations were assigned a score indicating their level of priority. Higher priority recommendation included:

- Replace the culvert that currently restricts storm-water flow in and out of Farm Pond with one adequately designed and sized.
- Ask MVC to revise the Coastal District boundary to include the top of East Chop bluff (presently includes only the face of the bluff).
- Develop wetlands bylaw regulations for vegetation and upgrade regulations for Land Subject to Coastal Storm Flowage.
- Clear a 100-foot firebreak between the Southern Woodlands and vulnerable residences.
- Retrofit drainage in the vicinity of Waban Park/Inkwell Beach to prevent further beach erosion by stormwater discharge.
- Reduce damaging volume of direct stormwater

discharges to beaches and surface waters by infiltration of those segments of the systems where infiltration is possible back in the watershed.

- Retrofit 3 vulnerable sewer pump stations: Sunset Lake (relocate controls to operate remotely), Our Market parking lot (elevate control panel and relocate to landward side of bathrooms), elevate or relocate the control panel at the corner of School St/ Dukes County Ave.

¹ Hazard Mitigation Plan for Seven Towns in Duke's County. Draft February 2015.

Prepared by the Martha's Vineyard Commission.

2016 COASTAL VULNERABILITY ASSESSMENT AND ADAPTATION PLAN

The 2016 Coastal Vulnerability Assessment and Adaptation Plan, by consulting firm Kleinfelder with support from the Woods Hole Group, outlined sea level rise projections for Oak Bluffs, identified vulnerable town-owned infrastructure, and described specific strategies for protecting these assets against storm surge and sea level rise. The plan also included a projection of wetland classification change from sea level rise, including marsh migration and freshwater bodies converting to estuarine water.

The report identified inundation risks along Oak Bluff's coastline, and made the following recommendations:

- Oak Bluffs Harbor: raise perimeter bulkhead or create a hurricane barrier to close the harbor entrance channel.
- Hospital area: raise the low portions of Eastville Ave (940 ft) and County Rd to maintain emergency access to the hospital. Surrounding the area in dunes was briefly explored but deemed highly cost-ineffective.
- Farm Pond and Seaview Ave: extend existing seawall to Harthaven, or raise Seaview Ave, or construct a sacrificial dune system east of Seaview Ave.
- Sengekontacket Pond and Joseph Sylvia State Beach: eventually abandon road and dunes and allow barrier beach to migrate westward, or utilize a beach and dune restoration program to protect the road (may be unsustainable over time).
- Brush Pond and parts of Farm Pond: thin layer deposition for marshes to keep up with rising tides.

Acknowledgements

Special thanks to the Oak Bluffs Library for providing the facilities for this workshop and to Kronig's Market for providing dinner. This project was made possible through funding from the Massachusetts Executive Office of Energy and Environmental Affairs, and through the efforts of the project's Core Team members: Liz Durkee, Tony Lima, Christine Flynn, Wendy Brough, Robert Whritenour, John Rose, and Kevin Johnson.

CRB Workshop Project Team

Organization	Name	Role
Oak Bluffs Conservation Agent	Liz Durkee	MVP Core Team Leader
Martha's Vineyard Land Bank Commission, Oak Bluffs Parks Commissioner	Tony Lima	MVP Core Team
Martha's Vineyard Commission	Christine Flynn	MVP Core Team
Assistant Town Administrator, Oak Bluffs	Wendy Brough	MVP Core Team
Town Administrator, Oak Bluffs	Robert Whritenour	MVP Core Team
Oak Bluffs Water District	John Rose	MVP Core Team
Fire Chief, Oak Bluffs	Kevin Johnson	MVP Core Team
Dodson & Flinker	Peter Flinker	MVP Provider, Facilitator
Dodson & Flinker	Dan Shaw	MVP Provider, Facilitator
Dodson & Flinker	Nate Burgess	MVP Provider, Facilitator
Dodson & Flinker	Allison Gramollini	Facilitator

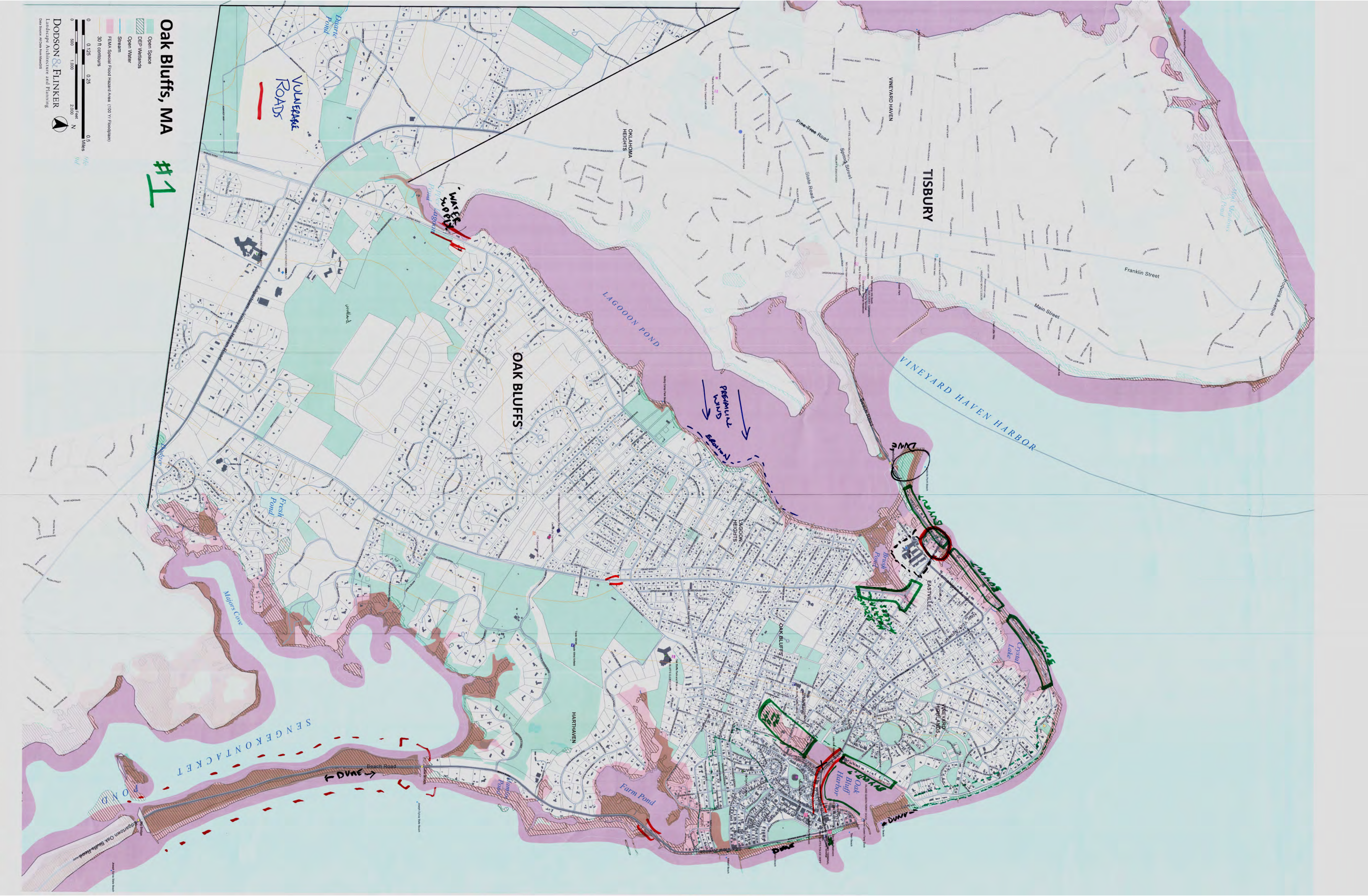
Citation

Flinker, Peter and Daniel Shaw (2018). Town of Oak Bluffs Community Resilience Building Workshop Summary of Findings. Dodson & Flinker.

CRB Workshop Participants

**indicates participation in group workshop exercises*

First	Last	Entity
Christine	Flynn*	Martha's Vineyard Commission
Dave	Grunden	
Suzanne	Cioffi*	Martha's Vineyard Transit Authority
Mark	Hanover*	Steamship Authority
Richard	Seelig*	Oak Bluffs Citizens' Beach Committee
Ian	Peach*	MV Land Bank Commission
John	Rose	Oak Bluffs Fire Chief
Tom	Chase	The Nature Conservancy
Jason	Balboni*	Oak Bluffs Selectman
Doug	Abdelnour*	Oak Bluffs Businessman
Carol	Bardwell*	Martha's Vineyard Hospital
Chick	Stapleton*	Friends of Sengekontackett/ School Env. Ed.
Jim	Monteith*	OB Wastewater/ MV Camp Meeting Association
Kevin	Johnson*	Oak Bluffs Water District
Wendy	Brough*	Assistant Town Administrator
Amy	Billings*	Oak Bluffs Parks & Recreation
Sam	Low*	Oak Bluffs Harthaven Community
Sheri	Caseau*	Martha's Vineyard Commission
Valci	Carvalho	
Donna	Hayes*	Oak Bluffs
Tony	Lima*	MV Land Bank, OB Parks Commissioner
Jo-Ann	Taylor*	Martha's Vineyard Commission
Dan	Martino*	Lagoon Pond Association/ Cottage City Oysters
Rose	Cogliano*	OB Council on Aging
Meegan	Lancaster*	OB Health Agent
JoJo	Lambert*	OB Planning Board
Liz	Durkee	OB Conservation Agent



Community Resilience Building Risk

RAISE
KEEPS

TABLE 1

www.CommunityResilienceBuilding.com

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Priority for action over the Short or Long term (and Ongoing)				SEA LEVEL RISE	EXTREME HEAT HUMIDITY, DROUGHT	COASTAL FLOODING, EROSION	SEVERE STORMS	Priority	Time
Features	Location	Ownership	V or S					H - M - L	Short Long Ongoing
Infrastructural									
VULNERABLE ROADS	ON MAP	STATE & TOWN	V				① PROTECT/SECURE/RAISE/ENHANCE VULNERABLE ROAD SEGMENT	M	
ROAD NETWORK & COUNTY ROAD	TOWNWIDE	TOWN & PRIVATE	S				ENHANCE KNOWLEDGE OF LESS VULNERABLE ROUTES & MAKE USABLE	M	○
BULKHEADS / REVENEMENTS / ETC.	ON MAP	TOWN	V					L	
WATER SUPPLY STATIONS & DISTRIBUTION	LAGOON POND	TOWN	V	(STUDY) RELOCATE TO HIGHER GROUND	ENSURE VIABILITY		① ROAD ACCESS	H	L
WASTEWATER STATIONS	SUNSET POND								
HOSPITAL / ACCESS	SPECIFIC	PRIVATE	V				② ROAD ACCESS ③ BUYOUTS / GREEN SPACE	H	○
STEAMSHIP & HARBOR				⑤		③	④	H	○
Societal									
HISTORIC BLDGS + LANDSCAPES	(SEE MAP) DOWNTOWN / E. CHOP DRIVE	PRIVATE	V	SEE ⑤	EDUCATIONAL PROGRAM: COST/BENEFIT IMPROVEMENTS re. Cape Light		UNDERGROUND POWER LINES	M	○
PUBLIC HEALTH	TOWNWIDE	PUBLIC / STATE	V			ZONING LIMIT USES w/ POTENTIAL DAMAGE	PLAN/FUNDING FOR CLEANUP	H	○
TAX REVENUE FROM PRIVATE HOMES	TOWNWIDE	PRIVATE	V			EXPLORE MARKET-BASED INCENTIVE PROGRAMS FOR RELOCATING BLUFF HOMES		L	L
TOURISM / COMMERCE	DOWNTOWN & BEACHES	TOWN / PRIVATE	V	BUYOUTS AND GREEN INFRASTRUCTURE NW SIDE OF HARBOR		CHANNEL PROTECTION	④	M*	○
ELDERLY SERVICES		TOWN, STATE, LANDBANK	V					L	
Environmental									
LAGOON / SEGMENT POND SHELLFISH / HATCHERY	SPECIFIC	STATE, COUNTY, TOWN	V			③	③	M*	○
WETLANDS / SALT MARSH	TOWNWIDE	TOWN, STATE LANDBANK	V/S	② VOLUNTARY BUYOUT & RESTORED WETLAND SEE MAP		④	VOLUNTARY BUYOUT ① RESTORED WETLAND	M*	○
URBAN CANOPY WOODLANDS	TOWNWIDE	TOWN, PRIVATE, LANDBANK	V					L	
BEACH	ALL	TOWN, PRIVATE, COUNTY	V	SEE ③	EXPAND BEACH	③ BUYOUTS + GREEN INFRASTRUCTURE	SEE ③ LIVING BEACHES	M*	○
DUNES	SEE MAP	STATE	V/S					M	S/L
WATER QUALITY (NITROGEN) SUPPLY & WETLAND	TOWNWIDE				STREAMLINE STATE PERMITTING FOR SEPTIC (ACT. TECHNOLOGIES)	EXPLORE COST/BENEFIT OF DENITRIFICATION vs. FLUISHING OF NITROGEN AT LATERAL CHAMBER			

ALSO... FIRE

WILDFIRE

HURRICANE
NOREASTERS

LAND
SUBSIDENCE (?)

Community Resilience Building Risk Matrix

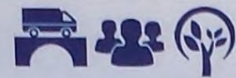


TABLE 2

www.CommunityResilienceBuilding.com

H-M-L pri				Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)				Priority	Time
V = Vulner								H-M-L	Short Long Ongoing
Features	Location	Ownership	V or S						
Infrastructural									
SEWER PUMPS	HARBOR	TOWN						H	S
FERRY DOCK		DOT							
ELECTRICAL STATION		TOWN		MOVING ELECTRIC FROM LAKE ST. TO DUCES COUNTY RD; BACKUP BATTERY				H-M	O
HOSPITAL/NURSING HOME		PRIVATE		BACKUP EMERGENCY SUPPLY					
ROADS/BRIDGE	LAKE SEA. BRIDGE	TOWN/STATE							
BRIDGE		STATE							
Societal									
ELDERLY/SENIOR POP.	DT/ CAMPGROUND		V						
SCHOOL A/ SHELTER	OB ELEM.		S						
FIRE/EMS SYSTEMS			S	ENHANCE EMERGENCY COMM. SYSTEM					
" COMMUNICATION			S						
BACKUP ENERGY SUPPLY			V/S	BATTERY STORAGE (LANDFILL) MOVING ELECTRICAL FROM LAKE ST. TO DUCES COUNTY					
Environmental									
LOCAL WATER SUPPLY	ON MAP	LATER DIST. (TOWN)	V/S						
DUNES/BLUFFS	E. CHOPPED BEACH WALK	STATE	V	ADDING SEP. TO E. CHOP BLUFF					
SHELLFISH / NITROGEN		TOWN	V	OYSTER BEDS	OYSTER REEFS ALONG SHELLFISH WAVE BARRIER	MARSH DEP. PROJECT DIRECT GROW FUND			
SENSE CONTACT - LAB WORK		TOWN	V/S						
SINGLE-USE PLASTIC		(ALL)	V						
SHORE BIRDS	CARSON ISL.	COUNTY	S.						

OB HARBOR

DOWN-TOWN

HURRICANE/NOV EASTER

FLOODING

EROSION

TEMP. RISE EXTREME

Hurricane barrier outside of OB Harbor
→ Oyster beds

Culvert/raised rd @ Sea View

growing along Beach Rd (C Senegambian)

Scavenger Farm Road: culvert w/ raised roadway

Backup emergency supplies (food, water, fuel)

TREE TRIMMING ⇒ LESS FREQ. OUTAGE

NOREASTERS

SUBSIDENCE (?)

Community Resilience Building Risk Matrix					www.CommunityResilienceBuilding.com				
TABLE 3					Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)				
Features	Scale	Vulnerability	Value	Mitigation	Hazard	Severity	Priority		Time
							H - M - L	Short Long Ongoing	
Infrastructure									
HOSPITAL		MASS GENERAL	V+S	RAISE ACCESS ROADS OR CONTROL GATES ON LAGOON	SEVERE STORMS RAIN + WIND			H	
COASTAL ACCESS ROADS	TOWN-WIDE	TOWN + STATE	V	RAISE ROADS; SEA WALLS AS NECESSARY	CONSTRUCTED OYSTER REEF	STABILIZED EAST WHARF.		H	
WELLS + DISTRIBUTION SYSTEM	TOWN WIDE	TOWN	V+S	RAISE CAUSEWAY HIGH P.		RETREAT FROM BLUFF DRIVE BUILD WHARF.		H	
HARBOR		TOWN	V+S	OYSTER REEF	GLASS SEA WALL	REDESIGN JETTIES - GATES AT ENTRANCE		H	
FERRY DOCK		SSA	V+S	"				L	
POWER LINES	TOWN WIDE	EVERSOURCE	V+S	DON'T KNOW!				L	
Societal									
ELDERLY (SENIORS) KUPUNA		WISG + REVEREND PONG		PROTECT HARBOR + CAMPGROUND	COMPREHENSIVE LIST OF SENIORS → COMMUNICATION	GOOD NEIGHBORHOOD PROGRAMS		H	E (EXPENSIVE)
TOURISM				PROTECT HARBOR + BEACHES	PROTECT V.H. CAUSEWAY TO FERRY			H	
ECONOMY					(SEE ABOVE)			M	
HISTORIC CHARACTER				PROTECT DOWNTOWN + HISTORIC NEIGHBORHOODS				M	
HOUSING				ENCOURAGE SMALL UNITS, COTTAGE, MULTI-FAMILY, APARTMENTS				M	MOORE RETAIL
SOCIAL + ECONOMIC DIVERSITY				NEED AFF. HSG FOR EMPLOYEES	INCREASE DENSITY - NECESSARY UNITS!			M	
Environmental									
SHELLFISHING + NURSERIES				PROTECT BARRIER BEACHES / CAUSEWAYS		BUILD THATCH CULTURE		H	
BEACHES				ROCKS, ROCK BARS				H	
MARSHES								M	
WATER QUALITY				STORMWATER BMPs. RETAIN VEGETATION		BUILD ON FANS		H	
BLUFFS								L	

FIX PERMIT PROCESS

RAISING HOSPITAL ACCESS ROADS

RAISE HEAD OF LAGOON CAUSEWAY

J19911 THE JETTIES

FARM POND SEA WALL + CULVERT

CLASS HARBOR WALL

* FRIENDS + NEIGHBORS OF SENIORS UNITS

* FRIENDS + NEIGHBORS OF SENIORS

NO REPAIRS

SUBSIDENCE (?)

Community Resilience Building Risk Matrix



www.CommunityResilienceBuilding.com

GROUP #4

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength


Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)


H-M-L priority for action over the Short or Long term (and Ongoing)				STORMS: Hurricanes, Nor'easters, Storm Surge			SEA LEVEL RISE	WILDFIRE	OCEAN ACIDIFICATION, Fish die off ALGAL BLOOMS etc	Priority	Time	
V = Vulnerability S = Strength										H - M - L	Short Long Ongoing	
Features	Location	Ownership	V or S									
Infrastructural												
SUPPLY: FOOD, FUEL, WATER	dispersed (in red on map)	PRIVATE + PUBLIC	S/V	* Permanent bldg to house emerg. supplies				*		H	S/O	
PUBLIC WELLS	specific	WATER DISTRICT	V (now on streets)				Build new public wells south toward forest			M	L	
SEPTIC TANKS	everywhere but downtown	PRIVATE	V				Update septic Regulations		expand sewer to low-lying + constant leaks	H	S	
POWER GRID + COMMUNICATION/phone Above ground	everywhere	ever source	V	undergrounding						M/L	L	
Societal												
DEPENDENCE ON VOLUNTEER emergency responders	Town/ish wide	Public + Private	V/S	* Full time regional Emergency Response Plan				*		H	S/O	
AGING POPULATION	Town W.	PRIVATE + PUBLIC HUB	V	Text Message Alert System						H	S	
Campground Houses (historical Bldgs)	MVCMA	Private	V	Allow Floodproofing renovations			Allow Floodproofing renovations	Allow Allow Fire Proof Roof Materials + other firewise strategies		M	L	
Homeless	nowhere	Private	V							M	S/O	
Mental Health + addiction	everywhere	Private	V						Plan/Awareness among emerg. responders about Homeless	M	S/O	
BRAZILIAN Population (churches) Portuguese-speaking	Town W/ide + CHURCHES	Private	S V is communication	Build communication and inclusion in planning - takes deliberate effort, bridge the language barrier					FOR HAZARDS, RESILIENCE planning	M	S/O	
Environmental												
Marsh Health	marked on map	Public, Private Land trusts	V	SOFT INFRASTRUCTURE protect against S. surge			Purchasing at-risk areas, protect marsh migration areas			M	L	
entrance TO Lagoon, sand build up	marked on map	STATE, county towns	V	Dredge channel to allow Boat Access to safe harbor						M	S/O	
BEACHES	eastern end of town	TOWN, STATE (some private)	V/S	nourish Beaches (storm mitigation, culture + economic benefits)						H	S/O	
Ponds - water Quality	on map	TOWN + STATE	V/S	STORMWATER RUNOFF (2 yr storm pluvy)					more nature-based landscaping - instead of fertilizers, shallow reefs, etc	M	O	
Herring run At upper lagoon pond	upper lagoon pond	TOWN/STATE	V				RAISE level of causeway - prevent habitat from becoming salt (Herring spawning)			L	L	


NOREASTERS

SUBSIDENCE (?)




APPENDIX B: COMPILED MATRIX

Community Resilience Building Risk Matrix				www.CommunityResilienceBuilding.org												
<div><div>H-M-L</div><div>priority for action over the Short or Long term (and Ongoing)</div><div>V = Vulnerability S = Strength</div></div> <div></div>				Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)												
				Sea Level Rise	Erosion, coastal flooding	Severe Storms	Extreme Temperatures, Humidity, Drought	Wildfire	Ocean Acidification, Fish Die-offs, Algal Blooms	Priority	Time					
										H - M - L	Short Long Ongoing					
Features	Location	Ownership	V or S													
Infrastructural																
Steamship and Harbor	Location: Harbor; Ferry terminal at Seaview Ave and Oak Bluffs Ave Vulnerable Areas: Along Beach Road at Sengekontacket; along Seaview Ave; along harbor entrance; on East Chop Drive along harbor and along bluffs	Town, Private, MassDOT/Steamship Authority	V	Voluntary buyouts of properties in vulnerable areas such as along dunes and adjacent to harbor. Implementation of green infrastructure such as dune buildup, beach nourishment, wetland restoration	Voluntary buyouts of properties in vulnerable areas such as along dunes and adjacent to harbor. Implementation of green infrastructure such as dune buildup, beach nourishment, wetland restoration	Voluntary buyouts of properties in vulnerable areas such as along dunes and adjacent to harbor. Implementation of green infrastructure such as dune buildup, beach nourishment, wetland restoration				H	O					
Ferry Terminal	Intersection of Seaview Ave. and Oak Bluffs Ave.	MassDOT	V	Hurricane barrier outside of Oak Bluffs Harbor - living breakwater or extended seawall to protect ferry terminal from wind/wave/flood damage						H	S					
Oak Bluffs Harbor (2)		Town	V	Hurricane barrier outside of Oak Bluffs Harbor - living breakwater, redesigned jetties, or extended concrete seawall with gates. Kleinfelder: A1. Raise perimeter bulkhead with a permanent barrier, and raise the dune on Jetty Beach and behind East Chop Beach Club to prevent flood water entrance. Beach nourishment to further fortify beach/dune. A2. Temporary flood barrier stored horizontally in the sidewalk and deployed in advance of anticipated storms. B. Hurricane barrier to close harbor entrance channel. Replace existing jetties with concrete walls and flood doors.		Hurricane barrier outside of Oak Bluffs Harbor - living breakwater or extended seawall. Possible glass sea wall along bulkhead.				H	S					
Hospital/Nursing Home (4)	Vulnerable Access Roads: Eastville and County Roads	Hospital - Private; Access Roads - Town	V/S	Raise access roads, especially intersection of Eastville and County Roads. Alternative: control gates on lagoon. Kleinfelder: Raise the low areas of Eastville Ave. and County Rd. to prevent flooding of these access roads.		Create backup emergency supplies for hospital of food, water, fuel				H	M/O					
Seaview Ave.	Seaview Ave.	Town, State	V	Culvert/raised road at Seaview Ave. to Farm Pond. Kleinfelder: A. Extend existing seawall to Harthaven, and raise wall to a total height of 12' above sea level to meet FEMA base flood elevation. B. Construct a protective dune and beach east of Seaview Ave.						H	S					
Coastal Access Roads	Townwide	Town, State, County	V	Raise Roads; Seawalls as Needed; Constructed Oyster Reef; Retreat from East Chop Drive	More/strengthened jetties and groins along Beach Rd. at Sengekontacket					H	S					
Supplies: Food, Water Fuel	Fuel supply point at Packers Barge	Public, private	V/S			Permanent building to house emergency supplies. Particular attention to ensuring hospital has sufficient emergency supply of food, water, fuel				H	S/O					
Electrical Station	Intersection of Lake Ave. and Oak Bluffs Ave. near "Our Market"	Town	V/S	Move electric infrastructure from Lake Ave. electrical station to Dukes County Road station. Kleinfelder: Raise electrical panels above flood level or encase them in a waterproof enclosure.		Create a backup solar battery bank at town landfill. More regular tree trimming to reduce risk of power outages during storms				H	S					
Town Water Supply/Distribution	Upper Lagoon Pond, Swift Pond; Wastewater Treatment Station on Pennsylvania Ave.	Town	V	Study to ensure viability of relocation to higher ground. Raise Causeway. Build new public wells south (towards forest)		Ensure continued access to vulnerable roads. Voluntary buyouts for vulnerable parcels and implementation of green infrastructure measures				H	L					

Community Resilience Building Risk Matrix				www.CommunityResilienceBuilding.org							
<div><div><div>H</div><div>M</div><div>L</div></div><div>priority for action over the Short or Long term (and Ongoing)</div><div>V = Vulnerability S = Strength</div></div> <div></div>				Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)							
				Sea Level Rise	Erosion, coastal flooding	Severe Storms	Extreme Temperatures, Humidity, Drought	Wildfire	Ocean Acidification, Fish Die-offs, Algal Blooms	Priority	Time
										H · M · L	Short Long Ongoing
Features	Location	Ownership	V or S								
Septic Tanks	Everywhere except downtown	Private	V	Update septic regulations					Expand sewer to low-lying coastal areas to prevent septic discharge to local waters	H	S
Sewer Pump Stations (2)	Siloam Ave., School St.	Town	V	Hurricane barrier outside of Oak Bluffs Harbor - living breakwater or extended seawall to reduce risk of harbor flooding affecting sewer pump stations. Kleinfelder: Sewer pumps designed to operate underwater, but any associated electrical equipment should be raised and/or waterproofed. At School St, town has already installed an emergency generator on a raised platform; as much electrical equipment as possible should be moved to this platform. Electrical equipment at "Our Market" sewer pump station/restroom should be encased in a waterproof enclosure. Wooden electrical building at Siloam Ave./Lake Ave. substation should be replaced with a watertight structure.	Hurricane barrier outside of Oak Bluffs Harbor - living breakwater or extended seawall to reduce risk of harbor flooding affecting sewer pump stations					H	S
Stormwater facilities	Townwide	Town, MassDOT, private	V	MVC: Reconstruct stormwater facilities to the 25-year standard rather than 10-year						"H", 70 (93rd percentile ranking)	
Vulnerable Roads	Lake Ave, Oak Bluffs Ave, Eastville Ave @ Beach St, Eastville Ave. @ County Rd. (Hospital Access), Barnes Rd. (Water Supply Access)	State, Town	V	Protect, secure, raise, and/or enhance vulnerable road segments	Protect, secure, raise, and/or enhance vulnerable road segments. More/strengthened jetties and groins along Beach Rd. especially near Sengekontacket	Protect, secure, raise, and/or enhance vulnerable road segments				M	L
Road Network and County Rd.	Townwide	Town, Private	S			Enhance knowledge of less vulnerable roads and make usable				M	O
Power Lines, Phone Lines (2)	Townwide	Eversource	V/S			Undergrounding				M/L	L
Bulkheads, revetments, etc.	Lake Ave. and Circuit Ave. Extension along harbor	Town	V							L	

Community Resilience Building Risk Matrix																
<div><div>www.CommunityResilienceBuilding.org</div><div><div><div>H-M-L</div><div>priority for action over the</div><div>Short or Long term (and Ongoing)</div></div><div><div>V</div><div>= Vulnerability</div><div>S = Strength</div></div></div><div></div></div>				Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)												
				Sea Level Rise	Erosion, coastal flooding	Severe Storms	Extreme Temperatures, Humidity, Drought	Wildfire	Ocean Acidification, Fish Die-offs, Algal Blooms	Priority	Time					
										H - M - L	Short Long Ongoing					
Features	Location	Ownership	V or S													
Societal																
Elderly Population (3)	Downtown, Campground, Townwide	Town, Private	V/S	V: Need to protect harbor and campground. S: Designated elderly housing is inland and on elevated ground		Comprehensive list of seniors - good neighbor programs, strong communication; text mesasge alert system				H	O					
Public Health	Townwide	Public/State	V	Zoning to limit uses w/potential damage		Plan/funding for cleanup				H	O					
Economy	Townwide		V/S	Protect harbor and beaches	Protect VH causeway to ferry					H						
Tourism	Townwide		V/S	Protect harbor and beaches	Protect VH causeway to ferry					H						
Dependence on volunteer EMS	Town/Island Wide	Public, Private	V/S			Hire a full-time emergency response planner				H	S/O					
Stormwater standards/ bylaws	Townwide	Town		MVC: Revise stormwater regulations to the 25-year standard rather than 10-year						"H", 75 (100th percentile ranking)						
subdivision and building regulations/ bylaws	Townwide	Town, MVC, Private and Public Land Owners					MVC: Revise local subdivision and building regulations to require fire-proof roofing materials in areas vulnerable to wildfire			"H", 65 (86th percentile ranking)						
Emergency Services	State Forests	DCR					MVC: Develop an on-Island fire cache that would allow prescribed fire teams to respond on very short notice and conduct preventive prescribed burns.			"H," 65 (86th percentile ranking)	L					
Infrastructural Planning	Townwide	Town, MassDOT, Private			MVC: Revise public and private infrastructural planning to the 25-year standard rather than 10-year					"H," 71 (95th percentile ranking)						
Tourism/Commerce	Downtown and Beaches	Town/Private	V	Buyouts and green infrastructure NW side of harbor to reduce flood risk	Channel protection	Living breakwater outside of Oak Bluffs Harbor to protect tourist/economic areas				M*	O					

Community Resilience Building Risk Matrix				www.CommunityResilienceBuilding.org							
H-M-L priority for action over the Short or Long term (and U ngoing) V = Vulnerability S = Strength				Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)							
				Sea Level Rise	Erosion, coastal flooding	Severe Storms	Extreme Temperatures, Humidity, Drought	Wildfire	Ocean Acidification, Fish Die-offs, Algal Blooms	H - M - L	Short Long Ongoing
Features	Location	Ownership	V or S								
Historic Buildings and Landscapes	Downtown, East Chop Drive	Private	V	Voluntary buyouts of wetland areas, wetland protection and enhancements to protect adjacent areas from flooding		Underground power lines	Educational program: lost/benefit improvements (i.e. Cape Light)			M	O
Campground - Historical Buildings	MVCMA	Private	V	Allow floodproofing renovations		Allow floodproofing renovations		Allow fireproof roof materials and other fire wise strategies		M	L
Fire/EMS Communication	Townwide	Town	V/S			Enhance emergency communication system				M	S/O
Social and Economic Diversity	Townwide		S (Housing is a V)	Need affordable housing for employees. Social/economic diversity already exists - affordable housing is important						M	
Housing	Townwide		V	Encourage small units, cottages, multi-family units, apartments over retail; increase density w/ accessory units						M	
Homeless Population	Nomadic	Private	V			Plan for / awareness of homeless population among emergency responders				M	S/O
Mental Health and Addiction	Townwide	Private	V			Plan for / awareness of substance abuse and mental health among emergency responders				M	S/O
Brazilian/Portuguese-Speaking Population	Townwide (specific attention to churches)	Private	S (Communication is a V)	Build up communication and inclusion in hazard and resilience planning; make deliberate effort into bridging language barrier and including community members in planning process						M	S/O
Tax Revenue from Private Homes	Townwide	Private	V/S		Explore market-based incentive programs for relocating bluff homes					L	
Oak Bluffs Elementary School	Tradewinds Rd.	Town	S			S: School prepared to serve as emergency shelter				L	

Community Resilience Building Risk Matrix				www.CommunityResilienceBuilding.org							
<div><div></div><div>H - M - L priority for action over the Short or Long term (and Ungoing) V = Vulnerability S = Strength</div></div>				Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)							
										Priority	Time
				Sea Level Rise	Erosion, coastal flooding	Severe Storms	Extreme Temperatures, Humidity, Drought	Wildfire	Ocean Acidification, Fish Die-offs, Algal Blooms	H - M - L	Short Long Ongoing
Features	Location	Ownership	V or S								
Environmental											
Shellfish, Hatcheries/Nitrogen Pollution (3)	Sengekontacket, Lagoon	Town	V	Protect barrier bluffs and causeways - build culvert under Seaview Ave. at Farm Pond	Marsh deposition projects to ensure continued ecological health	Oyster reefs to filter water and add to shellfish resources				H	S/O
Beaches (3)	All	Town, Private, County	V	Voluntary buyouts of vulnerable dune areas, implementation of green infrastructure such as dune buildup and beach nourishment						H	S/O
Lagoon and Sengekontacket (2)	Specific	State, County, Town	V	Kleinfelder: Perform a detailed coastal processes study to understand the hydrologic and sediment transport systems in this area.	Voluntary buyouts of floodable areas and implementation of green infrastructure/marsh restoration programs to protect inland areas from flooding and erosion. Create a town fund for ongoing dredging needs	Voluntary buyouts of floodable areas and implementation of green infrastructure/marsh restoration programs to protect inland areas from flooding and erosion. Create and fortify oyster reefs as a wind/wave barrier and for shellfishing				H	S/O
Dunes/Bluffs (2)	Vulnerable dune areas: East Chop bluffs; along Seaview Ave.; along harbor entrance; along Beach Rd. at	Town, State	V/S	Voluntary buyouts of vulnerable dune areas, implementation of green infrastructure such as dune buildup and beach nourishment	Beach nourishment projects at East Chop Bluff, other vulnerable dune areas	Living breakwater outside of Oak Bluffs Harbor; beach nourishment as needed				H	O
State Forests	State Forests	DCR and State Forest Advisory Committee					MVC: Establish an overall management plan for the Island's State Forests, including establishment of specific procedures or Memoranda of Agreement regarding the transfer of land for new public water supplies and for easements to install water supply lines. /// MVC: Develop a dedicated on-island fire cache that would allow prescribed fire teams to respond on very short notice and conduct preventative prescribed burns.			"H", 65 (86th percentile ranking)	
Southern Woodlands	Southern Woodlands	MV Land Bank					MVC: Clear a 100' firebreak between the Southern Woodlands and vulnerable residences			"H", 65 (86th percentile ranking)	
Entrance to Lagoon		State, County, Towns	V			Dredge channel to allow boat access to safe harbor				M	
Water Quality (Nitrogen)	Townwide		V		Explore cost/benefit of denitrifying vs. flushing nitrogen at watershed scale		Streamline state permitting for septic, explore alternative technologies			M	S/L

Expected in MA by mid-21stCentury

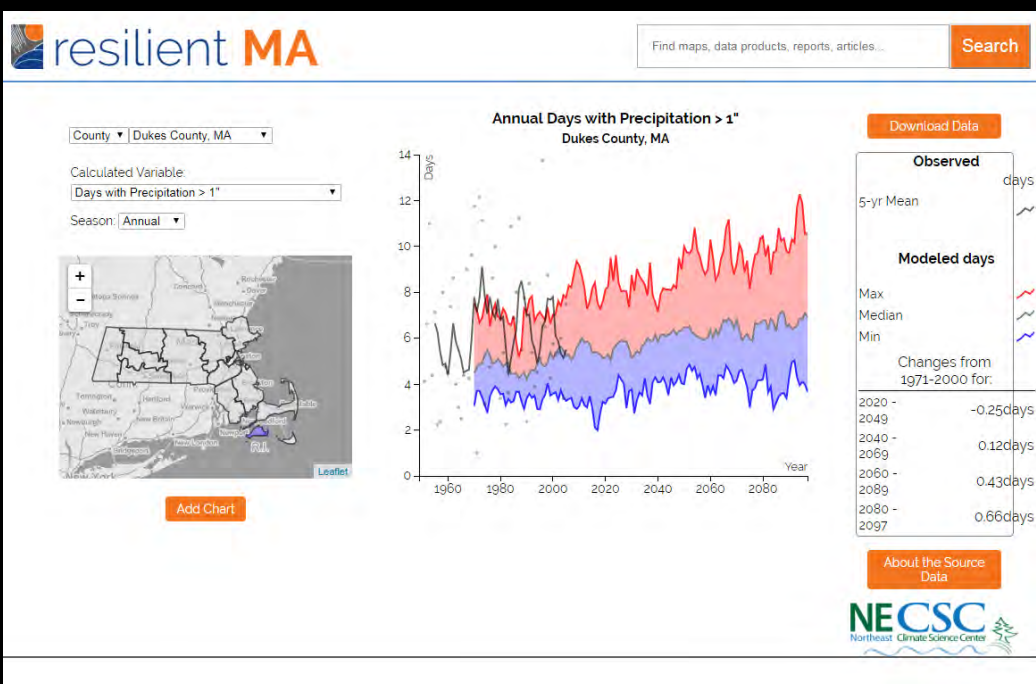
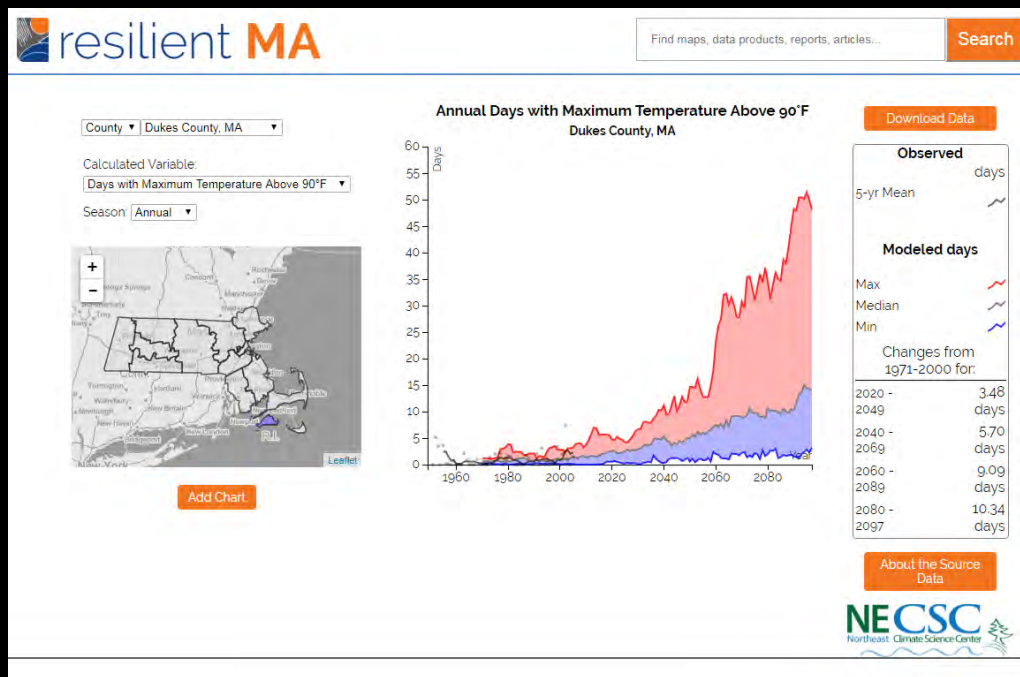
**Relative to the 1971-2000 average*

- Mean annual temp 2.8-6.2°F warmer
- 7-26 more days per year over 90°F
- 19-40 fewer days below 32°F (a decline of 13-27%)
- Total heating degree-days 11-24% lower
- Cooling degree-days 57-150% higher
- Growing degree-days 23-52% higher, and longer growing season

Expected in Dukes County by mid-21stCentury

**Relative to the 1971-2000 average*

- Mean annual temp 2-5°F warmer
- 4-15 more days per year over 90°F



Impacts of Climate Change?

- Intense rain events: increased flooding?
- Erosion?
- Disrupted ecosystems and habitats, fisheries?
- More dry periods, risk of wildfire?
- Rising Sea Levels?
- Others?

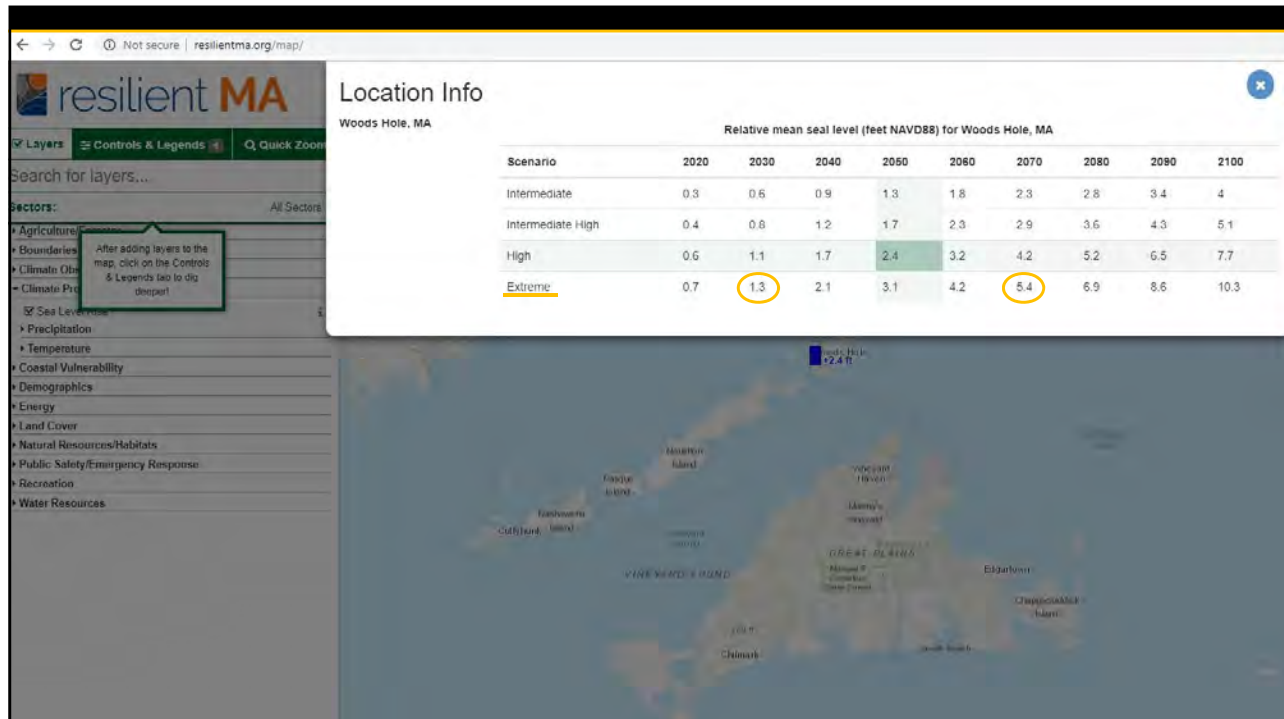
Martha's Vineyard Commission's 2015 Hazard Mitigation Plan

- Identified key hazards:
 - Sea Level Rise: 1.5' mid-century, 5' end of century
 - Hurricanes and nor'easters:
 - Flooding
 - Wind
 - Erosion
 - Wildfires
 - Drought

Coastal Vulnerability Assessment and Adaptation Plan Oak Bluffs, MA

Scenarios	2020	2030	2040	2050	2060	2070	2080	2090	2100
Global SLR (from 2013-year of interest) "Highest" (feet)	0.21	0.61	1.10	1.70	2.40	3.21	4.11	5.12	6.23
Global SLR (from 2013-year of interest) "Intermediate-High" (feet)	0.14	0.38	0.68	1.04	1.46	1.93	2.46	3.05	3.69
Global SLR (from 2013-year of interest) "Intermediate-Low" (feet)	0.07	0.18	0.32	0.47	0.63	0.82	1.02	1.24	1.48
Land subsidence (feet) @ 0.04 in./yr	0.02	0.06	0.09	0.12	0.15	0.19	0.22	0.25	0.29
Total Relative SLR - "Highest" (feet)	0.24	0.66	1.19	1.82	2.56	3.39	4.33	5.37	6.52
Total Relative SLR - "Intermediate-High" (feet)	0.16	0.44	0.77	1.16	1.61	2.12	2.68	3.30	3.98
Total Relative SLR - "Intermediate-Low" (feet)	0.09	0.24	0.40	0.59	0.79	1.01	1.24	1.50	1.77

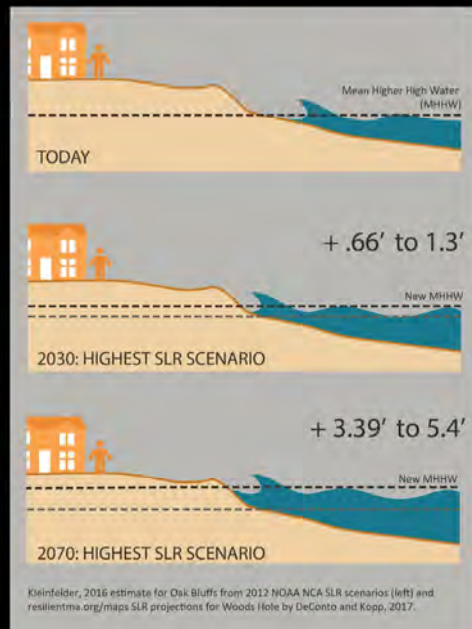
Figure 5 – Sea level rise estimates for Oak Bluffs using the 2012 NOAA NCA SLR scenarios



Sea Level Rise Projections

- Low, medium, high SLR scenarios
- Refinements to SLR modeling continues
- SLR is increase to average high tide

Sea Level Rise Projections



Massachusetts Sea Level Rise and Coastal Flooding Viewer

Interactive maps of coastal flooding areas and community facilities and infrastructure based on sea level rise scenarios, Federal Emergency Management Agency coastal flood zones, and hurricane surge models.

Intro Sea Level Rise FEMA Coastal Flood Zones Hurricane Surge

Expressed for the information depicted on the map. Coastal flood data can be directly compared for each facility by switching viewer tabs.

For planning purposes only. Sea level rise data courtesy of NOAA, January 2013. Please see the technical report (PCH 272 X3) for data sources and processing steps.

Potential Extent of Mean Higher High Water (MHHW) with Sea Level Rise

- MHHW
- MHHW + 1 ft Sea Level Rise
- MHHW + 2 ft Sea Level Rise
- MHHW + 3 ft Sea Level Rise
- MHHW + 4 ft Sea Level Rise
- MHHW + 5 ft Sea Level Rise
- MHHW + 6 ft Sea Level Rise

Public Facilities and Infrastructure

- Airport
- Community Health Center
- Electrical Generation Facility
- Fire Station
- Harbormaster
- Hospital
- Landfill
- Library
- Long-Term Care Residence

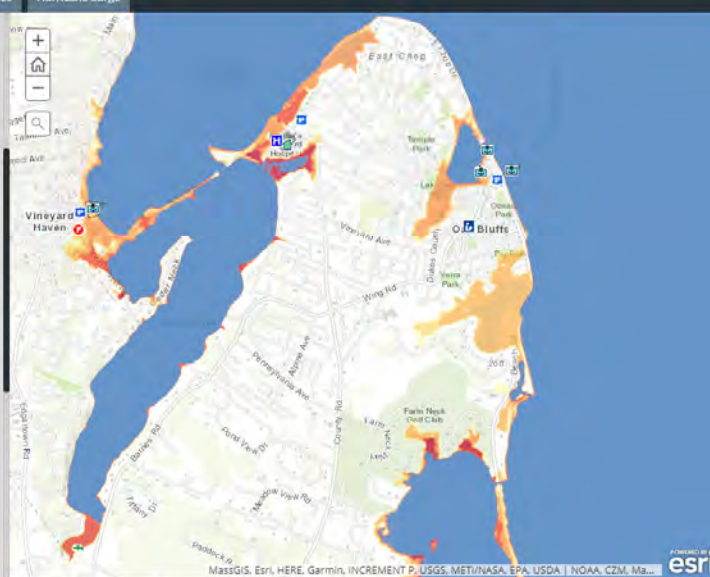




Figure 20 – Option A – Plan of Raised Perimeter Bulkhead and Dune

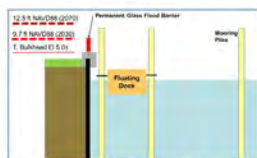


Figure 23 – Option A1 – Glass barrier normal

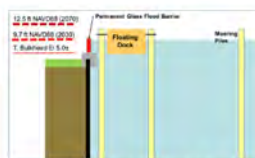


Figure 24 – Option A1 – Glass barrier during storm

Figure 25 shows some example photos of glass flood barriers. Sitting walls, benches and other amenities can be incorporated into the barrier system to make the area an inviting place for pedestrians. An added feature is that glass barriers can act as welcome wind breaks on windy days.



Figure 25 – Example photos of permanent glass flood barriers

Figure 26 is an illustration of the approximate scale of a permanent glass barrier along the harbor sidewalk.



Figure 26 – Approximate scale of a permanent glass flood barrier at elevation 9.7 feet NAVD88

Option A2 does not have a permanent flood barrier mounted on top of the barrier, therefore the existing docking system does not have to be changed. However, consideration should be given to the condition when water gets so high during a storm that docks exceed their mooring lengths or float over pilings and become loose.

In Option 2A, the flood barrier is stored horizontally in the sidewalk when it is not needed, and then is raised into position, either manually (active) or automatically (passive). Option 2A is illustrated in Figures 27 and 28.

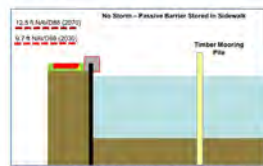


Figure 27 – Option A2 – Passive barrier stored



Figure 28 – Option A2 – Passive barrier deployed

Some examples of passive flood barriers are shown in Figures 29, 30 and 31.

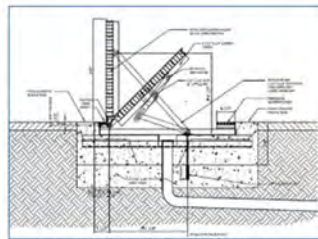
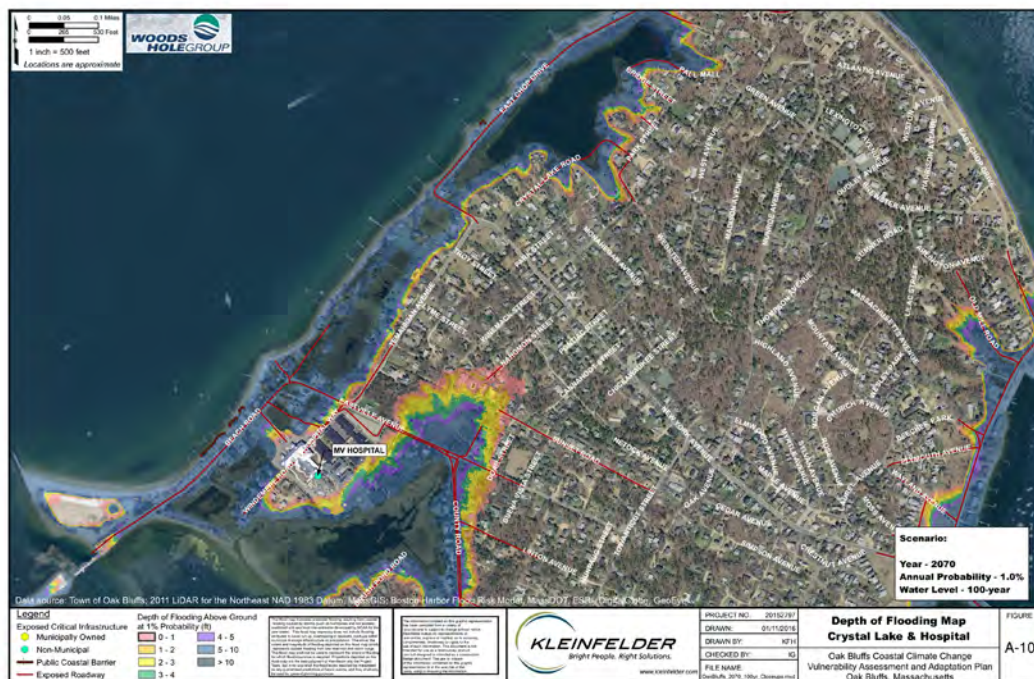
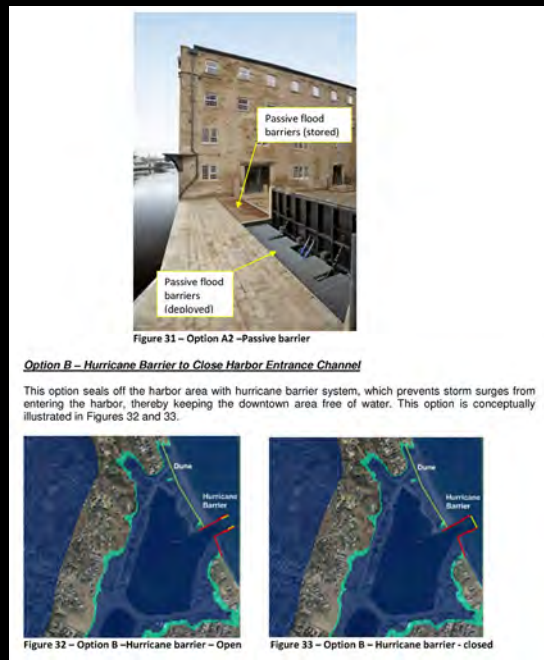


Figure 29 – Option A2 – Typical passive barrier



Figure 30 – Option A2 – Lourdes Hospital, Binghamton, NY



Adaptation strategies, Crystal Lake and Hospital area (2016 Kleinfelder report)

Option A: Surround hospital area with dunes

- 4,060 feet of enhanced dune and beach nourishment
- Roadway closure barrier for floods
- Culvert and tide gate connecting Brush Pond and Lagoon Pond
- High cost

Option B: Raise low area of Eastville Ave and County Rd

- 940 feet of Eastville Rd, and intersecting part of County Rd
- Would allow emergency access to hospital
- More cost effective



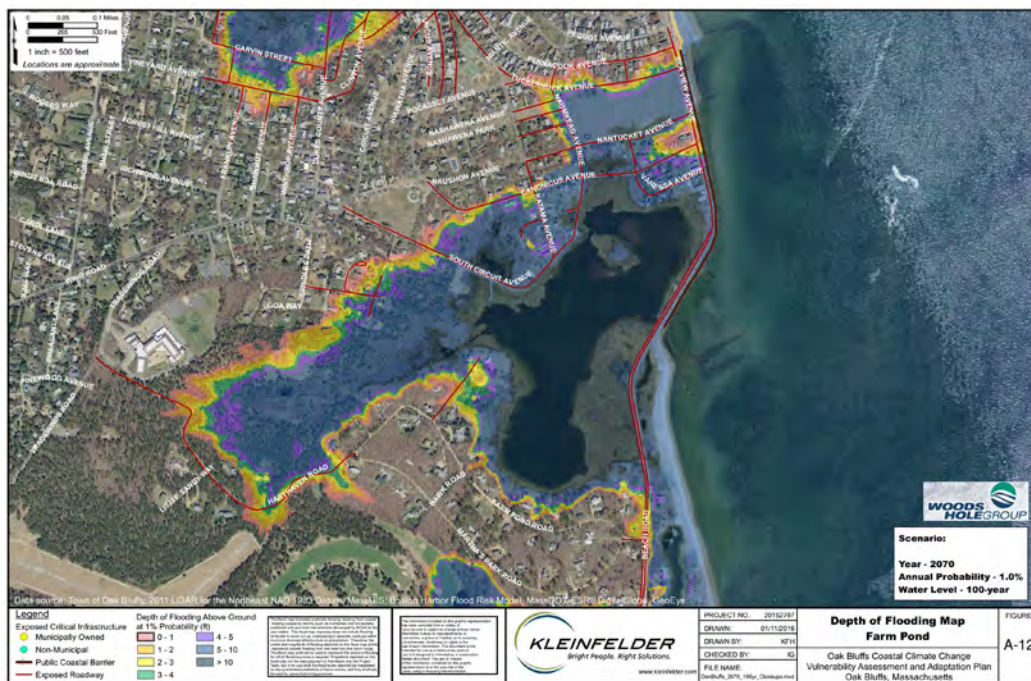
Figure 36 – Option A - Dune Protection at Hospital



Figure 37 – Existing beach between Lagoon and Brush Ponds looking east



Figure 38 – Option B – Raise Eastville Avenue and County Road



Adaptation strategies, Farm Pond and Seaview Ave (2016 Kleinfelder report)

Option A: Extend existing seawall to Harthaven

- Extend concrete seawall to protect Seaview Ave, and raise it by 6'
- Include a tide gate

Option B: Raise Seaview Ave

- Costly and difficult to protect from wave action

Option C: Constructed dune and beach east of Seaview Ave

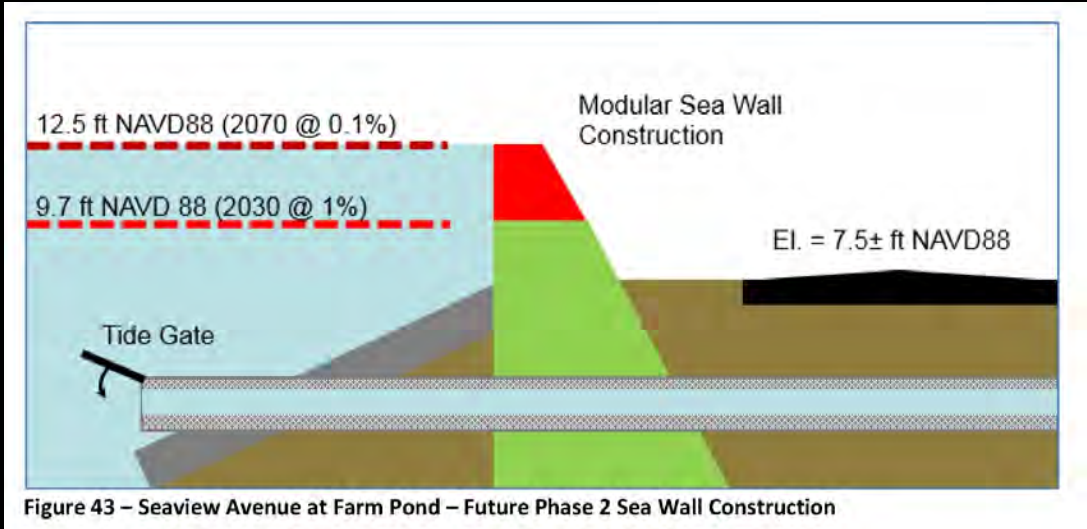
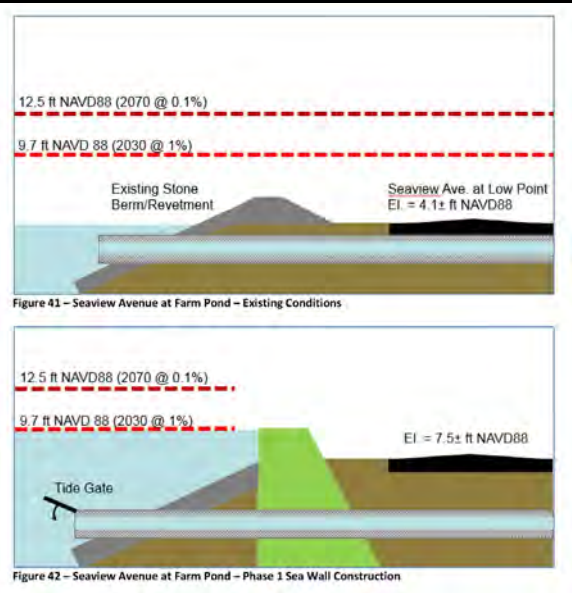
- Sacrificial dune system as tall as existing seawall, provides beach nourishment

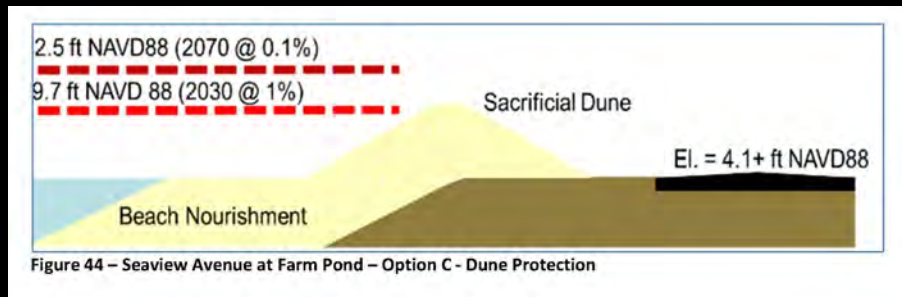


Figure 39 – End of Existing Seawall at Seaview Ave. at Farm Pond



Figure 40 - Farm Pond and Seaview Avenue Area Subject to Flooding in 2070 (1% Probability)

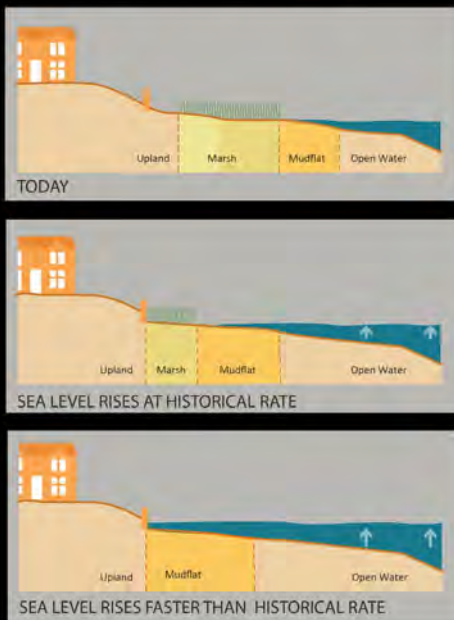




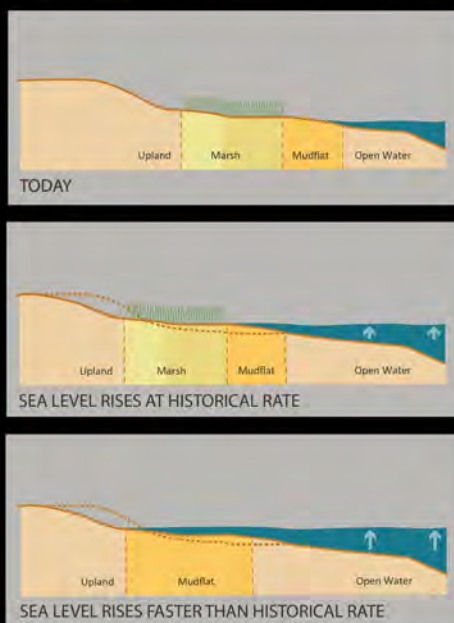
Adaptation Strategies, Environment (2016 Kleinfelder report)

- Thin layer deposition projects at Brush Pond and parts of Farm Pond to keep up with rising high tides
- Potential dune enhancement at Sylvia State Beach (temporary), Crystal lake (if preserving freshwater lake)
- Hamlin Pond and Harthaven have space for marshes to migrate

Tidal Marsh Migration w/ Coastal Structures



Tidal Marsh Migration w/out Coastal Structures



Adaptation Pathways



APPENDIX D: WORKSHOP GROUPS' TOP ACTIONS WITH LARGE GROUP "DOT VOTES"

The four workshop groups were asked to share their top three to five action items. Similar items were clustered into groups. All participants were given three green dot stickers and invited to place stickers next to action items they felt were most important. Participants could choose whether to put all 3 dots alongside one item, or spread their votes out among two or three items.

The Core Team used this information alongside the completed CRB Matrices, recommendations from the 2015 Hazard Mitigation Plan, 2016 Coastal Vulnerability Assessment and Adaptation Plan, and an assessment of short-range vs long-range prioritization to arrive at the top recommendations in this report.

