

A Resilient Hyannis Harbor

Massachusetts Municipal Vulnerability Preparedness Action Grant FY24

Created for the Town of Barnstable
Draft



Tuesday, June 11, 2024



Background

- The Town of Barnstable was recently awarded a \$199,000 Municipal Vulnerability Preparedness (MVP) action to develop a Hyannis Harbor Master Plan
- The goal of this plan is to better understand the current and future challenges/opportunities of this dynamic waterfront, and create a cohesive strategy for the mix of land uses and structures that activate the harbor daily



Background

A focus of the planning process will be through a lens of **climate resiliency** and will seek to review the mix of active uses around Hyannis Harbor, the growing development pressures around Hyannis Harbor and better align its current regulations and policies to meet today's needs.

Project Process



INITIAL PUBLIC
INVOLVEMENT AND
COMMUNITY
ENGAGEMENT



CONSULTANT REVIEW OF
EXISTING CONDITIONS
(EARLY 2024)



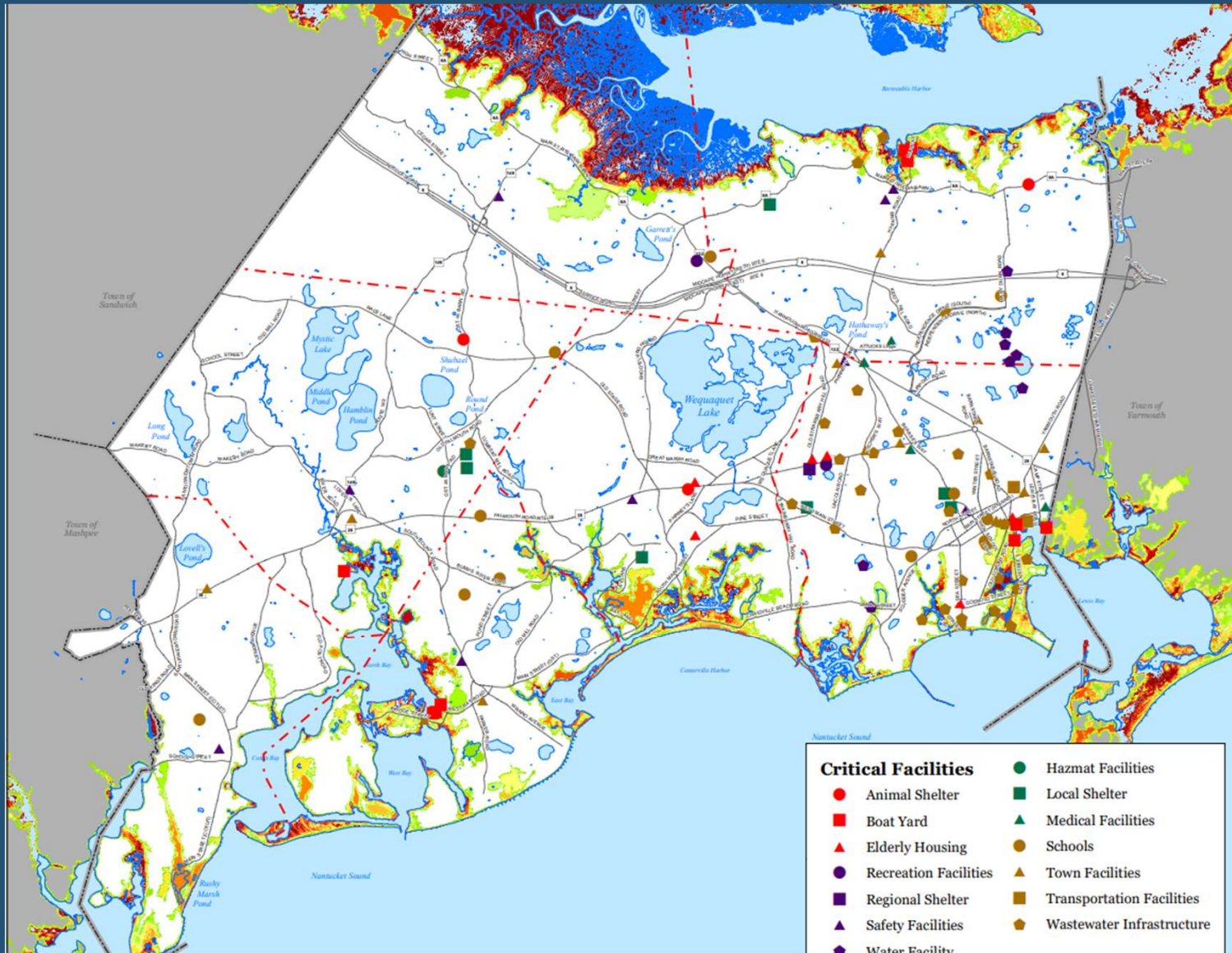
DRAFT HARBOR LAND USE
AND ZONING
RECOMMENDATIONS
USING PUBLIC INPUT AND
EXISTING CONDITIONS
DATA (BY SPRING 2024)



PUBLIC FORUM OF DRAFT
RECOMMENDATIONS
(SUMMER 2024)



FINALIZE DRAFT
RECOMMENDATIONS



Potential Extent of MHHW with Sea Level Rise

- Mean Higher High Water (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
- MHHW + 7 ft Sea Level Rise
- MHHW + 8 ft Sea Level Rise
- MHHW + 9 ft Sea Level Rise
- MHHW + 10 ft Sea Level Rise

- Fire District / Village Lines
- Major Roads
- Town Boundary
- Shoreline
- Water Bodies (May be obscured)

TOWN OF BARNSTABLE MASSACHUSETTS

2021 Hazard Mitigation Plan Update

Sea level Rise
Figure 5

Critical Facilities

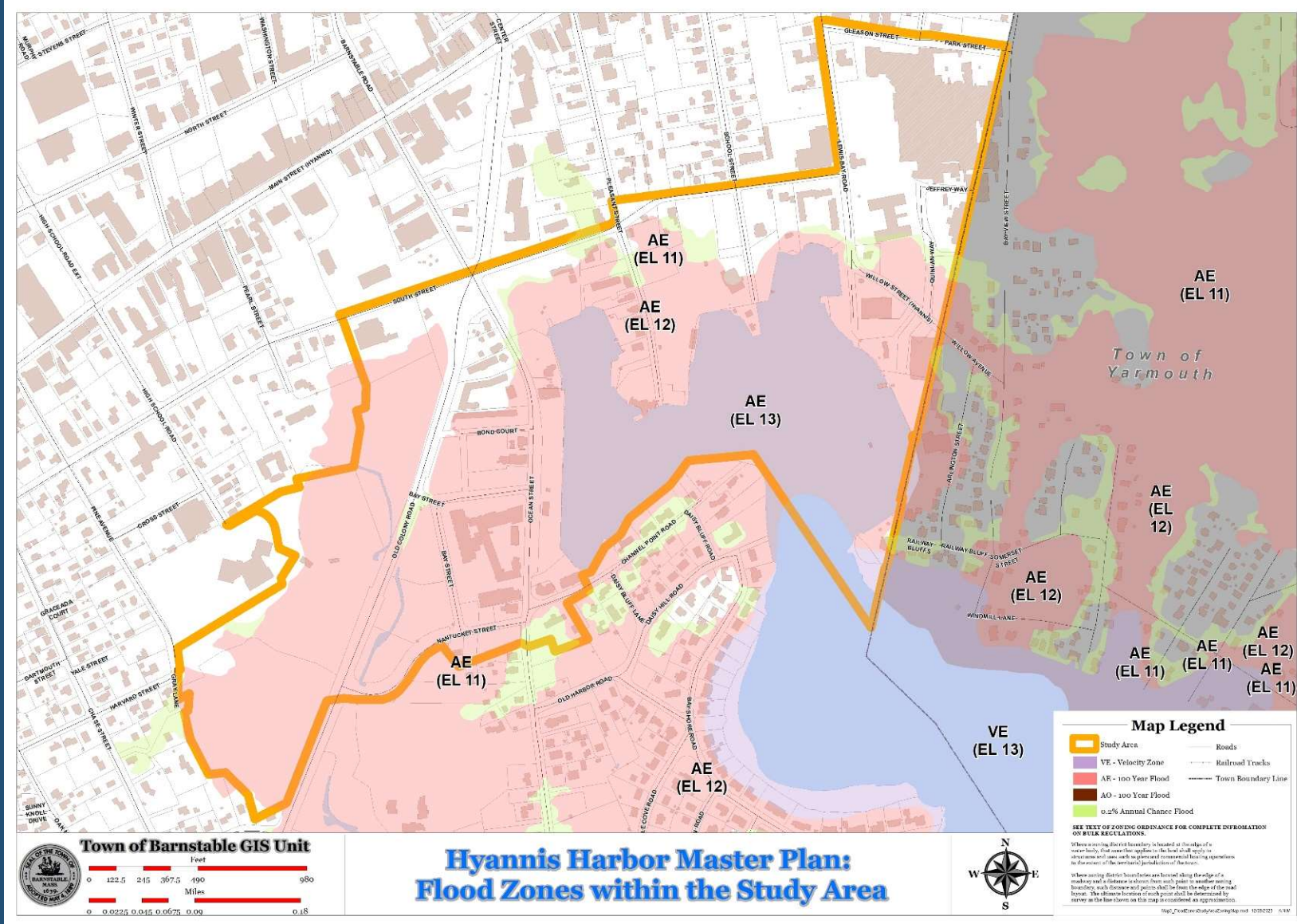
- Animal Shelter
- Boat Yard
- Elderly Housing
- Recreation Facilities
- Regional Shelter
- Safety Facilities
- Water Facility
- Hazmat Facilities
- Local Shelter
- Medical Facilities
- Schools
- Town Facilities
- Transportation Facilities
- Wastewater Infrastructure

Miles

0 0.5 1 2

sea_level_rise.mxd 2-15-22

Flood Map



Flooding Photos



Land Use and Development Objectives to Mitigate Flooding and Heat Impacts

Land Use and Development Objectives to



1. Elevate and Floodproof

Protect flood-sensitive uses such as residential units and critical building systems by elevating above future design flood elevations or dry floodproofing where below future design flood elevations



2. Design to Recover

Design buildings to withstand or recover from projected flooding (e.g. wet floodproofing, temporary barriers, water-resistant or replaceable materials)



3. Green Infrastructure

Use green infrastructure (e.g., swales, wetlands, green roofs) in addition to gray infrastructure (e.g. storage tanks) to manage stormwater on-site



4. Preserve Vegetation

Preserve existing vegetation (e.g. trees, ground cover, planted roofs)



5. Create Vegetation

Create new vegetated areas (e.g. trees, ground cover, planted roofs) and design so that plantings can thrive over time



6. Limit Paved Areas

Limit amount of paved area, increase permeable area



7. Provide Shading

Provide shade with trees or structural shading where trees are infeasible, especially over paved areas



8. Use Reflective Surfaces

Use solar-reflective surface materials for roofs, buildings, and paved surfaces to the extent possible



9. Promote Passive Resilience

Incorporate “passive resilience” features including high performance building envelope, shading, natural ventilation, and limit air leakage



10. Shelter in Emergencies

Provide spaces for sheltering and services during extreme events



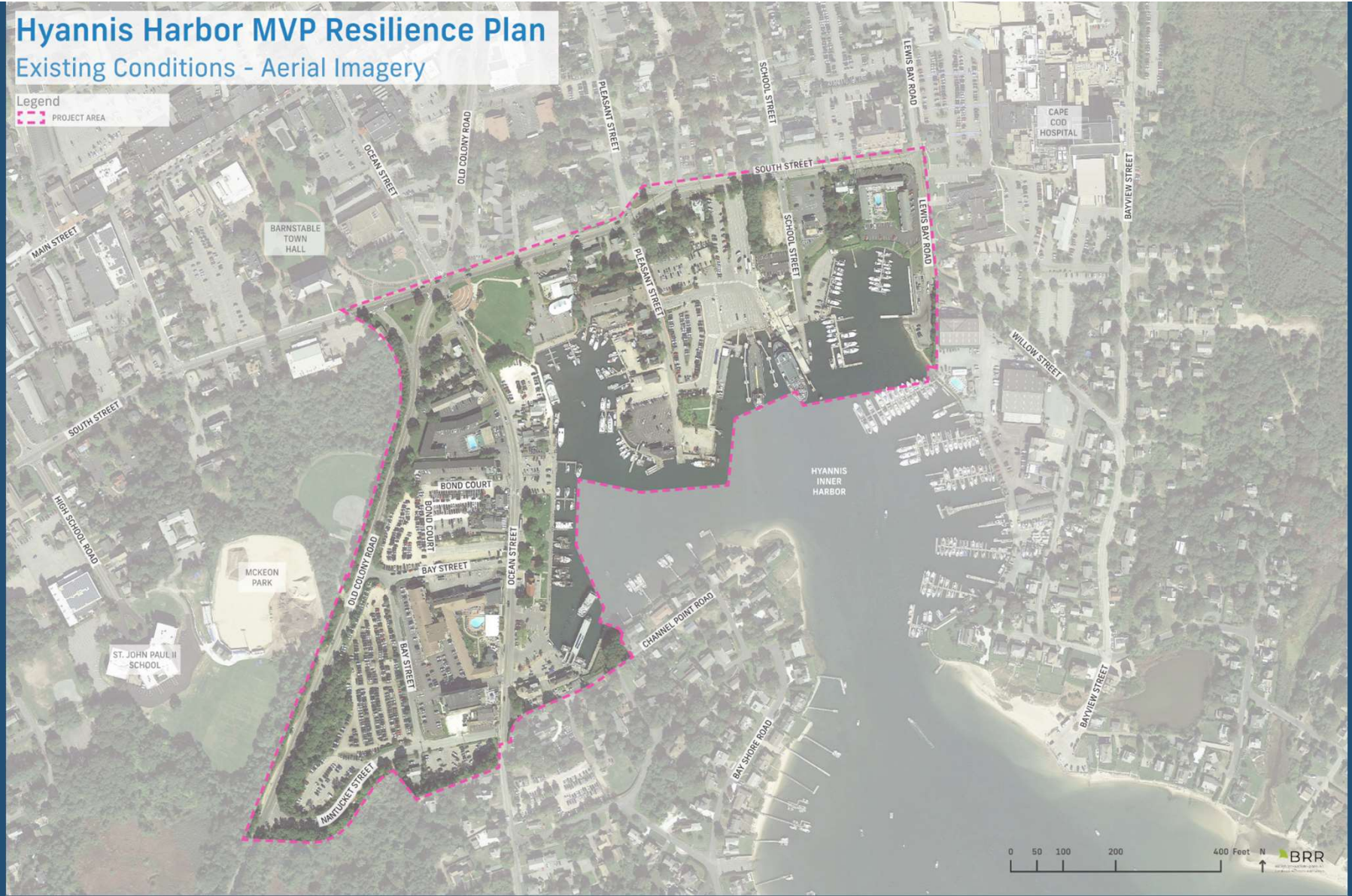
11. Create Emergency Plan

Create emergency plans with protocols to implement during an extreme weather event, where practical

Hyannis Harbor MVP Resilience Plan

Existing Conditions - Aerial Imagery

Legend
--- PROJECT AREA



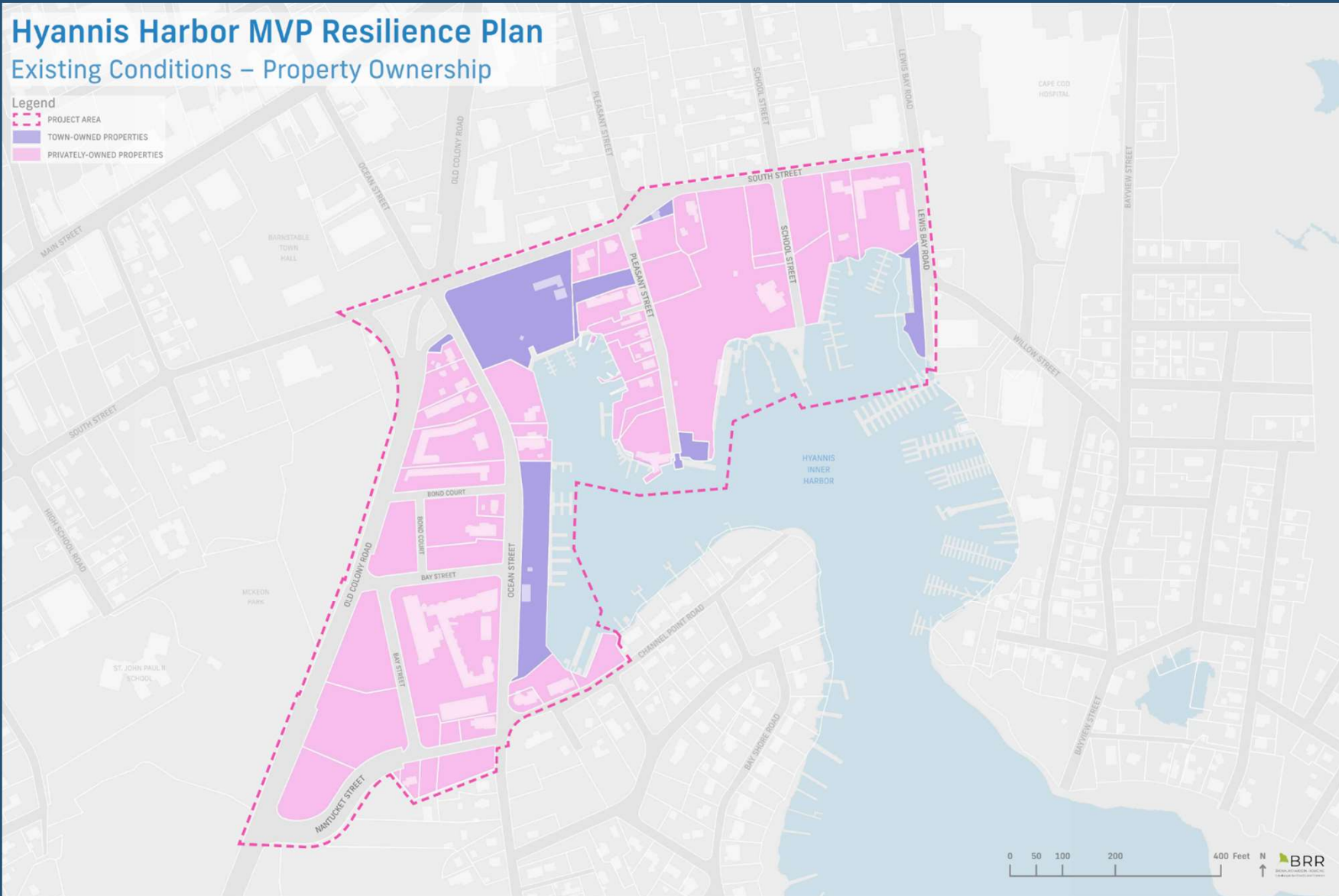
0 50 100 200 400 Feet N BRR

Hyannis Harbor MVP Resilience Plan

Existing Conditions – Property Ownership

Legend

- PROJECT AREA
- TOWN-OWNED PROPERTIES
- PRIVATELY-OWNED PROPERTIES

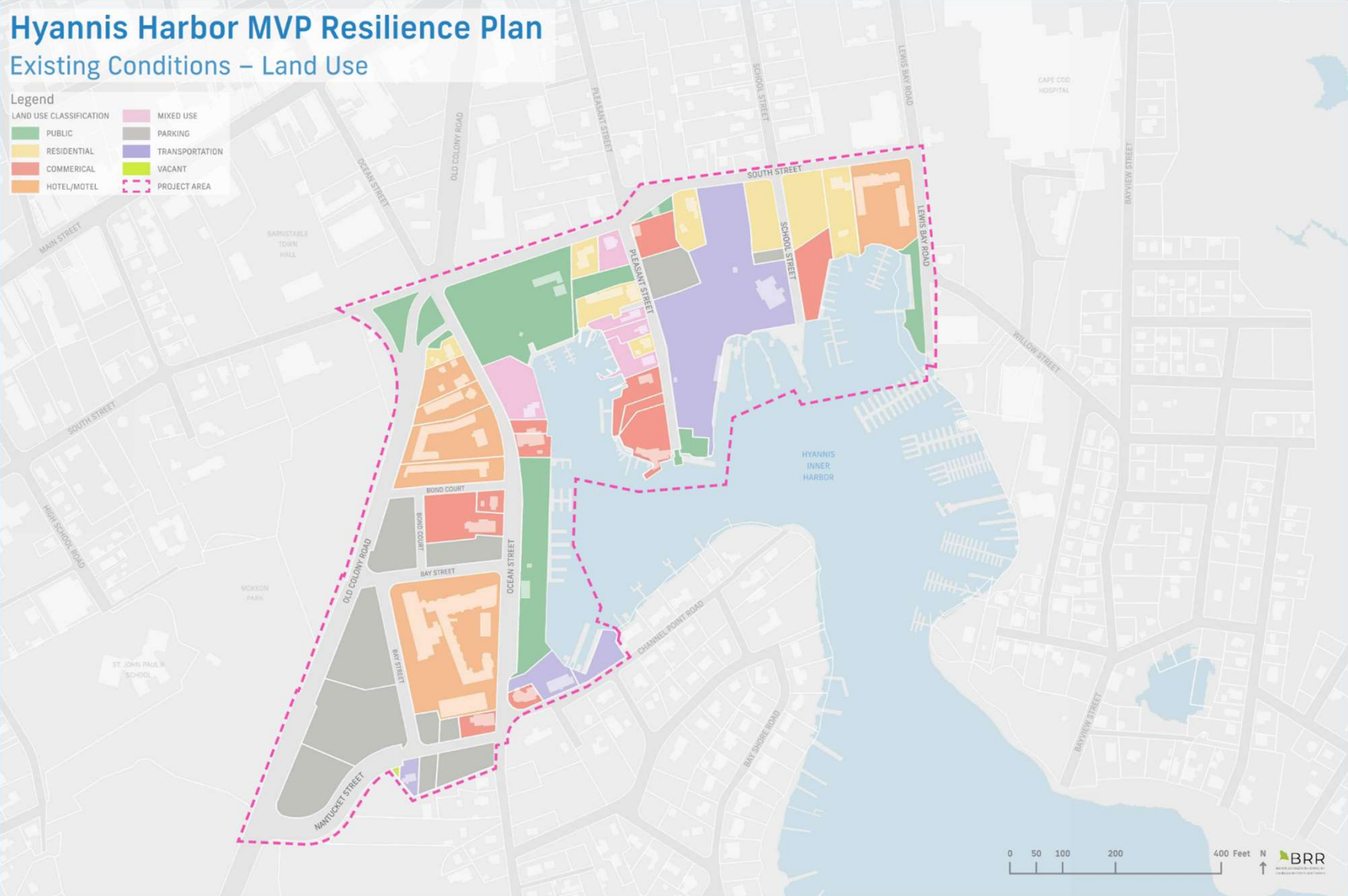


Hyannis Harbor MVP Resilience Plan

Existing Conditions – Land Use

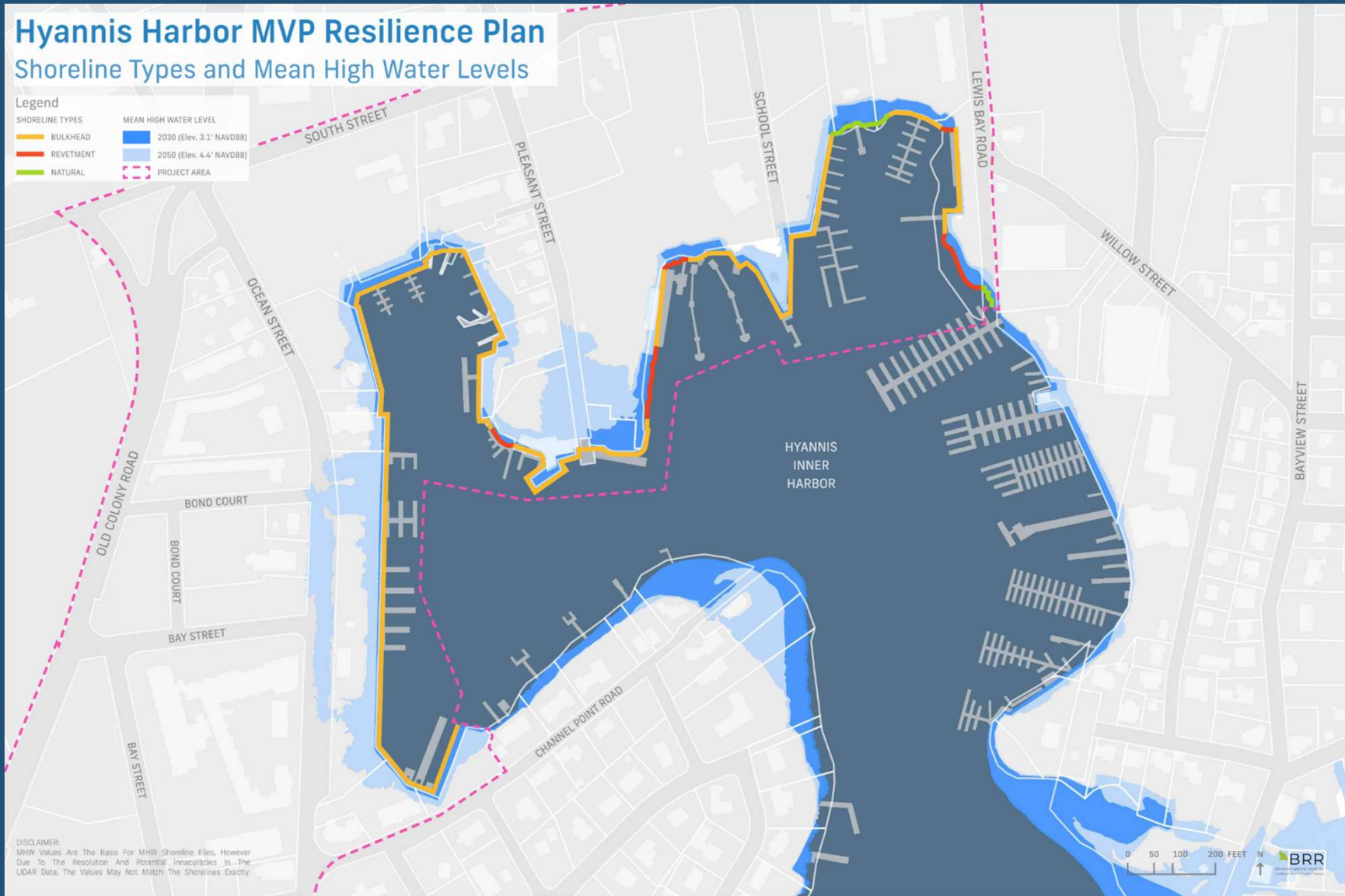
Legend

LAND USE CLASSIFICATION	
PUBLIC	MIXED USE
RESIDENTIAL	PARKING
COMMERCIAL	TRANSPORTATION
HOTEL/MOTEL	VACANT
	PROJECT AREA



Hyannis Harbor MVP Resilience Plan

Shoreline Types and Mean High Water Levels



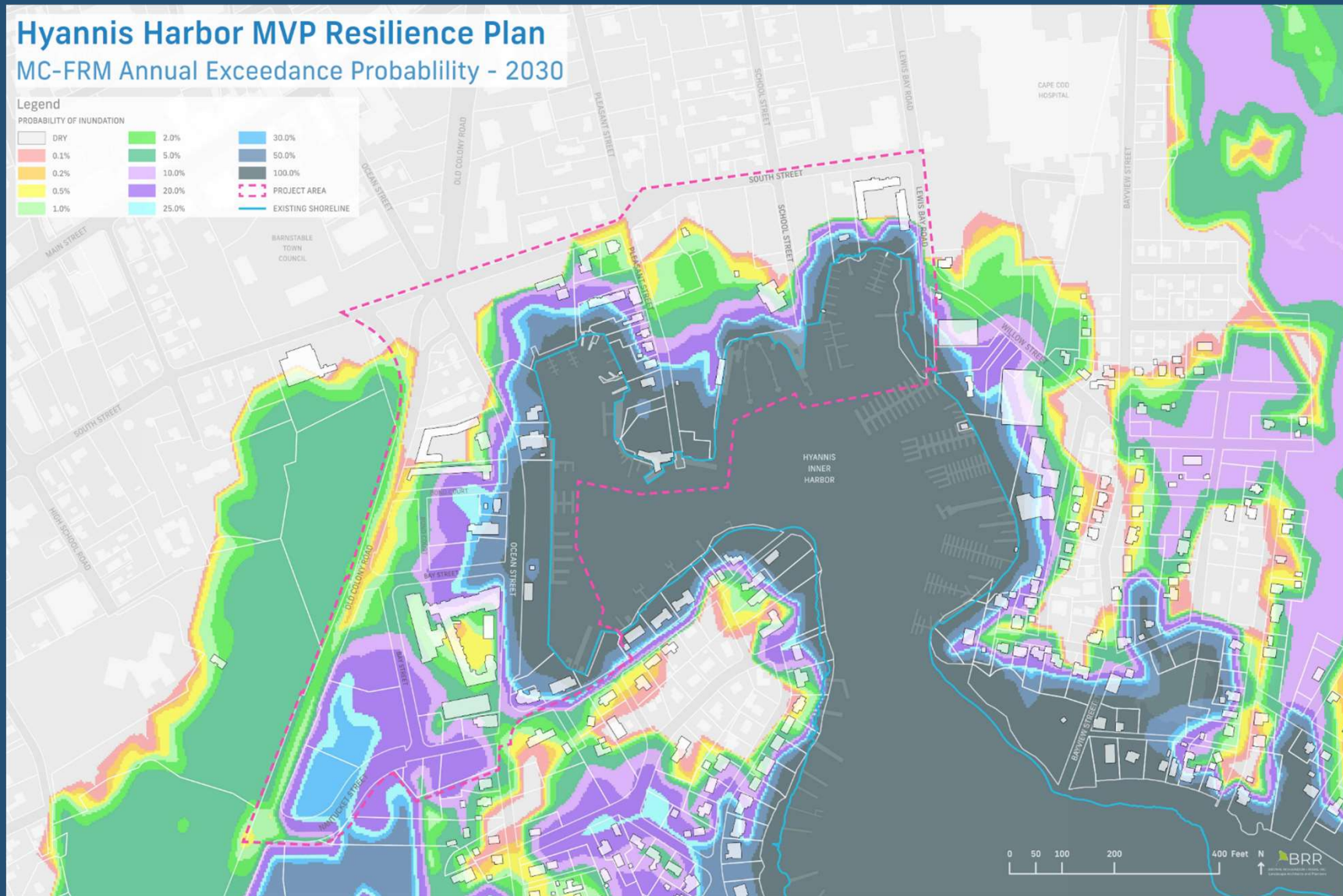
DISCLAIMER:
MHW Values Are The Basis For MHW Shoreline Files, However
Due To The Resolution And Potential Inaccuracies To The
LIDAR Data, The Values May Not Match The Shorelines Exactly.

Hyannis Harbor MVP Resilience Plan

MC-FRM Annual Exceedance Probability - 2030

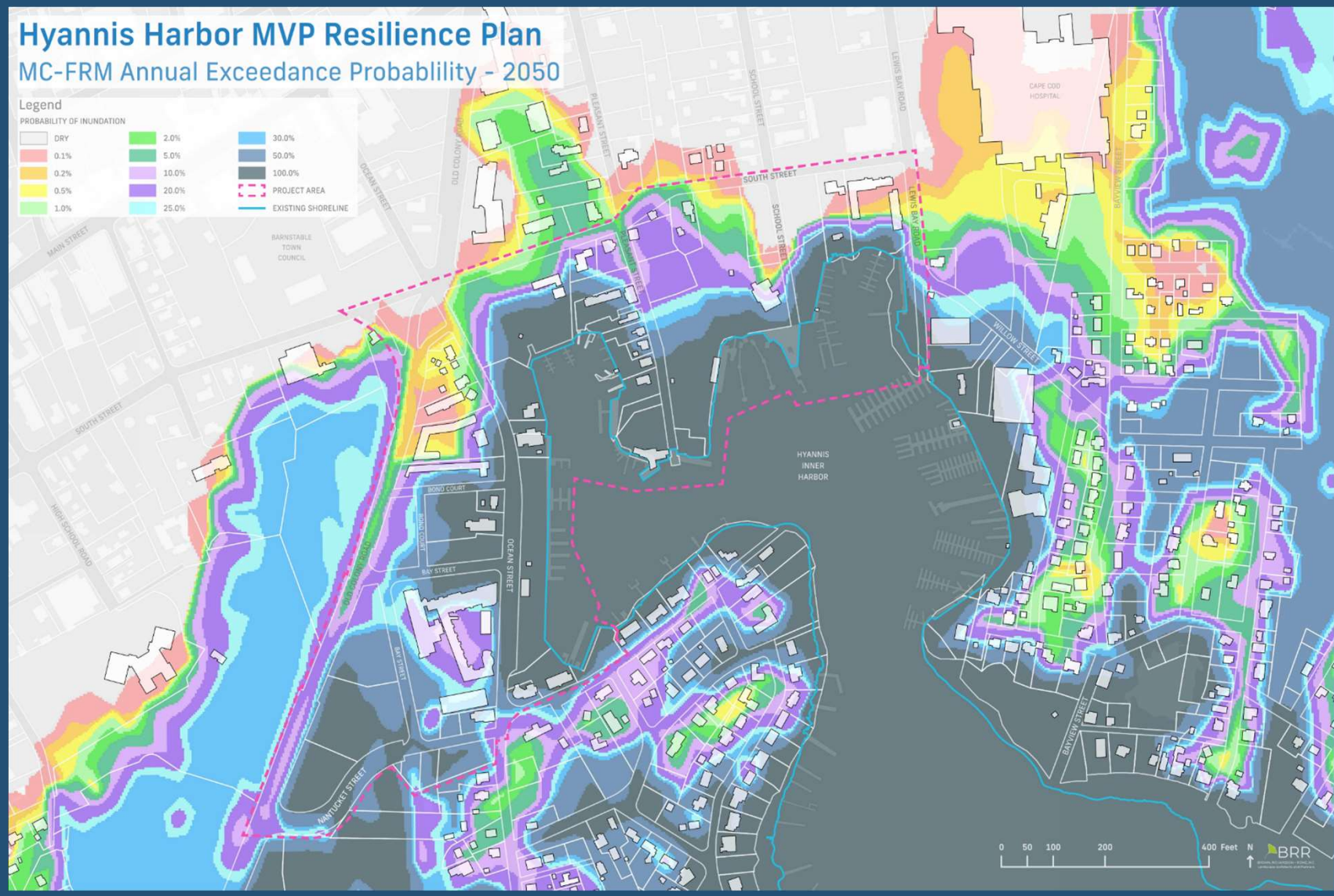
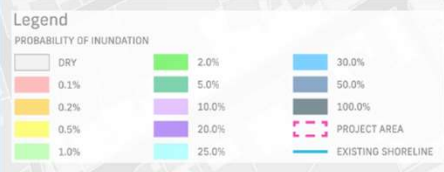
Legend

PROBABILITY OF INUNDATION



Hyannis Harbor MVP Resilience Plan

MC-FRM Annual Exceedance Probability - 2050



Coastal Flooding Assessment and Resiliency Recommendations

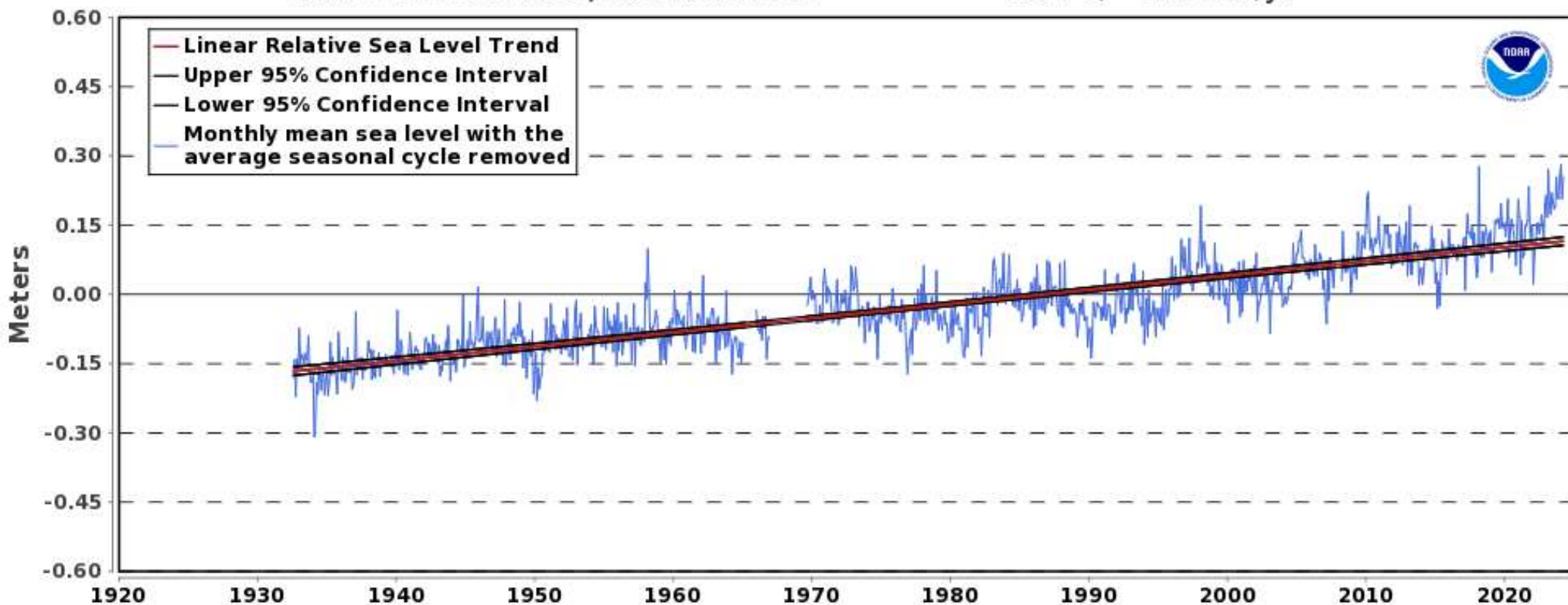


Historical Sea Level Rise

Woods Hole Tide Gauge, Station 8447930

8447930 Woods Hole, Massachusetts

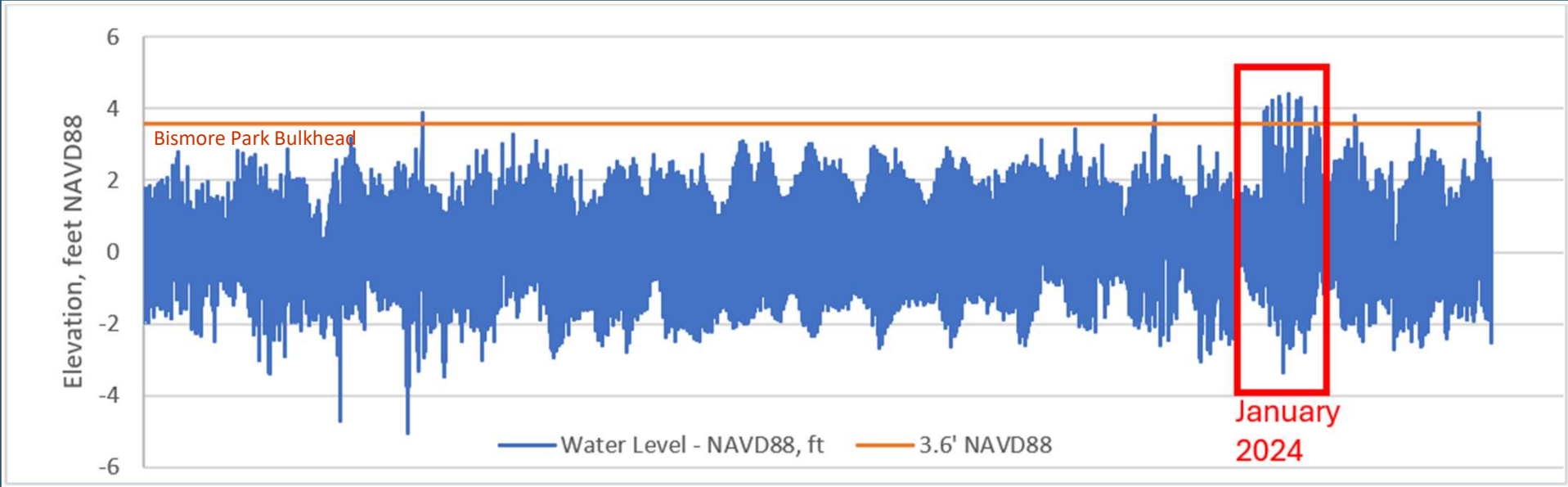
3.07 +/- 0.17 mm/yr



The relative sea level trend is 3.07 millimeters/year with a 95% confidence interval of +/- 0.17 mm/yr based on monthly mean sea level data from 1932 to 2023 which is equivalent to a change of 1.01 feet in 100 years.

Local Water Level Observations in Hyannis Harbor

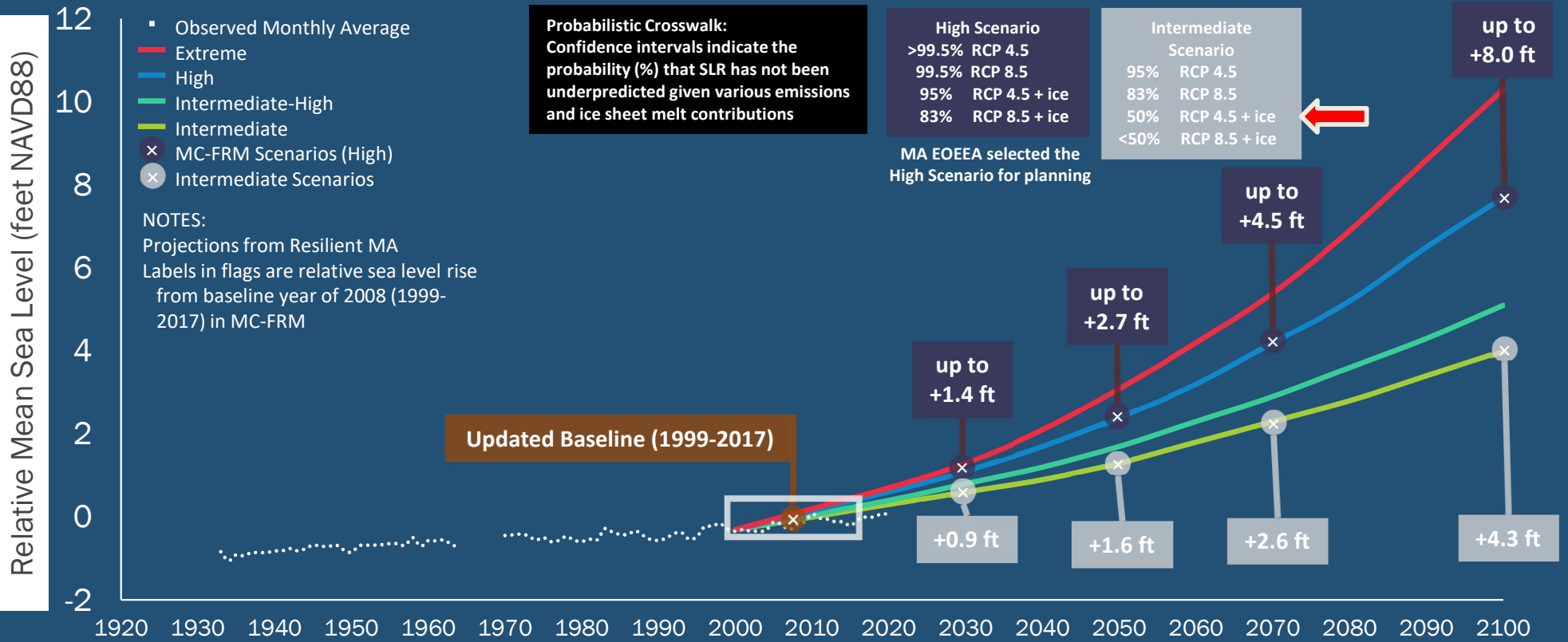
Source: Hohonu Tide Gauge (11/2/2022 to 5/10/2024)



<https://dashboard.hohonu.io/map-page/hohonu-111/HyannisHarbor,MA>

MA EOEEA Probabilistic Sea Level Rise Projections

MC-FRM SOUTH (DeConto & Kopp, 2017)





Projected Mean High Water

LEGEND

Dry		MHW Flooding		
		2070	2050	2030

Projected Tidal Benchmarks (elevation in ft. NAVD88)

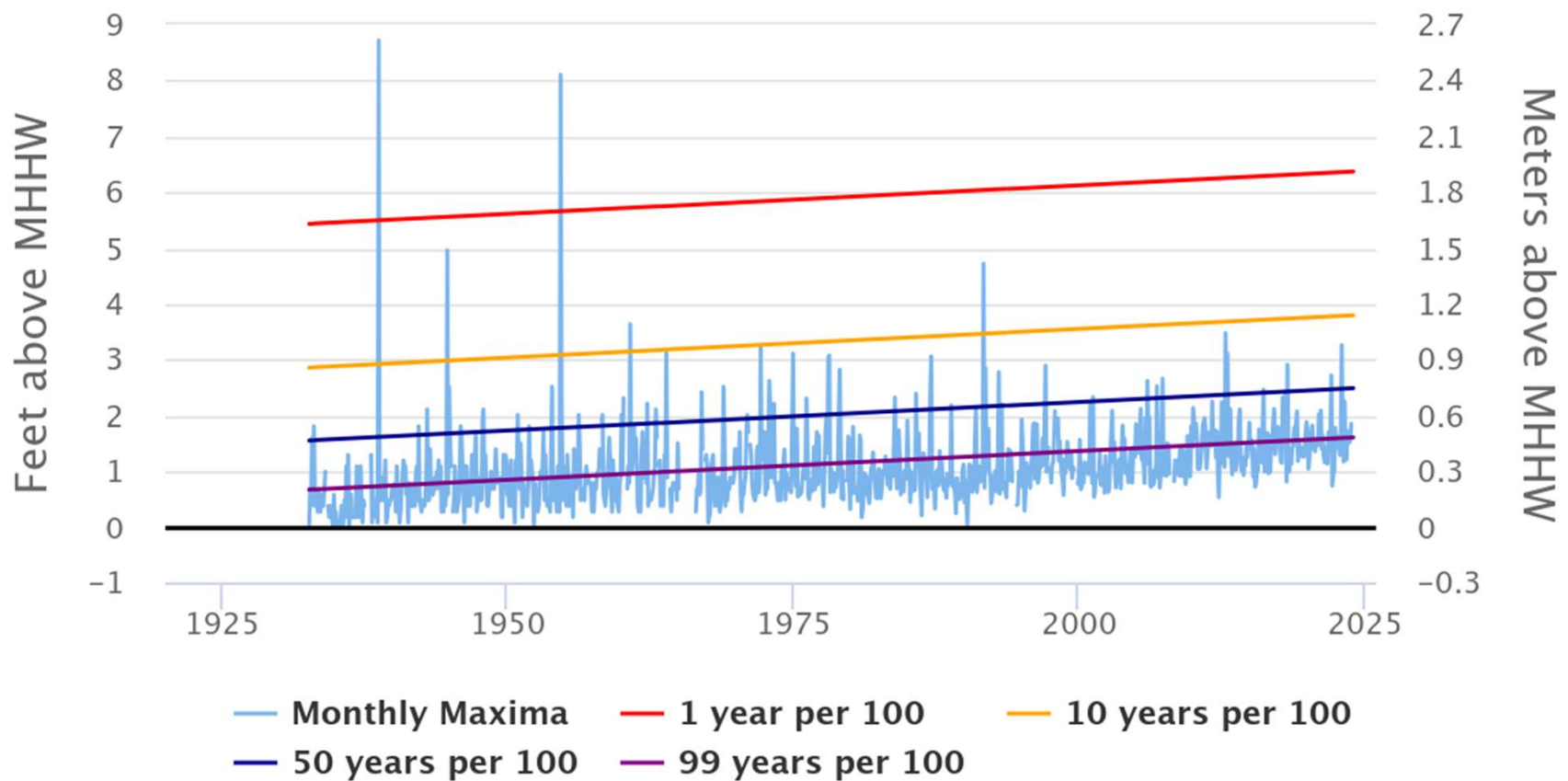
Hyannis Harbor

MC-FRM Tidal Benchmarks

	2030	2050	2070
MHHW	3.4	4.7	6.5
MHW	3.1	4.4	6.3
MLW	1.4	2.7	4.5
MLLW	-0.3	1	2.7



Extreme Water Levels at Woods Hole (Station 8447930)



Massachusetts Coast Flood Risk Model (MC-FRM)

INPUTS



SEA LEVEL
RISE



TROPICAL / EXTRA-
TROPICAL STORMS



LANDSCAPE



ELEVATION



CHANGING
CLIMATE

PROBABILISTIC /
HYDRODYNAMIC
MODEL



Includes relevant physical processes:
sea level rise, tides, storm surge, wind, wave setup
/ run-up / overtopping, future climate scenarios



FLOOD
PROBABILITY



FLOOD
DEPTH



FLOOD
DURATION



FLOOD
VOLUMES



FLOOD
PATHWAYS



WINDS



WAVES



CURRENTS



OUTPUTS

MC-FRM Annual Coastal Flood Exceedance Probability

	AEP	Return Pd.
	0.1%	1/1000
	0.2%	1/500
	0.5%	1/200
	1%	1/100
	2%	1/50
	5%	1/20
	10%	1/10
	20%	1/5
	25%	1/4
	30%	1/3.33
	50%	1/2
	100%	1/1



Image source: amazon.com/stores/Brybelly

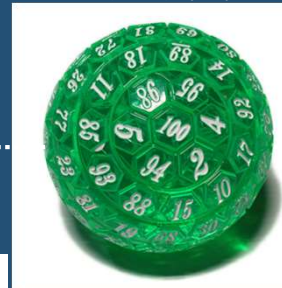


Image source: dicegamedepot.com

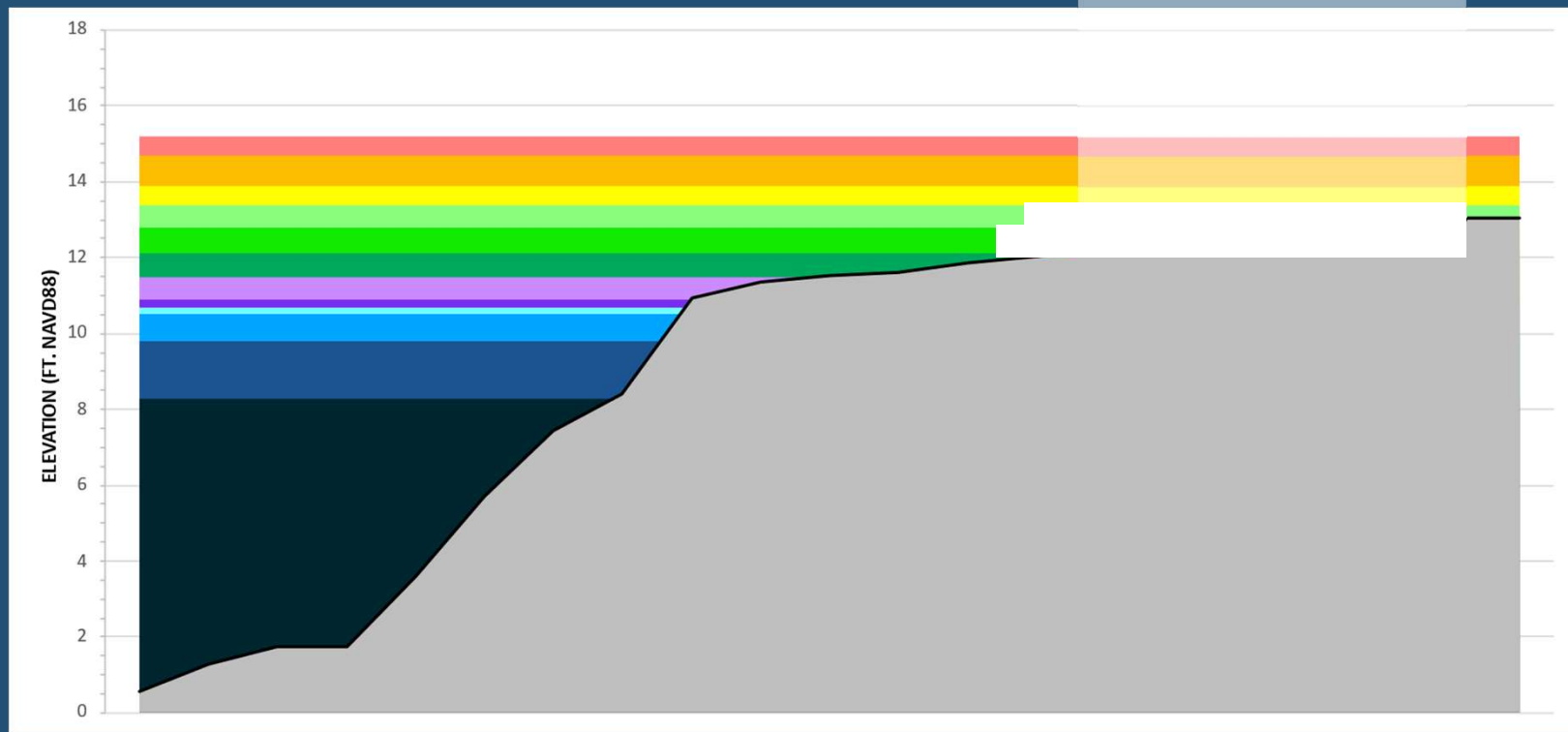


Image source: dicegamedepot.com

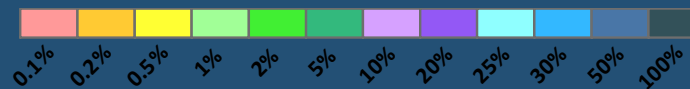
25 yr Cumulative Probability

	2.5%
	4.9%
	11.8%
	22.2%
	39.7%
	72.3%
	92.8%
	99.6%
	99.9%
	100%
	100%
	100%

Vulnerability Assessment Methods



COASTAL FLOOD EXCEEDANCE PROBABILITY



Critical Elevation Survey

The screenshot shows a software interface for a critical elevation survey. The main window displays a photograph of the Cape Cod Maritime Museum, a building with a red door and a sign that reads "CAPE COD MARITIME MUSEUM". Below the photo is a row of thumbnail images labeled IMG_000 through IMG_009, with IMG_001 highlighted. To the right, a "Property Grid" panel shows details for the image group: "Image Group ID: image_group_00201", "Date/Time: 03/21/2024 16:53:19", "Source: 2023-0795 Hyman", "Acquisition: Terrestrial", "Images: 10", "Oriented Images: 10", "Total Image Size: 8.01 Gps", and "Points: 2". At the bottom, a data table provides specific survey data for point IMG_001.

Point ID	Y	Point Role	Date/Time	Source	Observations	Nothing [NUT]	Existing [NUT]	Ortho Height [NUT]	CG 3D [NUT]	CG 2D [NUT]	CG 1D [NUT]	SD Nothing [NUT]
Maritime_UL_P18	05/23/2024 15:10:34	Calculated	05/23/2024 15:10:34	User-entered	8	2.73042334019	968.668.7963	17.2679	0.3034	0.0229	6.0748	6.0134
Maritime_UL_P72	05/23/2024 15:11:6	Calculated	05/23/2024 15:11:6	User-entered	5	2.7304284262	968.668.2374	17.2630	0.3184	0.0161	6.0118	6.0110



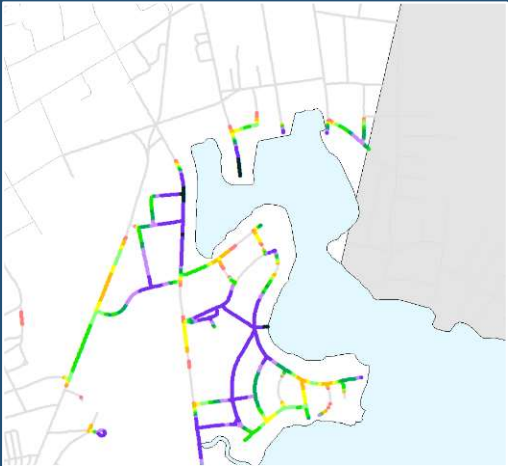
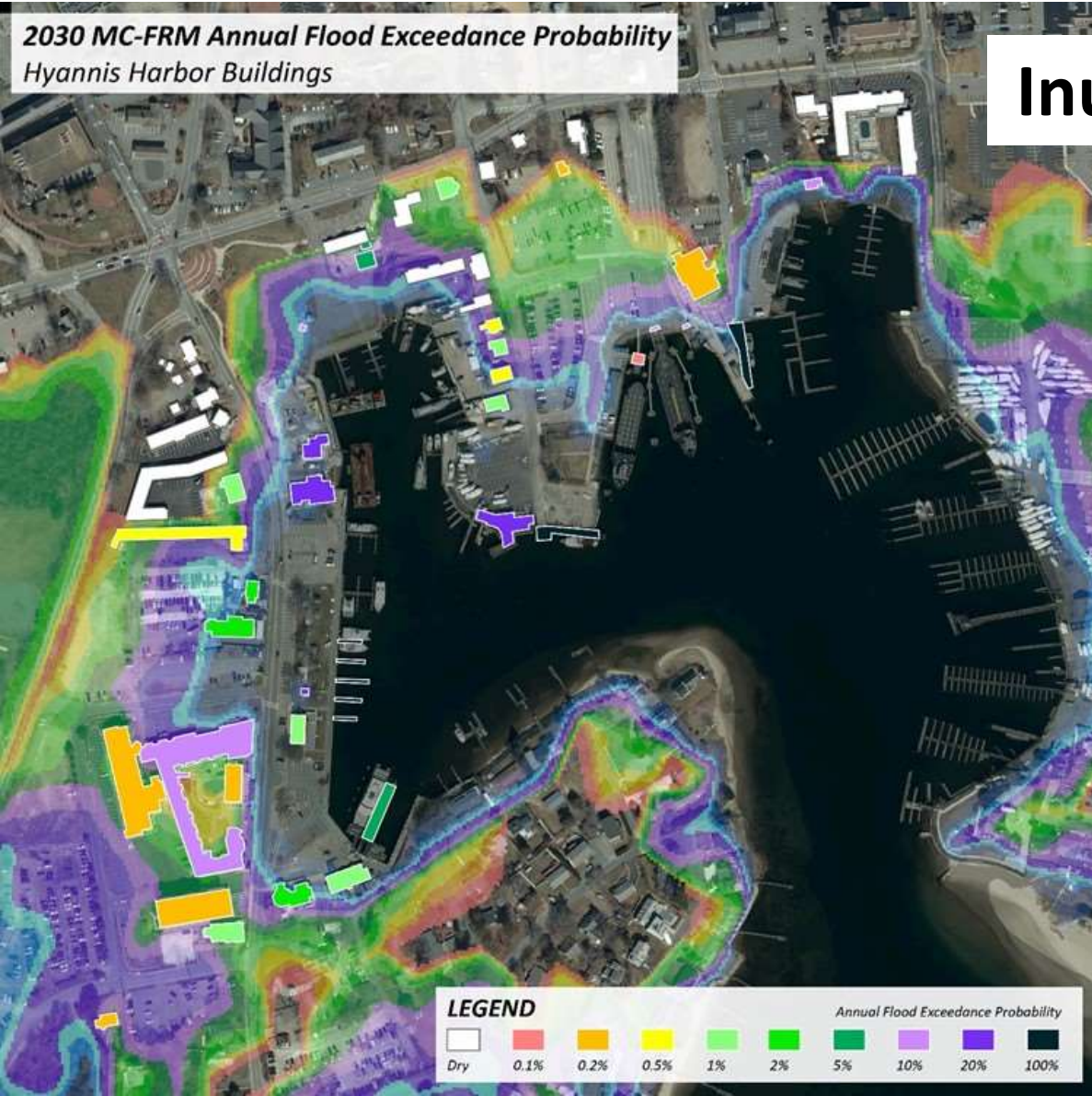
2030 MC-FRM Annual Flood Exceedance Probability
Hyannis Harbor Buildings

Inundation Probability 2030

*CEs from surveyed first floor elevations or equipment heights, modifications for existing floodproofing noted where observed

With 1.4 ft of SLR,
High probability storms (10%+ AEP) could flood:

- 2 restaurants
- 1 commercial structure
- 1 hotel structure
- 1 residential structure



Source: Cape Cod Low Lying Roads Project



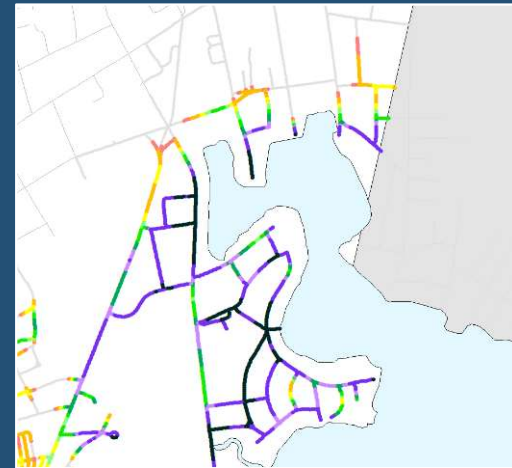
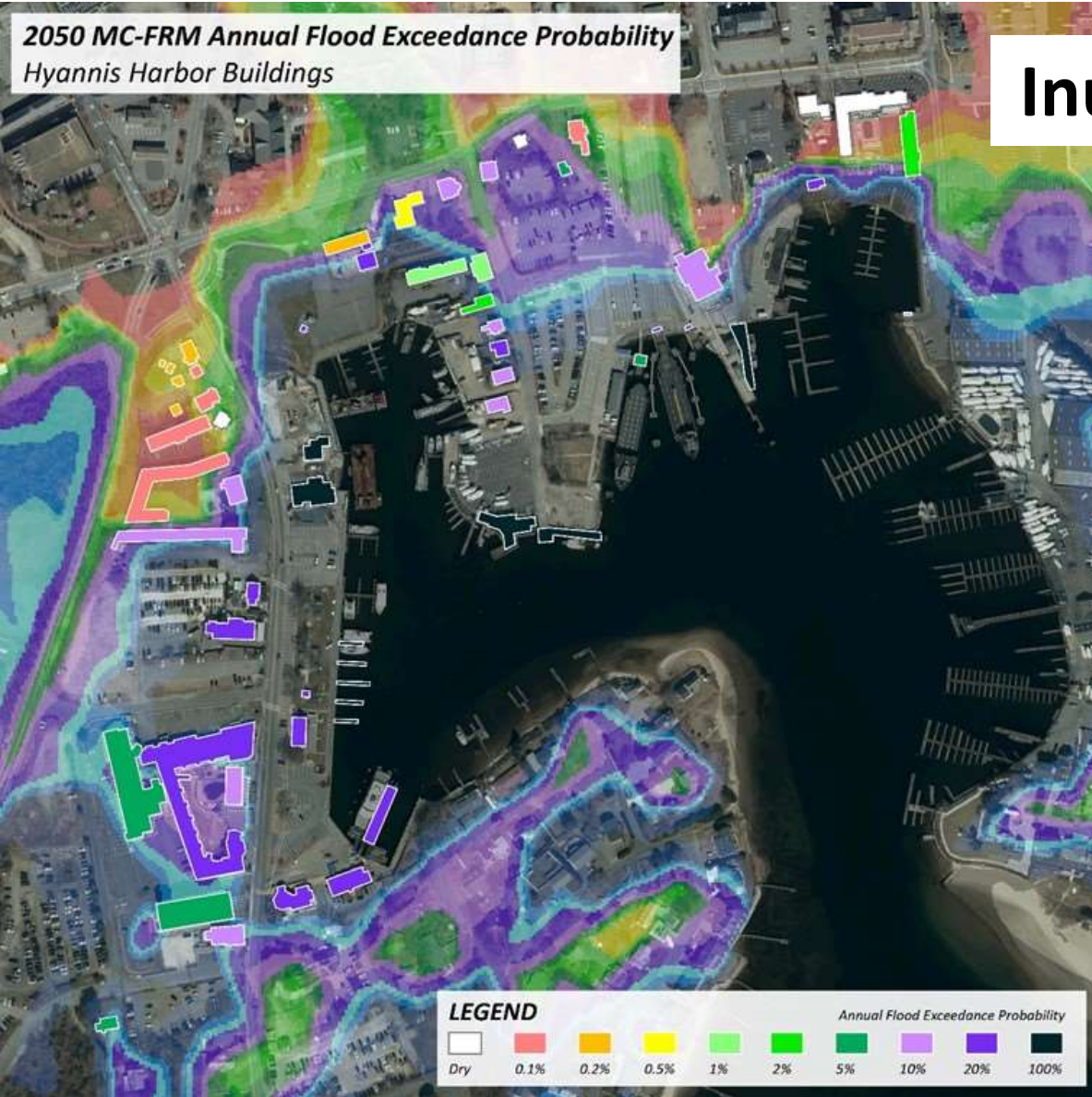
2050 MC-FRM Annual Flood Exceedance Probability
Hyannis Harbor Buildings

Inundation Probability 2050

*CEs from surveyed first floor elevations or equipment heights, modifications for existing floodproofing noted where observed

With 2.7 ft of SLR,
High probability storms (10%+ AEP) could flood:

- 7 restaurants
- 7 commercial structure (2 ferry)
- 3 hotel structure
- 3 residential structure
- 2 municipal structures (incl. harbormaster)



Source: Cape Cod Low Lying Roads Project

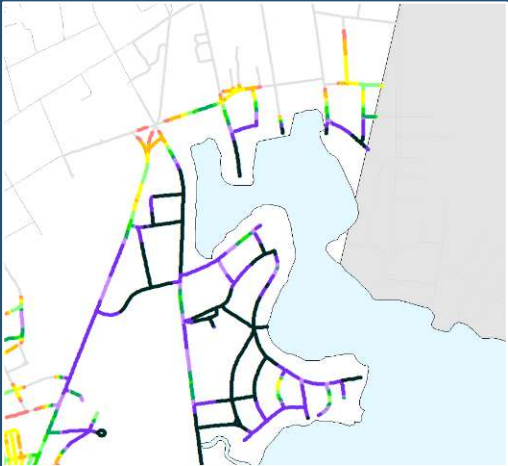
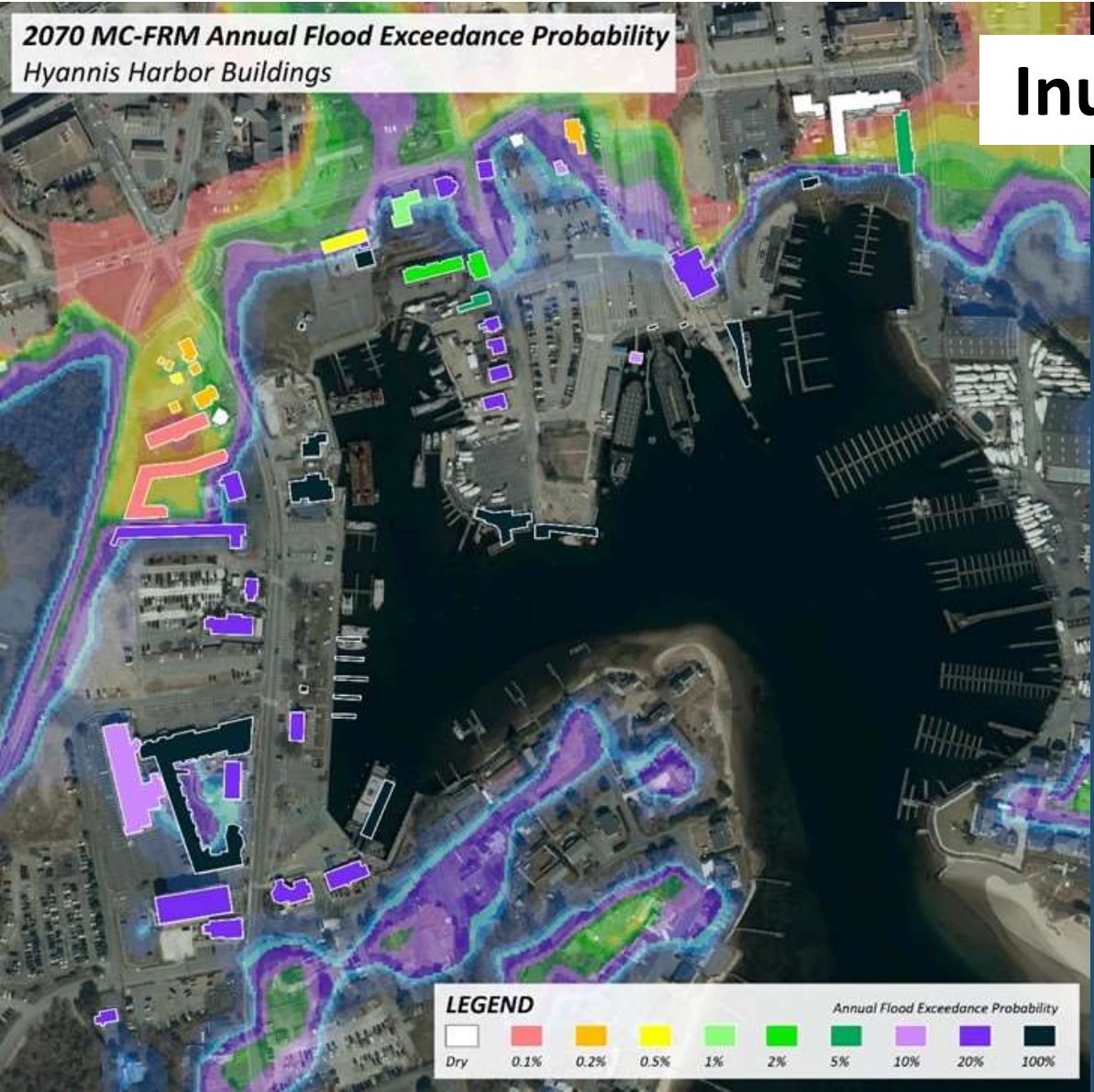
**2070 MC-FRM Annual Flood Exceedance Probability
Hyannis Harbor Buildings**

Inundation Probability 2070

*CEs from surveyed first floor elevations or equipment heights, modifications for existing floodproofing noted where observed

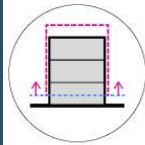
With 4.5 ft of SLR,
High probability storms (10%+ AEP) could flood:

- 7 restaurants
- 8 commercial structure (2 ferry)
- 5 hotel structure
- 4 residential structure
- 2 municipal structures (incl. harbormaster)



Source: Cape Cod Low Lying Roads Project

Adaptation Strategies – Building/Site Scale



Building Form + Access



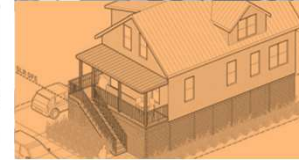
Elevate on extended foundation walls or open foundation



Elevate on fill



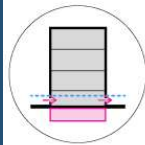
Repurpose/Relocate Ground Floor Use



Exterior circulation to SLR-DFE



Interior circulation to SLR-DFE



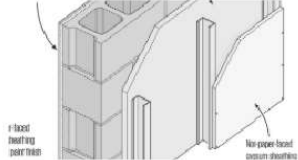
Building Adaptation



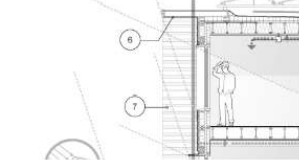
Wet Floodproofing



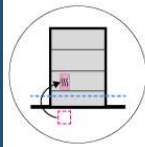
Dry Floodproofing



Flood Damage-Resistant Materials



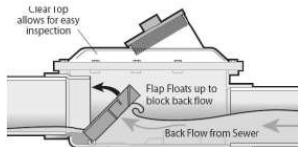
Enhanced Building Envelope



Building Systems



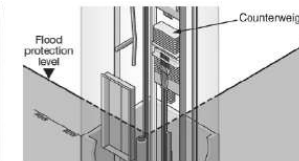
Protecting Critical Systems



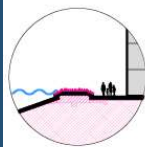
Backflow Prevention



Back-up Systems



Resilient Elevators



Site



Vegetated Berm



Deployable Barriers

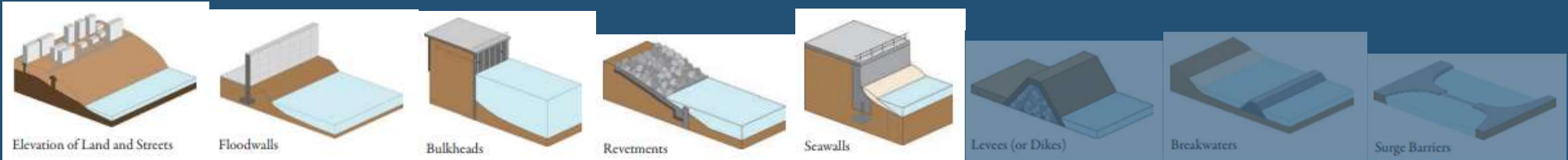


Perimeter Wall

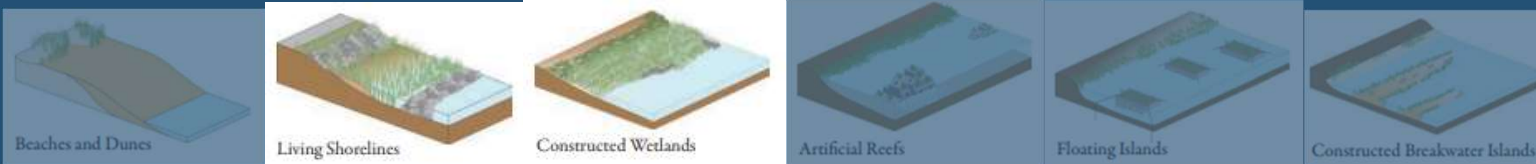
(Credit: Modified from Boston Planning & Development Agency, Coastal Flood Resilience Design Guidelines)

Adaptation Strategies –Landscape Scale

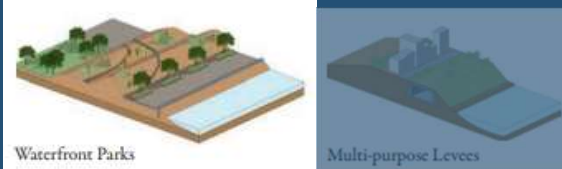
Protect (hardened infrastructure)



Protect (natural or nature-based infrastructure)



Protect (hybrid infrastructure)



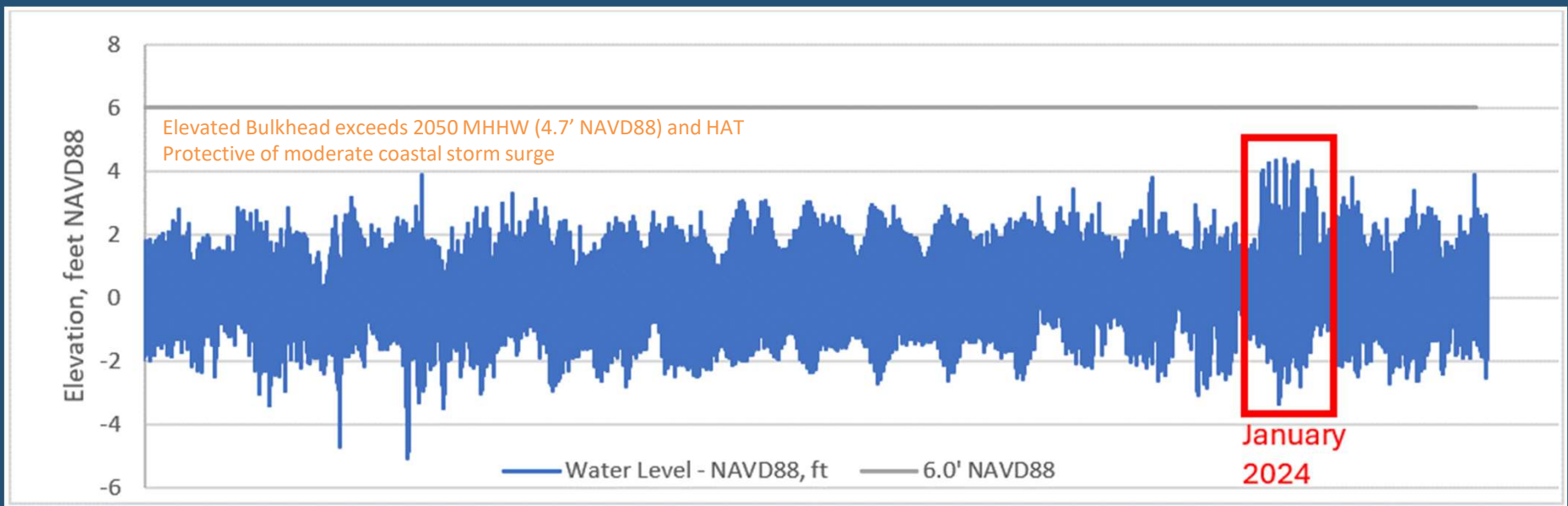
Relocate/Retreat



(Credit: Modified from NYCPlanning, Coastal Climate Resilience Urban Waterfront Adaptive Strategies)

Planning-Level Resilience Strategy (future tidal inundation)

Set a Harbor bulkhead target elevation for public and private renovations



Planning-Level Resilience Strategy (future coastal storms)

Set location-specific Design Flood Elevations based on projected 2050 1% significant wave crest elevations



CASE STUDY | COMMON BUILDING TYPES

LARGE COMMERCIAL/INSTITUTIONAL/MIXED USE BUILDING

Source: Cape Cod Commission Flood Area Design Guidelines



- ① Floodproof in place, if building materials are adequate and ground-floor uses can accommodate it, with floodproof materials below BFE/freeboard, and drop-in barriers for door and window openings below BFE/freeboard.
- ② Extend stairs to entry simply to front when possible or add additional entrance for greater accessibility.
- ③ Screen increased height of foundation or space below building with layers of vegetation or skirting, depending on height and character of surrounding neighborhood.
- ④ Allow dormer additions to upper levels to compensate for the loss of lower level areas that can't be elevated.
- ⑤ Design a series of platforms to soften the increase in elevation and provide usable public space.

Hyannis Harbor Resilience Interventions

MAINTAIN A USEABLE WATERFRONT

Elevate bulkheads to 6.0 ft NAVD88 (Bismore Park and Hyannis Harbor Park)

Integrate Harborwalk into elevated feature, but need to find tie-backs to close flood pathways

BUILD FOR FUTURE STORMS

Explore incorporating additional (incremental/deployable) protection on top of bulkheads

Use landscape/hardscape to build storm protection and storage for precipitation-based flooding

Floodproof (wet/dry) or elevate assets and buildings (different for commercial vs. residential)

Consider the streetscape; allow space to transition from street level where elevation must occur

RELOCATE USES TO LESS VULNERABLE AREAS

Active programming/infrastructure in low Bismore vs. elevated Aselton

Emergency operations center for Harbormaster

Reconsider parking strategies (especially for long-term lots)

RAISE LOW-LYING ROADWAYS

Ocean St. and Pleasant St. (both limited by tie-ins and flanking)

ADDRESS FLANKING PATHWAY

Nantucket St. elevation and culvert retrofit/modification

Zoning and Harbor Use Recommendations



Zoning Ordinance

- Implement a Coastal Flood Resilience Zoning Overlay District
- Permitted By Right: Food and Beverage Services, Retail Sales
- Permitted With Limitations: Brewery/Distillery
- Not Permitted: Office, Health Care Clinic, Research and Development
- Special Permit: Mixed-Use Development with Residences on Upper Stories

Zoning Ordinance

- Eliminate or Significantly Reduce All Minimum Parking Space Requirements
- Building Height Definition:
 - In areas subject to Design Flood Elevations it shall be measured from the higher of: (a) Grade or (b) Finished Floor Elevation
- Reduce Maximum Lot Coverage to 80%

Harbor Uses

- Relocate Commercial Fishing Offloading to South End of Pleasant Street and Establish a Fish Market



Harbor Uses

- Continue Harborwalk to School Street to a Destination at the South End



Harbor Uses

- Explore the Reuse of 91 South Street Property and Building

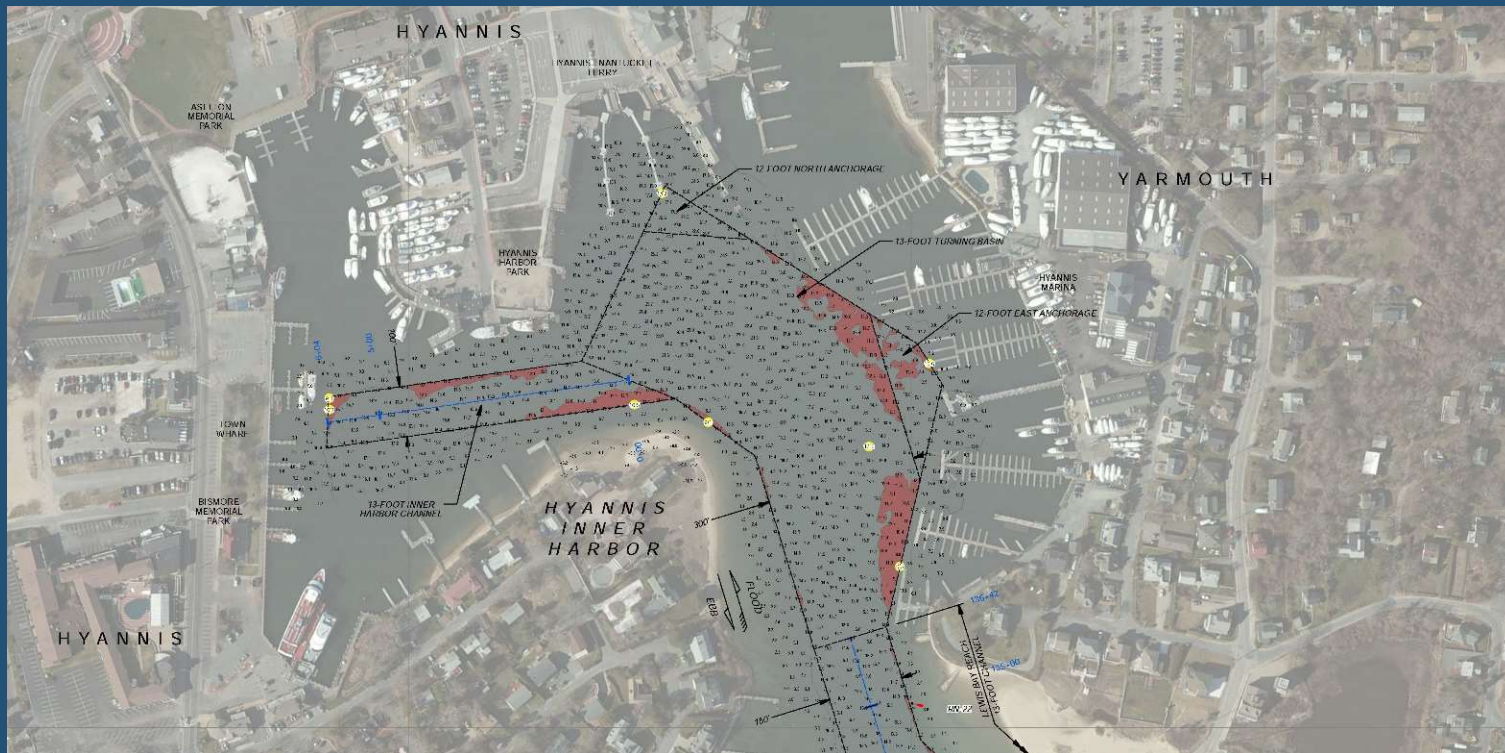


Public Access at Waterfront

- Extend Harborwalk to Provide Continuous Access along the Water's Edge
- Consider Implementing Business Supported Waterfront Improvement District Fund
- Improve Signage to Promote Public Access along the Waterfront

Public Access at Waterfront

- Extend Federal Navigation Channel Deeper into Harbor towards Aselton Park



Public Access at Waterfront

- If Zoning Permits Increased Building Heights, Implement Staggered Building Heights with Porches and Balconies
- Reduce Surface Parking to Improve Aesthetics and Environmental Benefits
- Give Priority to Water Dependent Uses along the Harbor

Land Use and Design Guidelines Recommendations



Resiliency

- Provide flood resiliency measures to improve overall resilience and functionality of the harbor zone over time
 - Establish consistent local Harbor Bulkhead Elevation (HBE) of 6.0' ft. NAVD88 (provides resiliency to 2050 Highest Annual Tide)
 - Incrementally increase height of publicly owned bulkheads (underway)
 - Coordinate with private landowners to encourage bulkhead or seawall improvements to meet consistent elevation
 - Consider opportunities to improve Nantucket Street flooding
 - Implement Harbor Zone minimum floor elevations for new construction and framework for flood proofing existing structures
 - Consider raising Ocean Street to improve resiliency

Program of Activities

- Prepare a program of activities to activate the harbor zone public realm
 - Events to animate the Harbor Zone and public spaces such as concerts, food truck events, brewery nights, festivals, markets, expanded artist shanties, outdoor movies in the park, direct to consumer seafood sales, etc.



Image: <https://artsbarnstable.com/venue/aselton-park/>

Harborwalk

- Develop design guidelines and expanded network for a continuous Harborwalk
 - Coordinate with adjacent private property owners to expand and define a publicly accessible Harborwalk
 - Develop a palette of common materials and widths for the Harborwalk



Streetscape Improvements

- Consider returning Harbor Zone Streets to two-way and implementing flood resilience strategies on priority streets
 - Convert South Street to two-way street
 - Implement proposed rotary and pedestrian crossing improvements at the 6-way intersection
 - Consider raising Ocean Street to improve resiliency

Public Open Space Improvements

- Develop park renovation plans for Aselton Park, Bismore Park, and Harbor Park areas that incorporate resiliency measures, expand Harborwalk, and implement the open space activation goals



Public Open Space Improvements

- Aselton Park: Accessibility improvements, stormwater improvements, potential new resilient home for expanded artist shanties, animated public area at rear of Maritime Museum and harbor's edge, new stage and park programming, etc.
- Bismore Park and Ocean Street: Phased improvements to align with bulkhead reconstruction projects, consider partial or temporary planned pedestrianization of Ocean Street in concert with raising street grades, expansion of Bismore Park westward in concert with Ocean Street raising or improvement, tree canopy strategy to address trees in decline and plan for raising of elevation to meet Ocean Street and bulkhead height increases, activities such as food trucks or other events to animate park, stormwater improvements, Harborwalk design, address conflicts with Hy-Line loading/offloading, etc.
- Pleasant Street and Harbor Park: Sidewalk accessibility improvements to improve the Harborwalk, consider shoreline improvements and raising of the south end of Pleasant Street to improve resiliency, redesign piers to accommodate commercial catch offloading and potential direct to consumer seafood sales, renovate Harbor Park to accommodate Pleasant Street improvements and to animate this underused public park, etc.

Sidewalks and Wayfinding

- Identify and implement desired sidewalk improvements throughout the Harbor Zone
- Develop a substantial Wayfinding strategy to better link destinations and guide visitors



Economic Development Recommendations

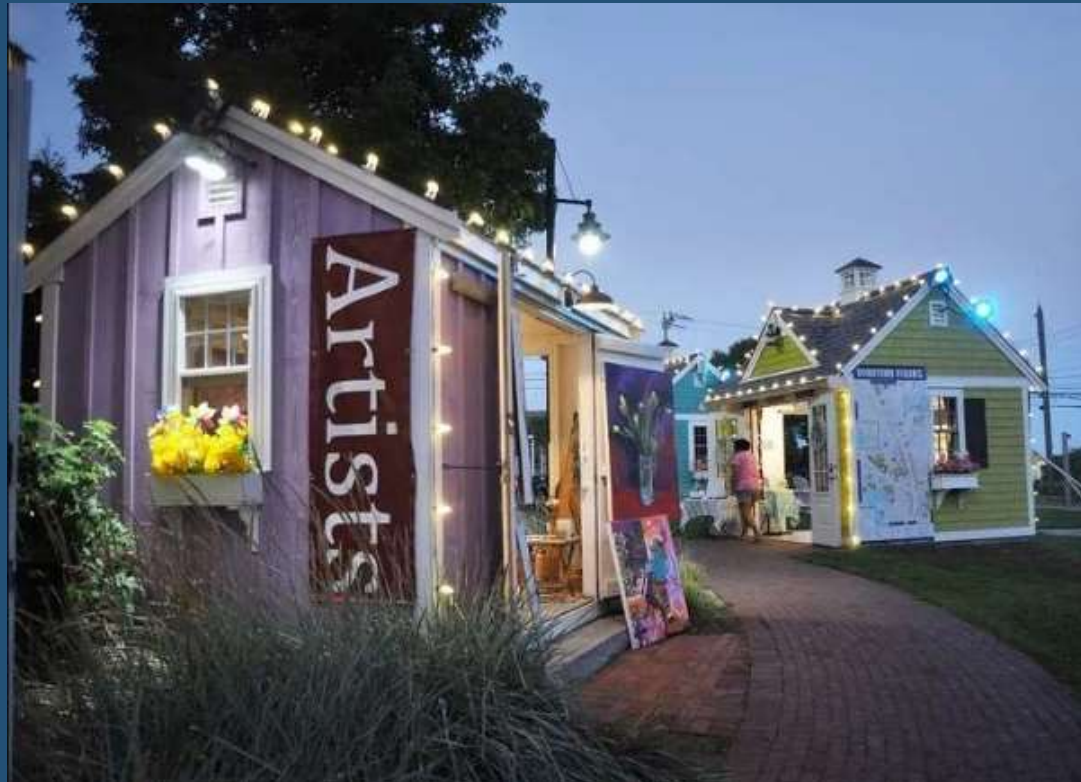


Image courtesy of Art Barnstable, artsbarnstable.com

Key Factors for Recommendations

- Enhance and support walkability,
- Support small local businesses,
- Support the local fishing industry,
- Increase connectivity to the downtown,
- Improve parking, and
- Increase the number of businesses providing services and goods supporting harbor uses

Strategy for Creating Recommendations

- Seek to capitalize on the tourists and commuters utilizing harbor facilities and maritime services by expanding and improving accessibility and point-of-interests around the Harbor. Support increased connectivity with the downtown and local neighborhoods to draw people to the Harbor to patronize local businesses beyond the hotels and ferry and boat tour services. This can be accomplished by making the Harbor a “destination point” to be visited and enjoyed as more than a commuter or tourist thru-point.

General Recommendations

- Define your market
- Develop “character,” “brand,” and sense of place for the Harbor
- Zoning and land use
- Develop a “Gateway to the Harbor” theme from Main Street down to Harbor
- Promote walkability and bikeability

Infrastructure (Streets, Streetscaping, Sidewalks, and Signage)

- Improve Six Points Intersection
- Improve pedestrian connections from parking lots to Harbor
- Return South Street to a two-way street
- Improve sidewalks
- Create a Continuous Harbor Walk from Bismore Park to the end of School Street

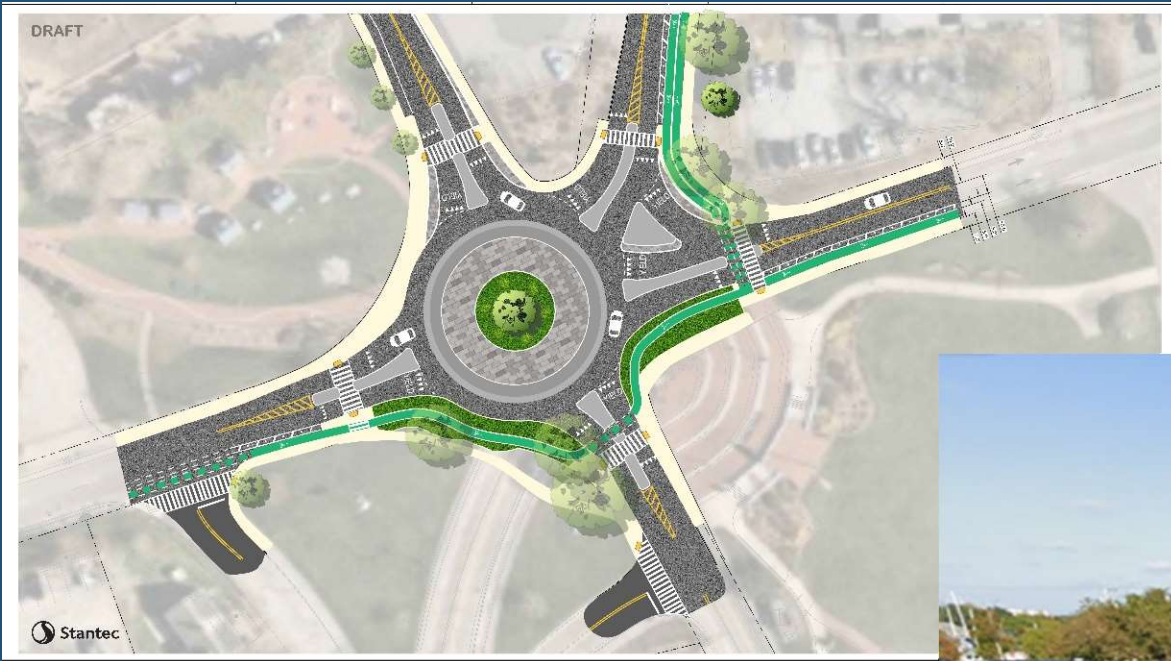


Image from Google Street View

Parking

- Improve existing parking lots
- Develop low-rise parking garage



Images from Specification Magazine, specificationonline.co.



Image courtesy of City of Glenwood Springs, CO (cogs.us)

Business/Tourism

- Expand use of Artists Shanties
- Improve commercial fishing offloading area
- Industry specific business incentivization
- Expand use of Aselton Park to draw more guests to the Harbor area



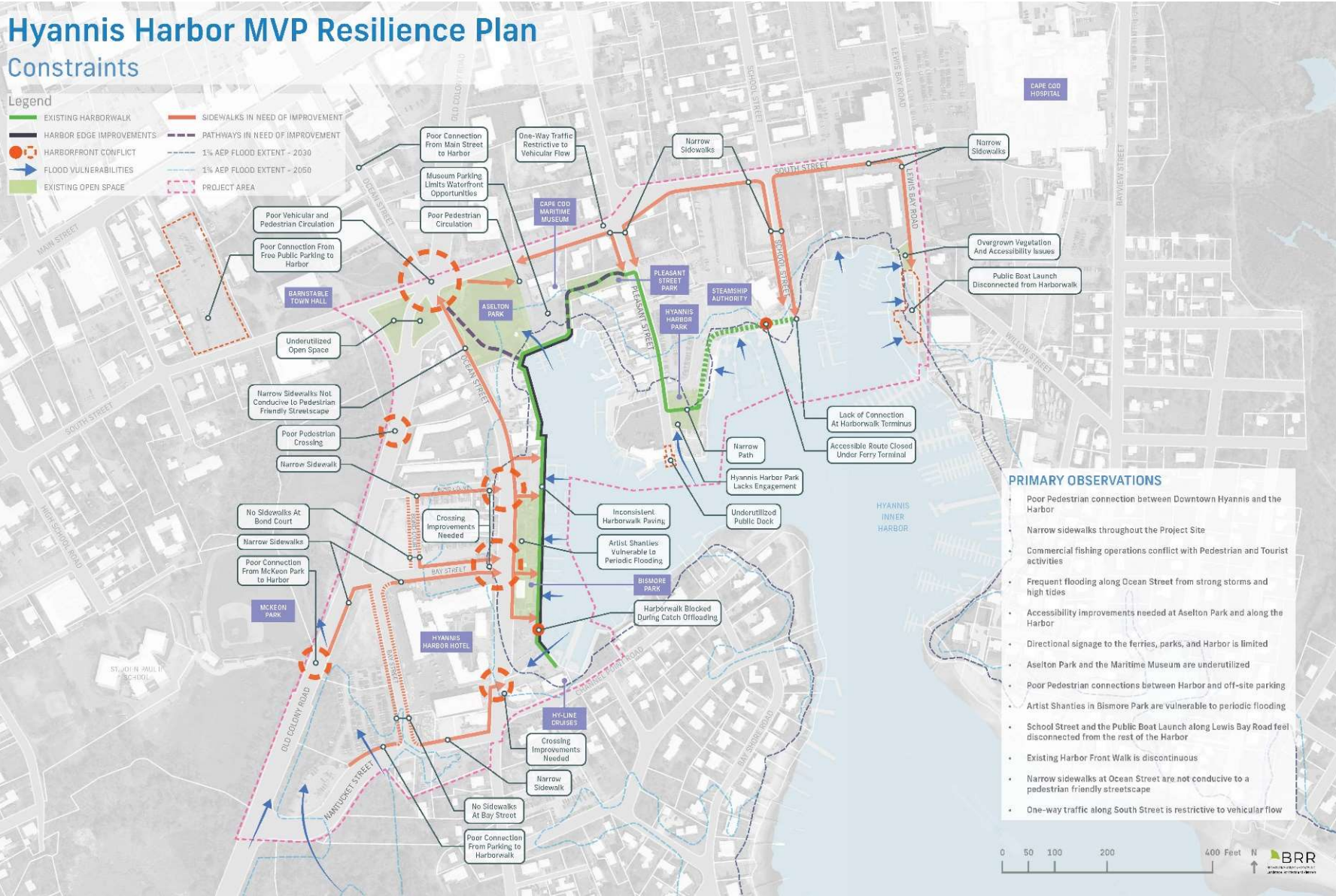
Image courtesy of Monterey Bay Fisheries Trust, MontereyBayFisheriesTrust.org

Hyannis Harbor MVP Resilience Plan

Constraints

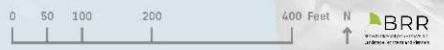
Legend

- EXISTING HARBORWALK
- SIDEWALKS IN NEED OF IMPROVEMENT
- HARBOR EDGE IMPROVEMENTS
- PATHWAYS IN NEED OF IMPROVEMENT
- HARBORFRONT CONFLICT
- 1% AEP FLOOD EXTENT - 2030
- FLOOD VULNERABILITIES
- 1% AEP FLOOD EXTENT - 2050
- EXISTING OPEN SPACE
- - - PROJECT AREA



PRIMARY OBSERVATIONS

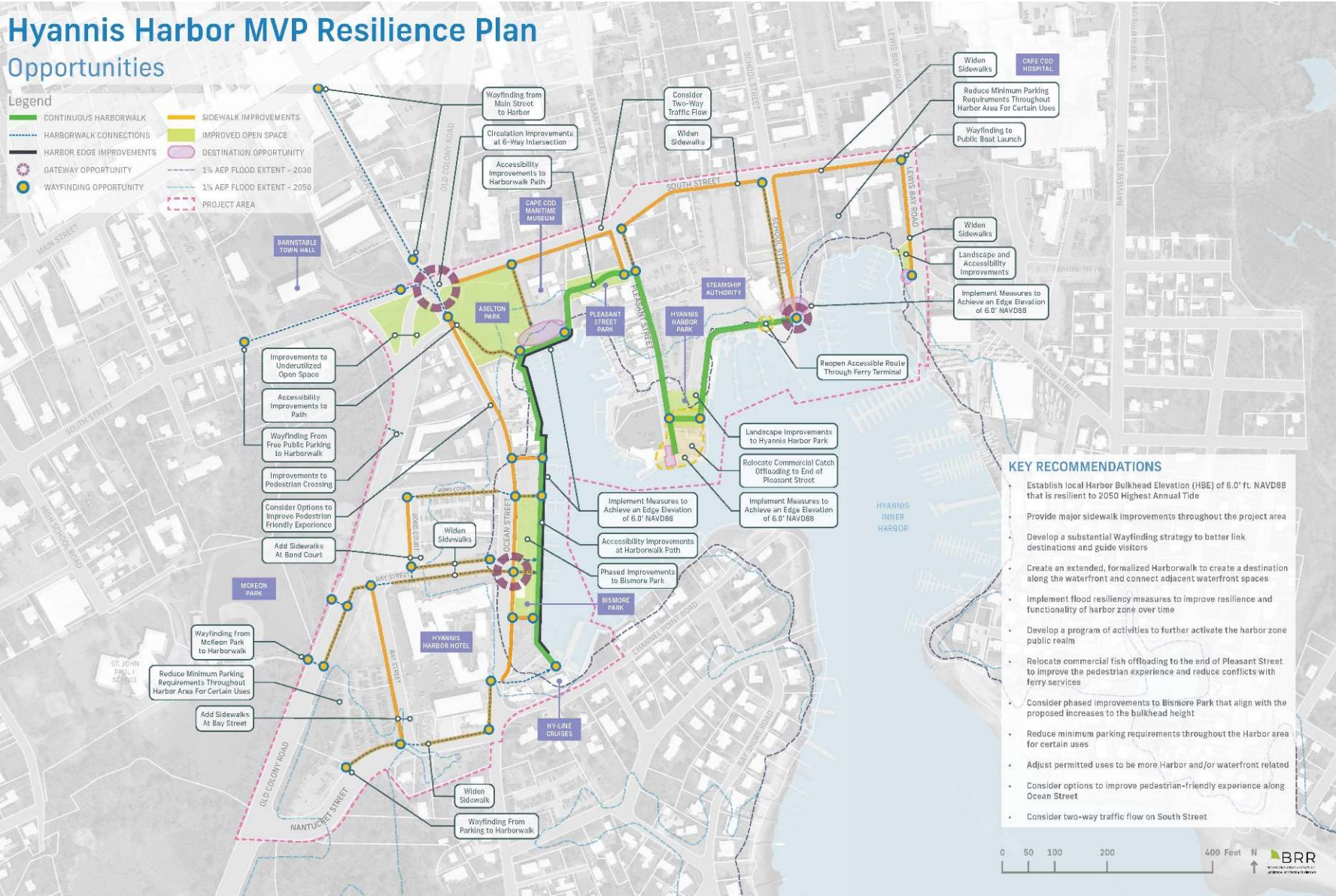
- Poor Pedestrian connection between Downtown Hyannis and the Harbor
- Narrow sidewalks throughout the Project Site
- Commercial fishing operations conflict with Pedestrian and Tourist activities
- Frequent flooding along Ocean Street from strong storms and high tides
- Accessibility improvements needed at Aseleon Park and along the Harbor
- Directional signage to the ferries, parks, and Harbor is limited
- Aseleon Park and the Maritime Museum are underutilized
- Poor Pedestrian connections between Harbor and off-site parking
- Artist Shanties in Bismore Park are vulnerable to periodic flooding
- School Street and the Public Boat Launch along Lewis Bay Road feel disconnected from the rest of the Harbor
- Existing Harbor Front Walk is discontinuous
- Narrow sidewalks at Ocean Street are not conducive to a pedestrian friendly streetscape
- One-way traffic along South Street is restrictive to vehicular flow



Hyannis Harbor MVP Resilience Plan Opportunities

Legend

- CONTINUOUS HARBORWALK
- HARBORWALK CONNECTIONS
- HARBOR EDGE IMPROVEMENTS
- GATEWAY OPPORTUNITY
- WAYFINDING OPPORTUNITY
- SIDEWALK IMPROVEMENTS
- IMPROVED OPEN SPACE
- DESTINATION OPPORTUNITY
- 1% AEP FLOOD EXTENT - 2030
- 1% AEP FLOOD EXTENT - 2050
- PROJECT AREA



KEY RECOMMENDATIONS

- Establish local Harbor Bulkhead Elevation (HBE) of 6.0' ft. NAVD88 that is resilient to 2050 Highest Annual Tide
- Provide major sidewalk improvements throughout the project area
- Develop a substantial Wayfinding strategy to better link destinations and guide visitors
- Create an extended, formalized Harborwalk to create a destination along the waterfront and connect adjacent waterfront spaces
- Implement flood resiliency measures to improve resilience and functionality of harbor zone over time
- Develop a program of activities to further activate the harbor zone public realm
- Relocate commercial fish offloading to the end of Pleasant Street to improve the pedestrian experience and reduce conflicts with ferry services
- Consider phased improvements to Bismore Park that align with the proposed increases to the bulkhead height
- Reduce minimum parking requirements throughout the Harbor area for certain uses
- Adjust permitted uses to be more Harbor and/or waterfront related
- Consider options to improve pedestrian-friendly experience along Ocean Street
- Consider two-way traffic flow on South Street

0 50 100 200 400 Feet N **BRR**

A Resilient Hyannis Harbor

Massachusetts Municipal Vulnerability Preparedness Action Grant FY24

Created for the Town of Barnstable
Draft

