

Downtown Neighborhood Flood Barrier

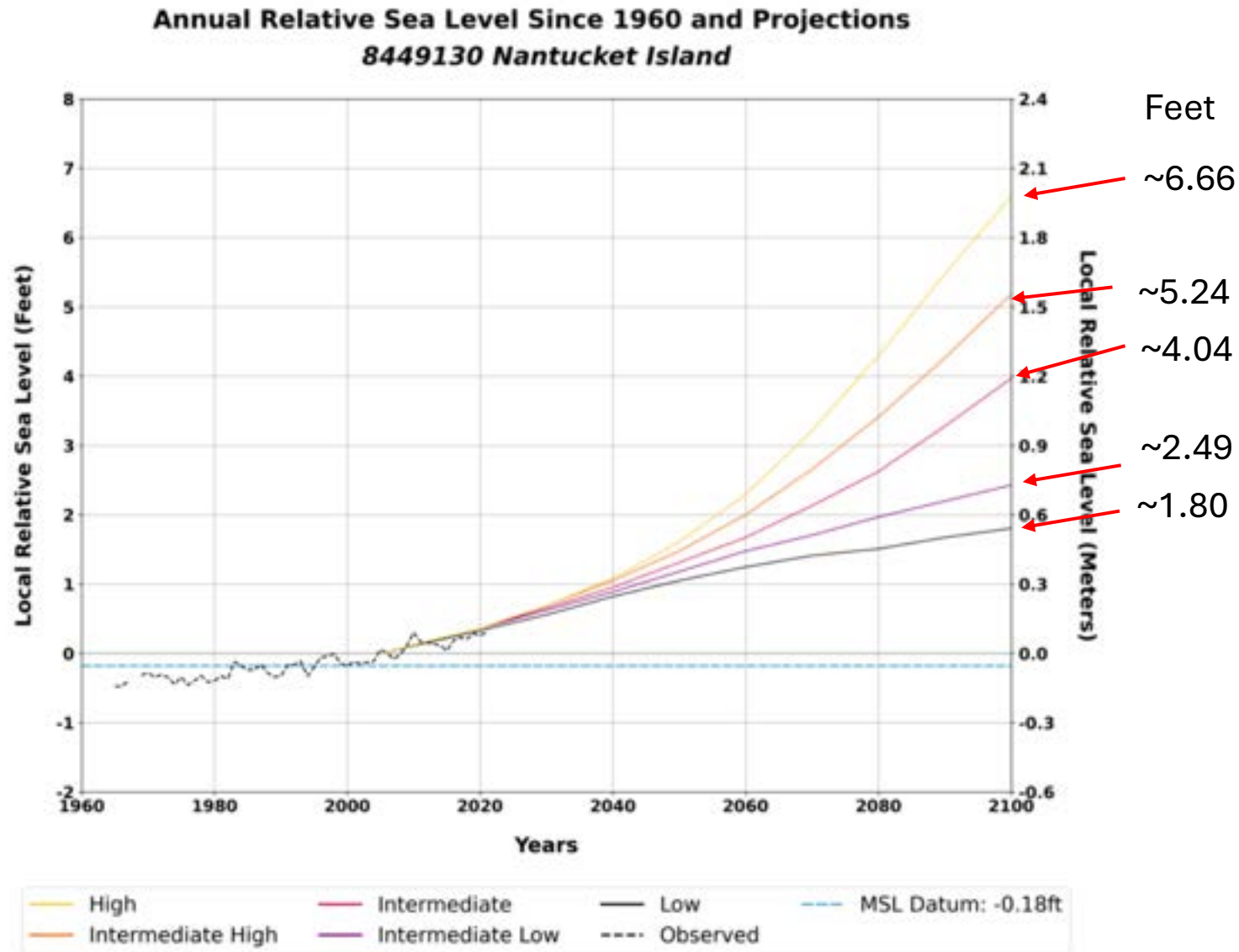
Coastal Resilience Plan recommendations #2-2 & #2-6



Coastal Resilience Advisory Committee
Tuesday January 28, 2025

Leah Hill, Coastal Resilience Coordinator
Town of Nantucket Natural Resources Department
Lhill@nantucket-ma.gov
508-228-7200 ext. 7603

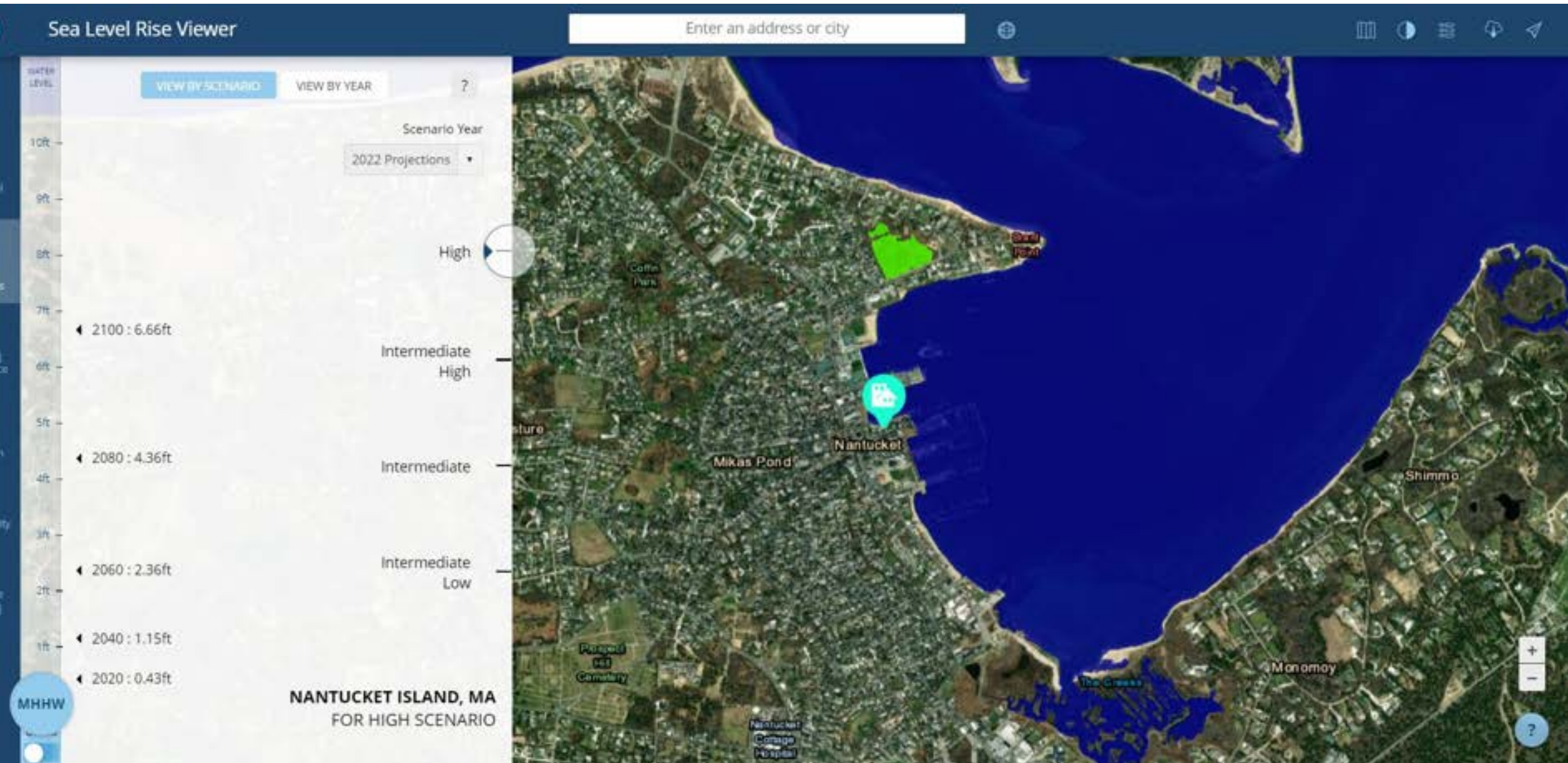
NOAA reports 2022 SLR scenarios for Nantucket



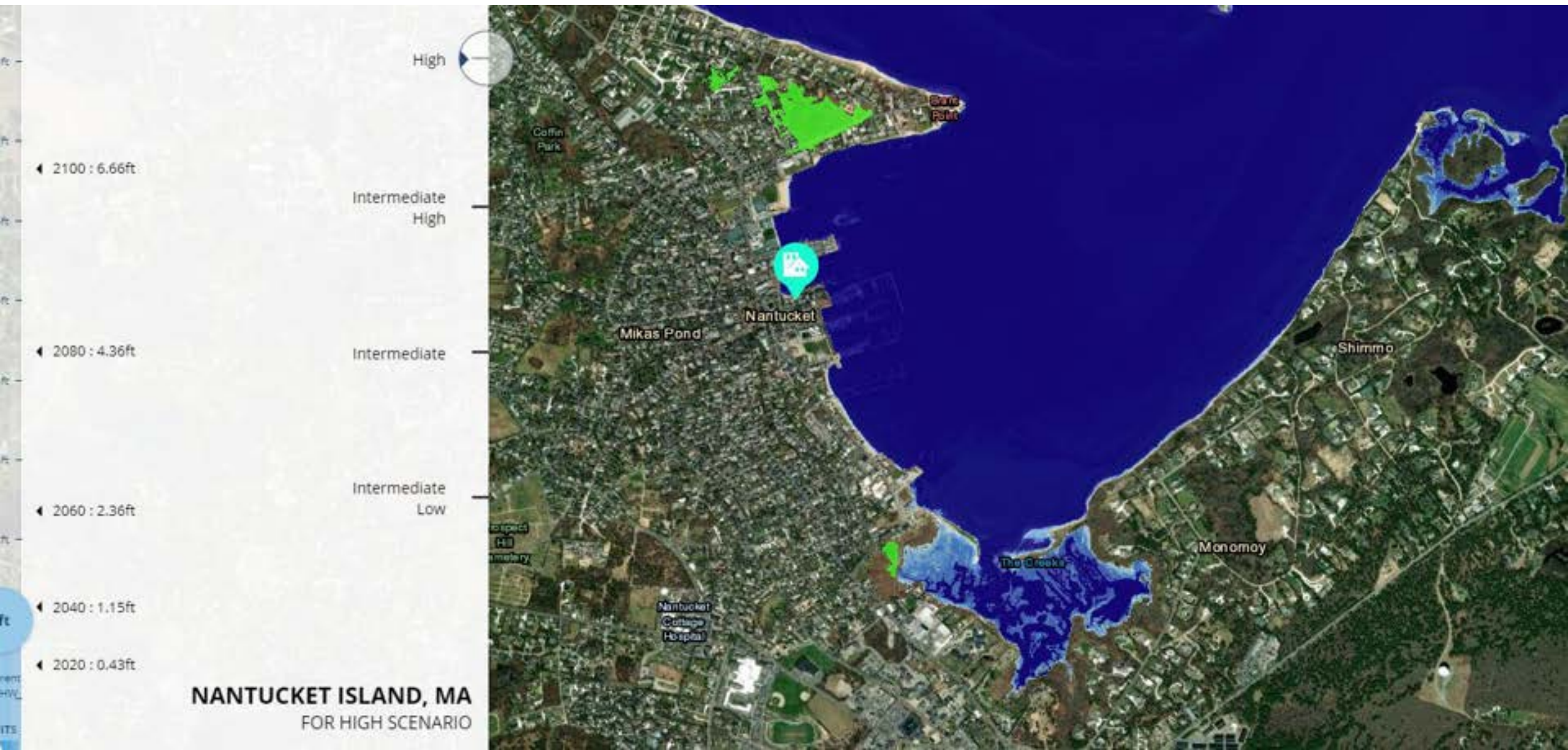
- NOAA tide gauge adjacent to Steamboat Wharf
- **4.01mm/yr with a 95% confidence interval of +/- 0.31 mm/yr based on monthly mean sea level data from**
- **1965-2024 = 9.3” SLR**
- **The CRAC recommends all Town Departments, Boards, Commissions and Committees and any service providers, contracted engineers and consultants need to be aware of and need to use the NOAA “High” scenario to accommodate current storm surge as well as Sea Level Rise in their decisions, deliberations and planning.**
- Plan for the worst, hope for the best

NOAA Sea Level Rise – Normal Day High Tide – PRESENT DAY

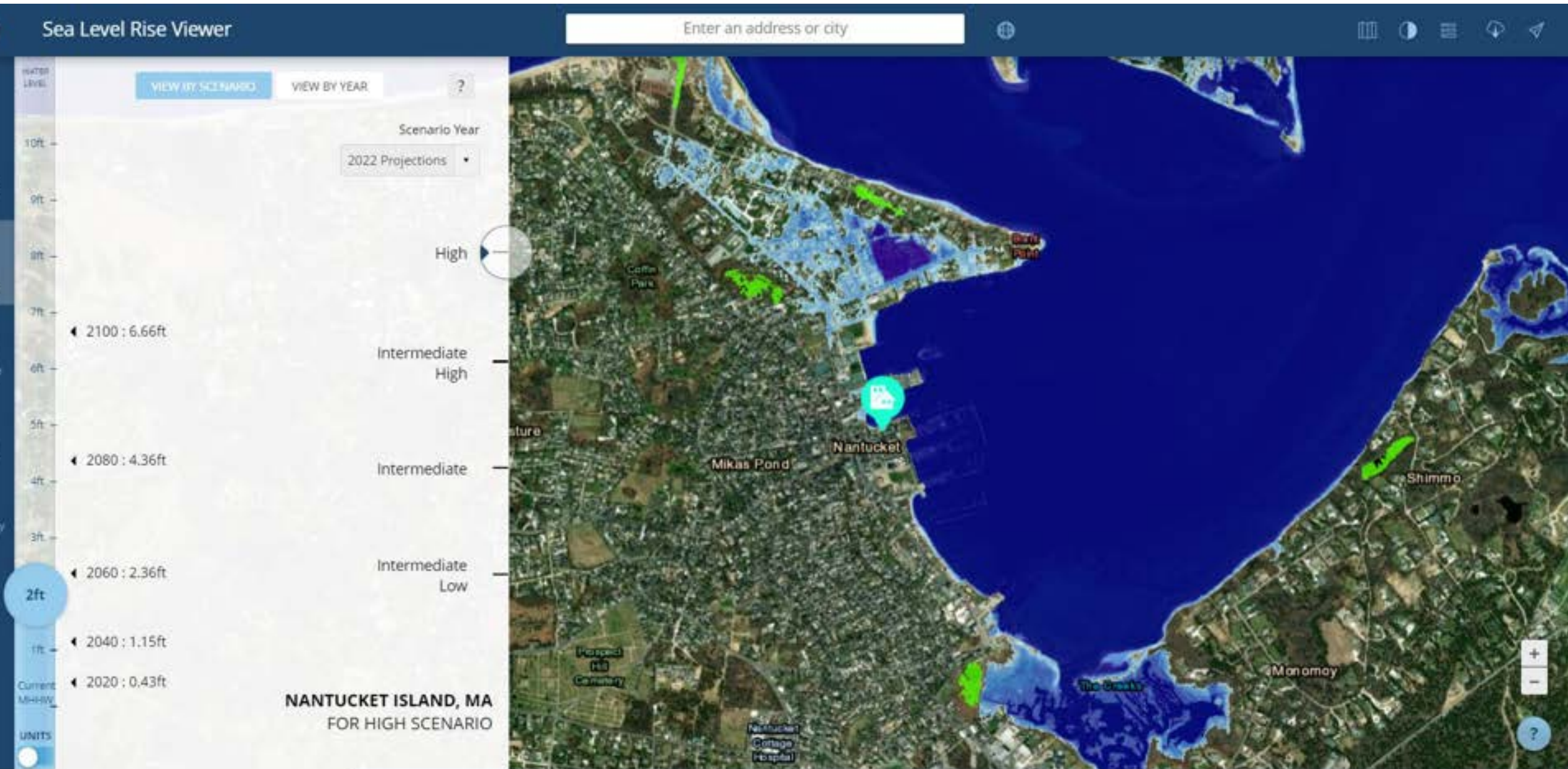
Bath Tub Model- All water rises equally



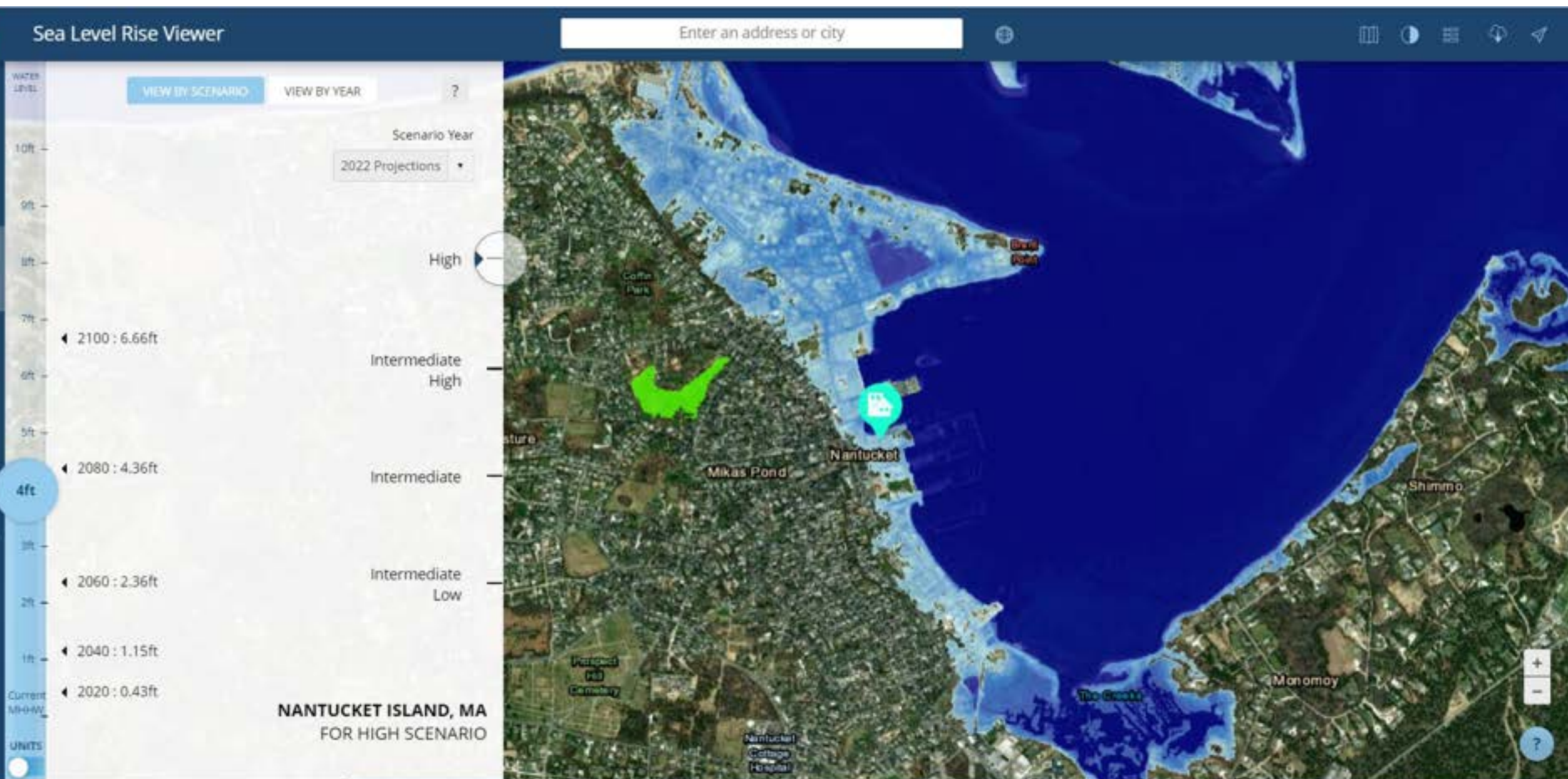
NOAA Sea Level Rise – Normal Day High Tide – 2030



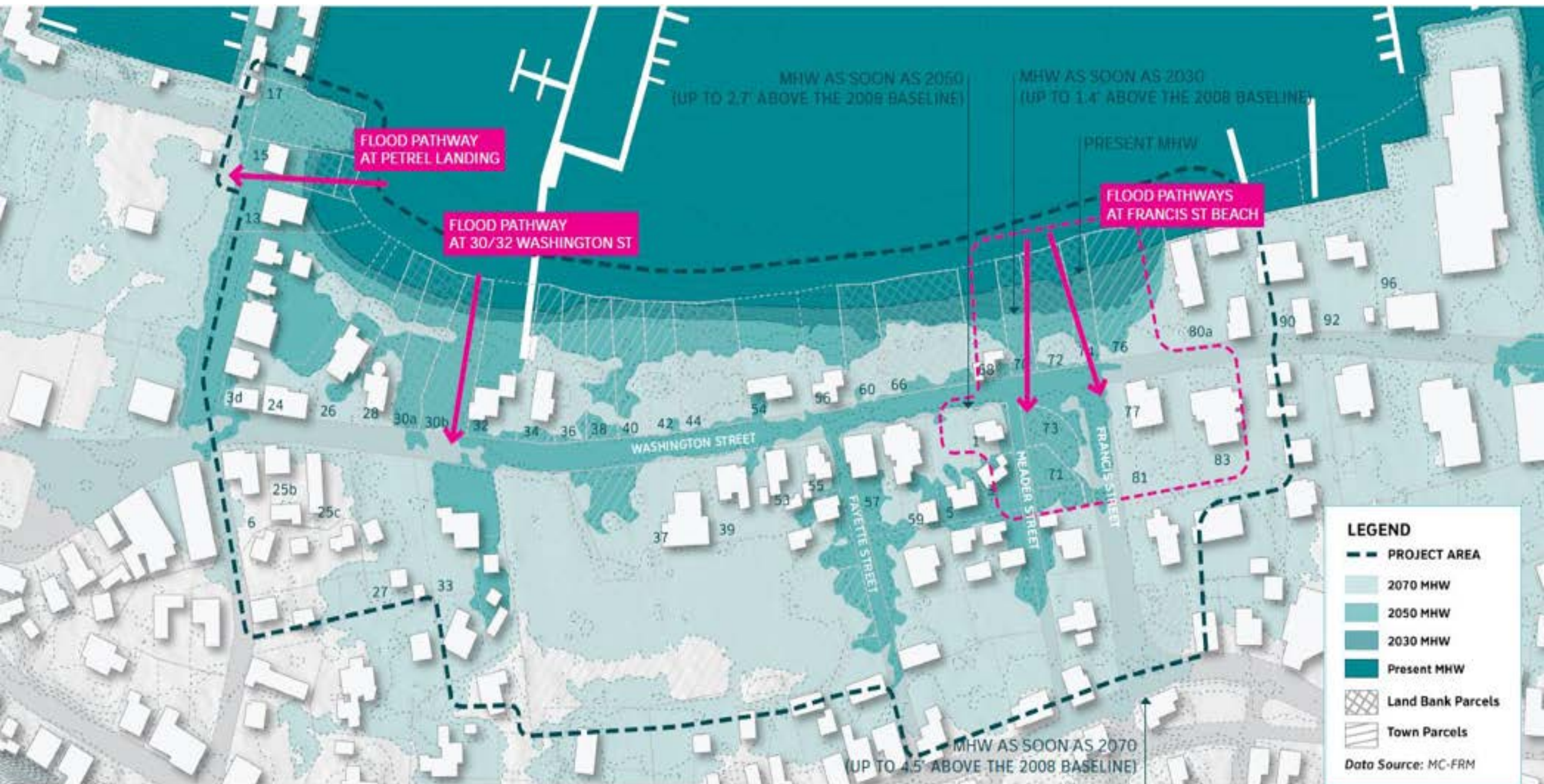
NOAA Sea level Rise – Normal Day High Tide – 2050's



NOAA Sea Level Rise – Normal Day High Tide – 2070's to 2080's







Massachusetts Coastal Flood Risk Model (MC-FRM)

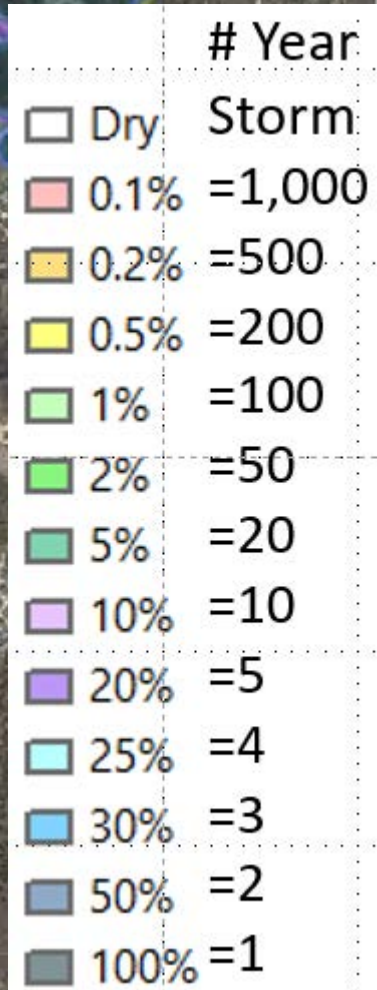
Includes: high tide, storm flooding, wave run-up, SLRfuture hurricanes and Nor'Easters

Probabilistic model and 10ft x 10ft resolution

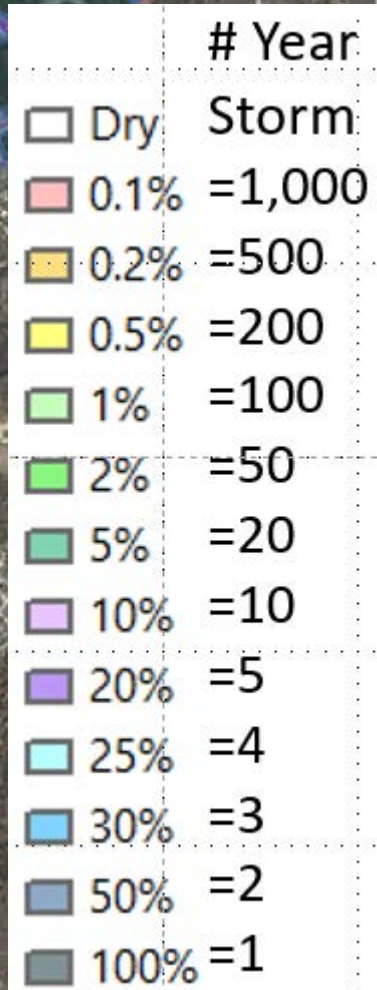
Present

	# Year
□ Dry	Storm
0.1%	=1,000
0.2%	=500
0.5%	=200
1%	=100
2%	=50
5%	=20
10%	=10
20%	=5
25%	=4
30%	=3
50%	=2
100%	=1

2030



2050

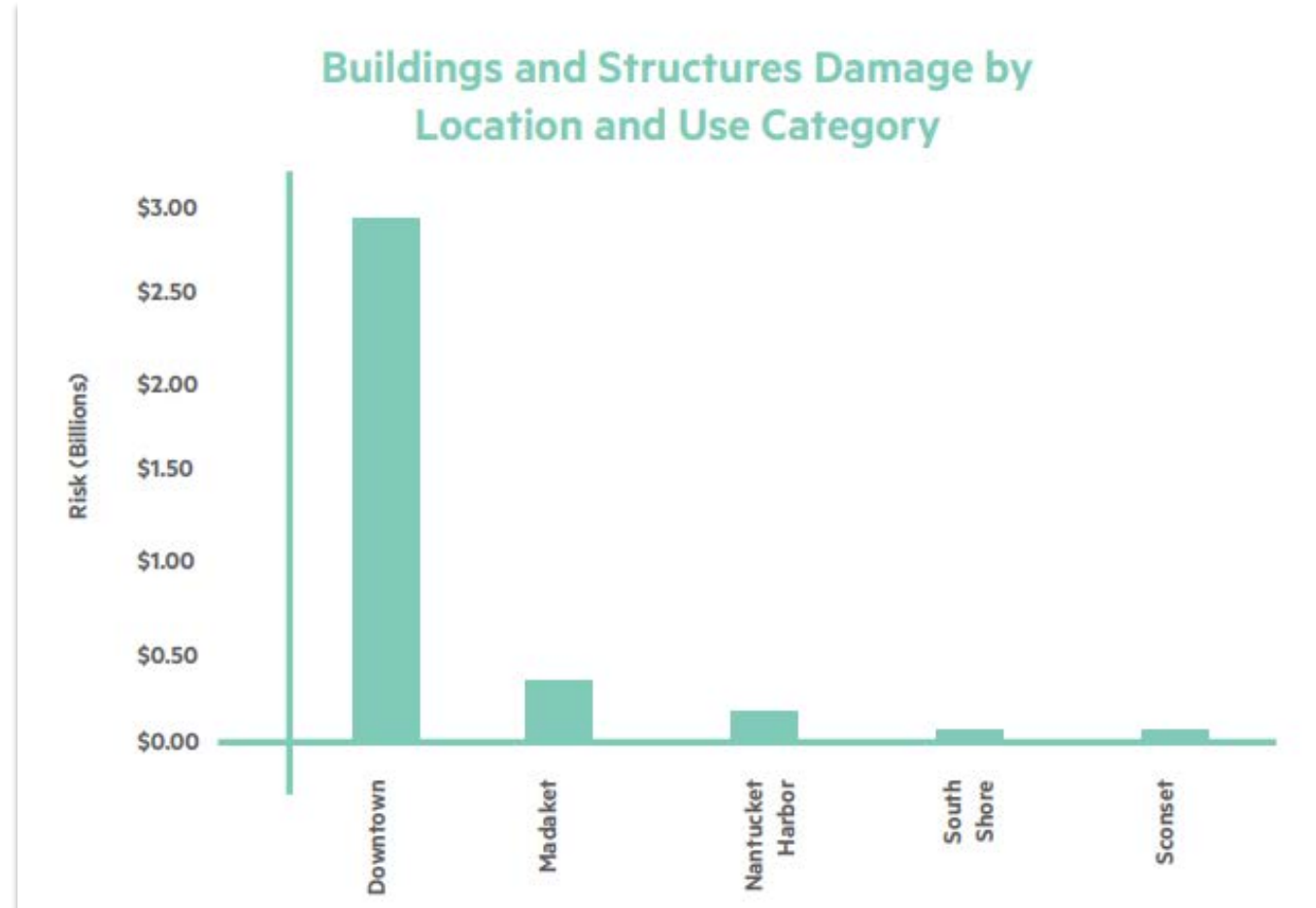


2070



Downtown Risks

- ▶ Top 5 Priority Assets: Steamship Authority, Coast Guard Station, Stop & Shop, Hy-line Cruises, National Grid
- ▶ Steamboat Wharf is the most essential and at risk facility on Nantucket
 - ▶ Loss of service at high tide as soon as 2050 to the wharf
- ▶ Loss of service to Easy St. as soon as 2030 at high tide
- ▶ High tide flooding on Easy St. has increased 6 fold in the last 40 years
 - ▶ Chronic inundation = flooding 26x/year that disrupts the community and requires mitigation action. First seen in 2010 and constant since 2016
 - ▶ Using NOAA's intermediate SLR (~4ft by 2100) Easy St. projected to flood 61 days in 2030



Near-Term Strategy 2020-2030

Potential Sand Bypassing

Erosion Monitoring and Mitigation

Wetland Restoration
and Conservation of
Eelgrass Habitat

Elevate Access Roads

Strategic Relocation of Structures in Priority Action Areas

Stabilize Brant Point with Sediment Deposition

Localized Protection for Coast Guard Site

Road Raised

Children's Beach Boat Ramp

Beach Berm Raised

Beach Nourishment at Children's Beach

Elevate Steamboat Wharf

Barrier with Access to Wharf

Elevate Straight Wharf

Raise Bulkhead

Upgrade Drainage Infrastructure

Public Access and Recreational Boating at
Petrel's Landing

Adapt Town Dock

Alternative Option for Coastal Berm

Ecological Restoration

Pedestrian Access

Reduction of Density and
Building-Scale Adaptation
in High and Moderate
Coastal Risk Areas



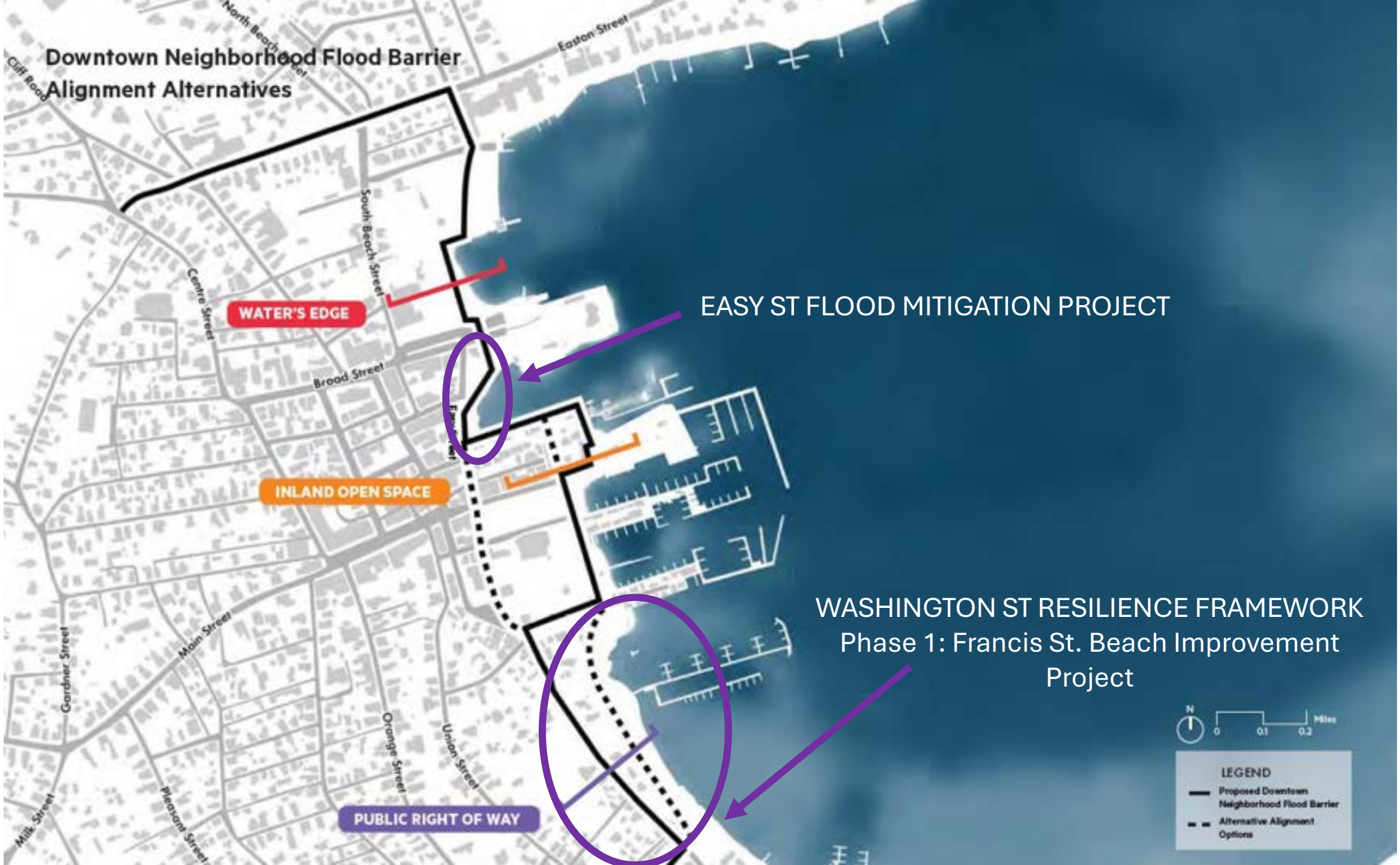
Overview of the Downtown near-term coastal resilience strategy, including the Downtown Neighborhood Flood Barrier, roadway elevation, and site and property scale adaption measures.

LEGEND

- Road Raised
- Potential Elevated Access Road
- Beach Berm
- Barrier with Access to Wharf
- Raise Bulkhead
- Priority Action Area Structure
- High and Moderate Coastal Risk Area Structure

Near-Term Strategy 2020-2030





Downtown Island-Wide Coastal Risk Framework

The Jetties

Brant Point

Nantucket Harbor

Steamboat Wharf

Straight Wharf

Downtown

The Creeks and
Consue Springs

Polpis Road

Mid-Island

LEGEND

- Public Roadways
- Private or Unknown Roadways
- Area Protected by Proposed Near-Term Strategy
- Existing Structures
- Priority Coastal Risk Areas
- High Coastal Risk Areas
- Moderate Coastal Risk Areas

Risk Summary

Priority Action Areas of Extreme Coastal Risk

Priority Action Areas face extreme coastal risks today or within the next decade. Density should be proactively reduced in these areas to reduce the immediate threat to people, property, and livelihoods. Due to the extreme coastal risk, large structural investments are not recommended in these areas due to prohibitive maintenance costs and limited potential benefits.

High Coastal Risk Areas

High Coastal Risk Areas may be exposed to coastal hazards within the next 30 years, or the lifetime of a typical mortgage. Due to the imminent and growing risk, large structural investments are not recommended in these areas under most circumstances, except where necessary to ensure public safety.

Moderate Coastal Risk Areas

Moderate Coastal Risk Areas may be exposed to coastal hazards by 2070. In these areas approaches to adapt or protect against flooding may be appropriate. Changes in coastal risk should be monitored and decisions made accordingly.

Lower Coastal Risk Areas

Lower Coastal Risk Areas are not likely to be exposed to coastal hazards by 2070. Comprehensive planning is recommended to strategically optimize opportunities in lower risk areas.



NANTUCKET ISLAND RESORTS

RESILIENCY ASSESSMENT

Update for Nantucket
Coastal Resilience
Advisory Committee

Sustainable Coastal Solutions, Inc.



January 2025

RESILIENCY ASSESSMENT

Sea-Level Rise Implications

- Short-Term (Flooding from Moderate to Severe Nor'easters)
- Long-Term (Infrastructure Sustainability)

Sea-Level Rise Projections

- Data Versus Models
 - We can check how well state projections have performed over past 15+ years
 - Projections are being updated by NOAA, based upon data and science
- High Emissions Projections by NOAA and Others – *Good Conservative Limit*

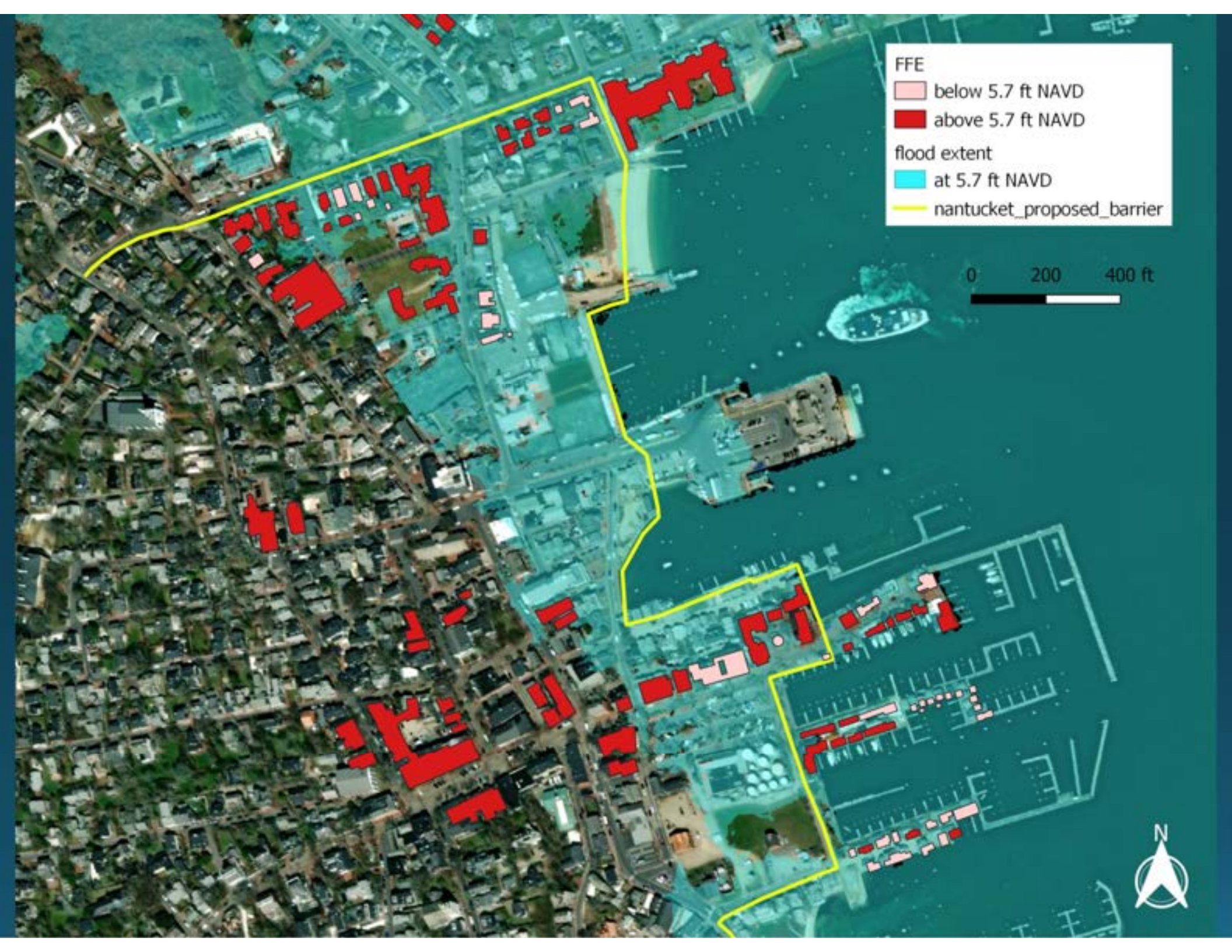
Storm Surge and Wave Modeling (MC-FRM)

- Data Versus Models
 - Storm Surge - How do MC-FRM model results compare to data (e.g. Nantucket tide gage) and other models for existing conditions?
 - Storm Waves – How do wave model results compare to other analyses?

Sea Level Rise Implications

- Increase in Nuisance Flooding Frequency and Impacts from 'Typical' Nor'easters
- Long-Term Implications on Infrastructure Sustainability





FFE

below 5.7 ft NAVD

above 5.7 ft NAVD

flood extent

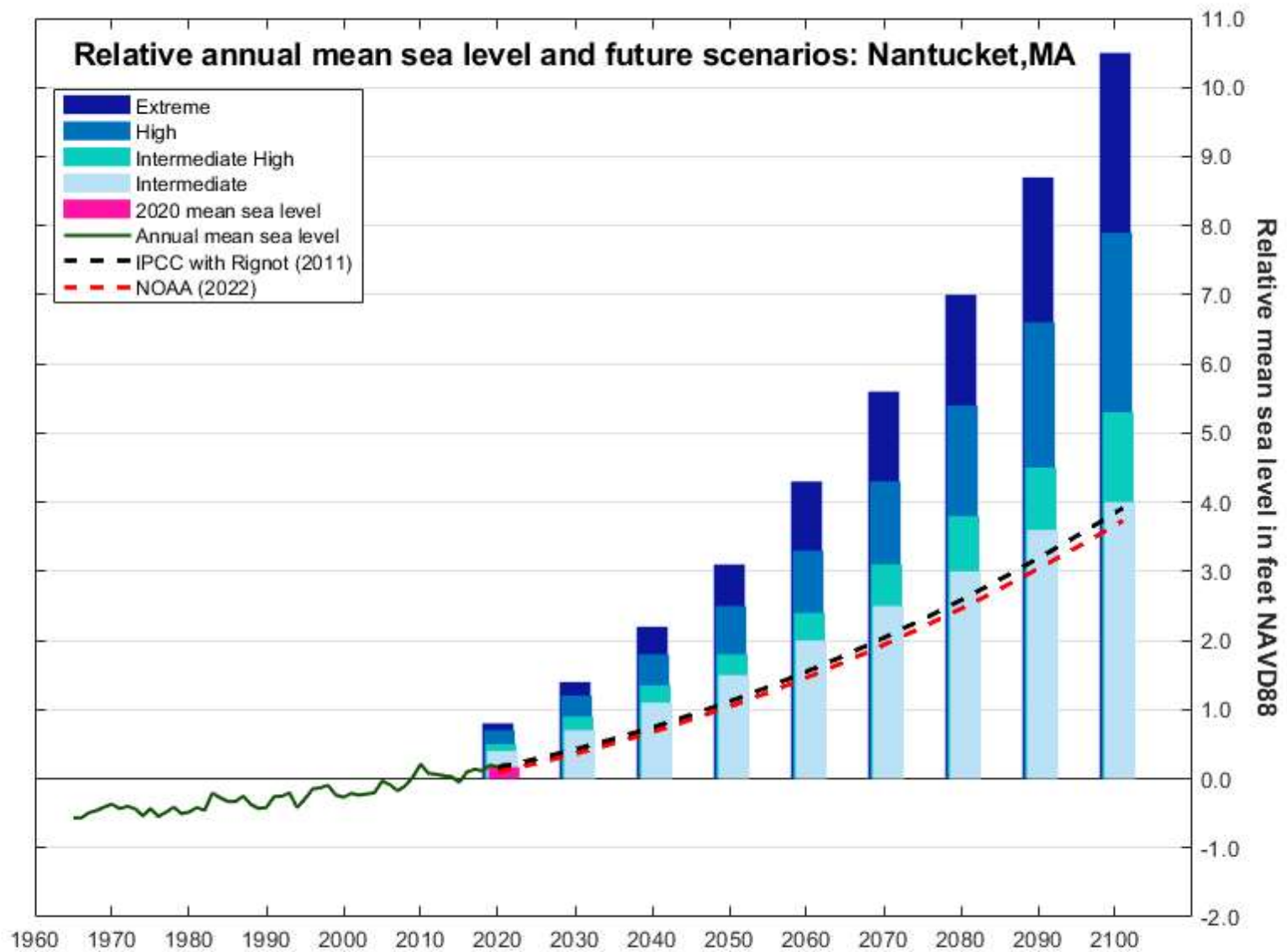
at 5.7 ft NAVD

nantucket_proposed_barrier

0 200 400 ft



Sea-Level Rise Projections – Planning to 2070

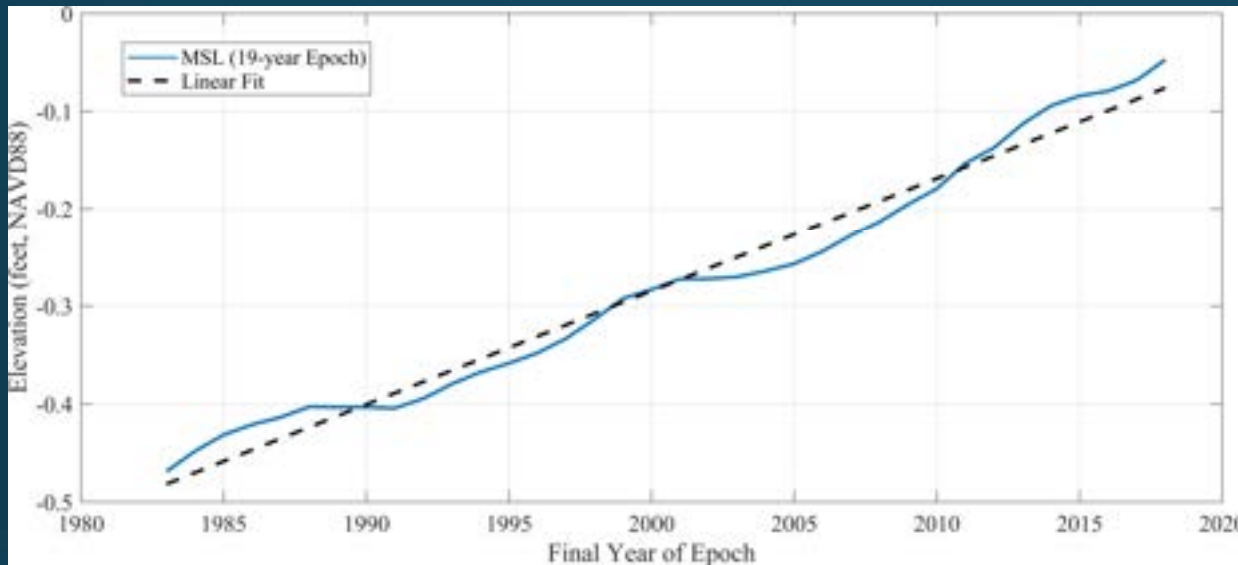


Proposed Approach

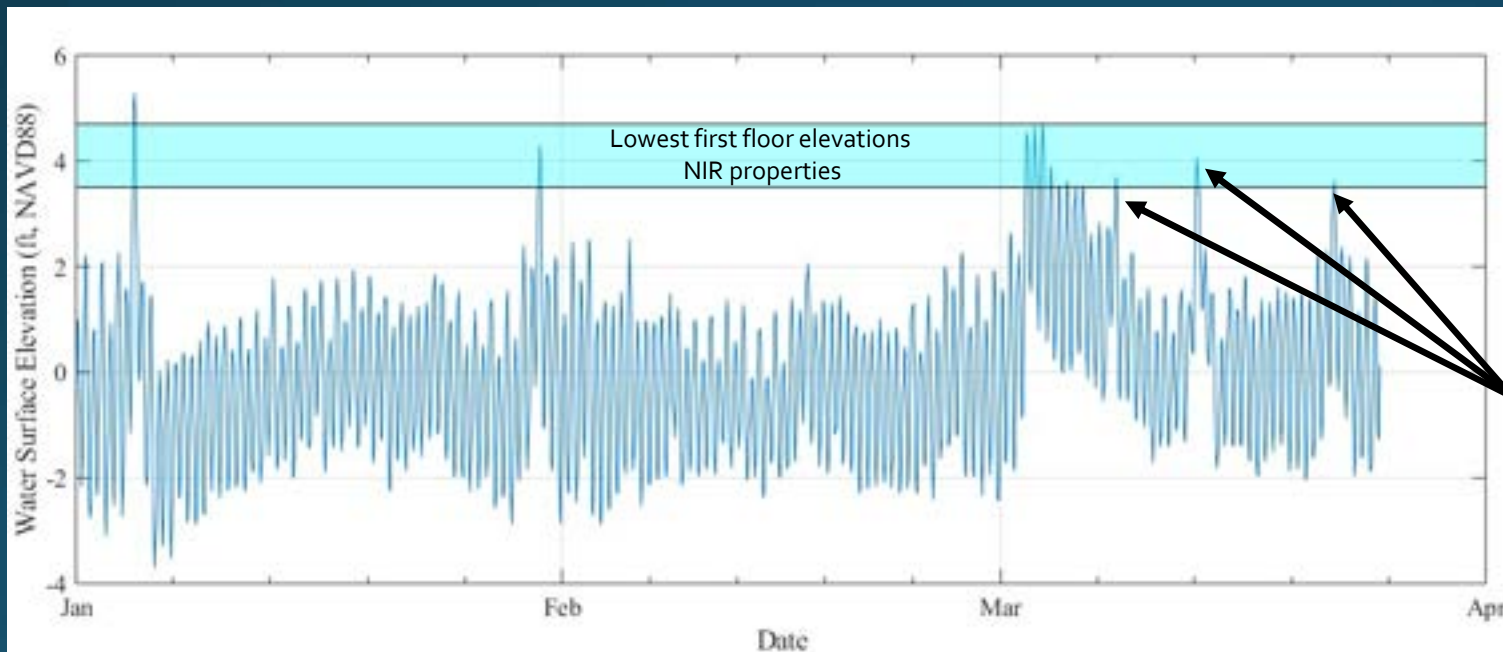
- Short-Term Plan (over next 10-15 years) - Incremental Flood Protection to Address Likely Sea-Level Rise
- Longer Term Plan for ~1ft by 2050 and Potentially ~2 ft by 2070



Existing Conditions Storm Flooding



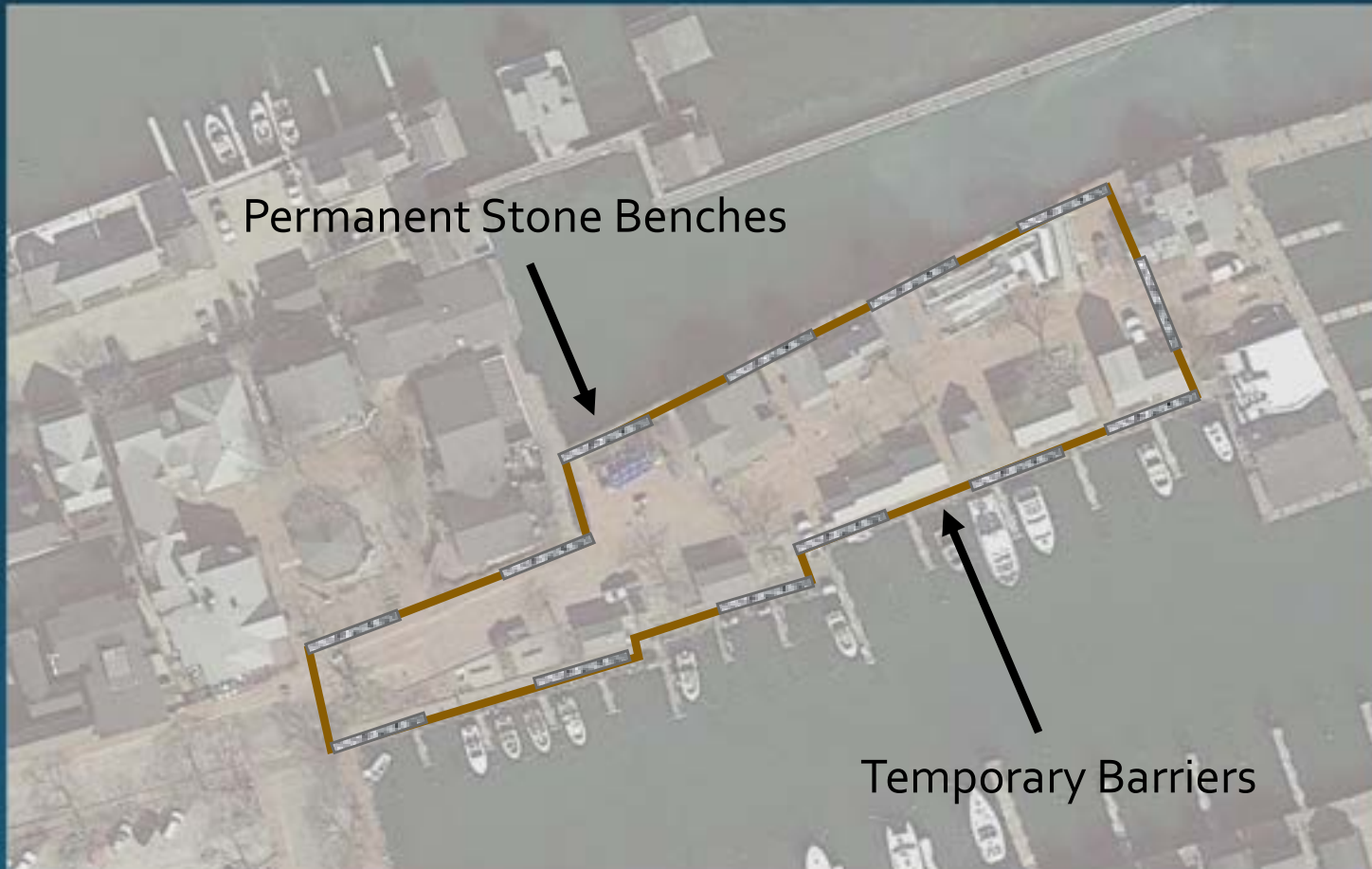
Average of sea level rise (1965 through 2023). Linear trend of sea level rise 0.16 inches/year (4.0 mm/year) or ~9 inches since 1965.



40 years ago, many of these events would not flood NIR property first floor elevations.

Mitigation Options – Working with the Town

- Elevate wharf infrastructure and others, as needed
- Raise bulkhead(s)
- Gated barriers between stone benches, as necessary
- Construct berm
- Temporary flood barrier (e.g., sand bags, fence)
- Incorporate White Elephant into flood protection



Mitigation Options – Working with the Town

- More modest proposals to achieve appropriate 2050 protection
- Ensure flood protection can be modified over time to accommodate rising sea levels
- Understand commitment for installing temporary flood protection structures

Temporary Flood Walls



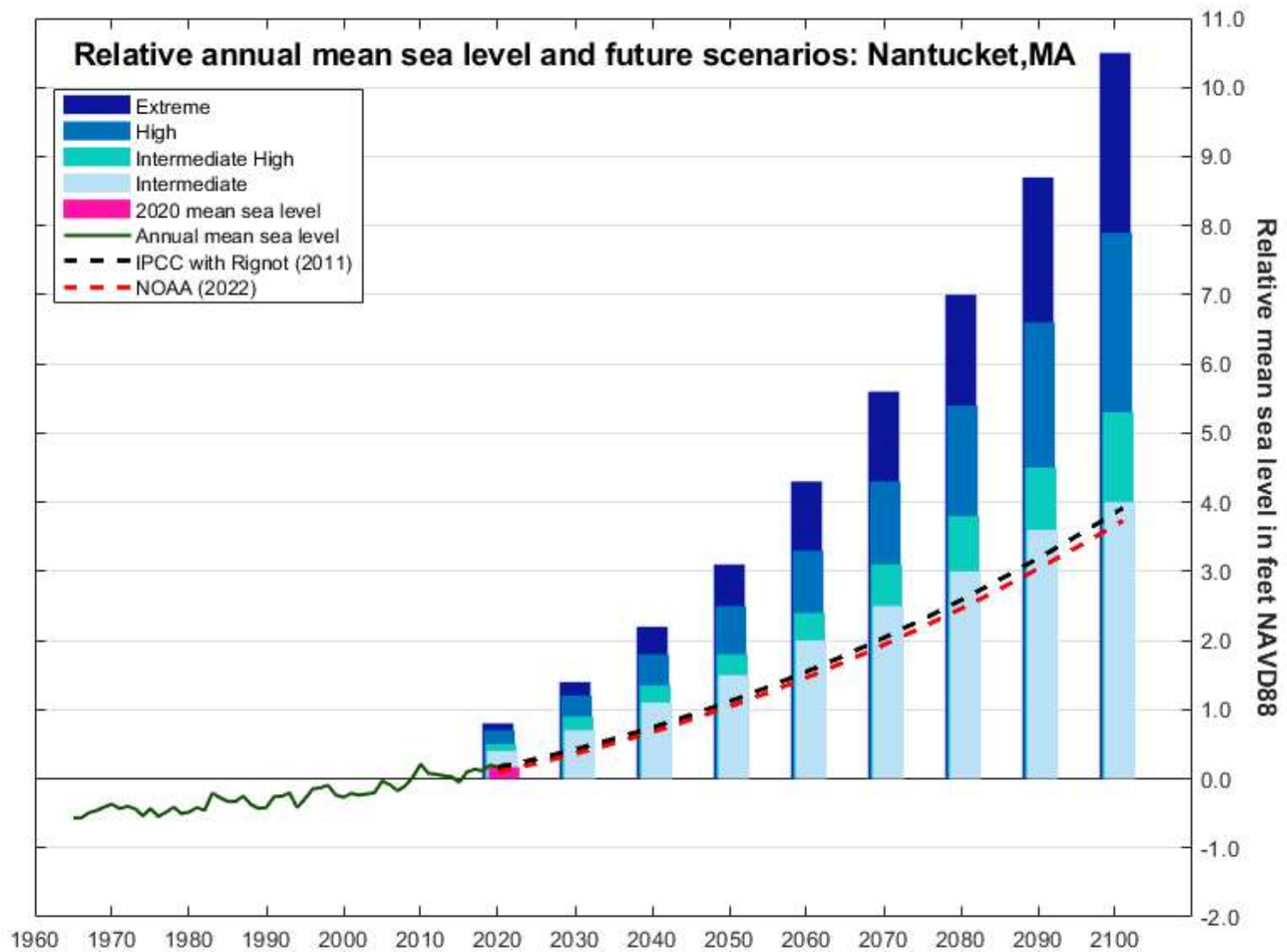
EEA/MC-FRM Sea-Level Rise Guidance (2016)

Suggestion of the “High” Scenario

Relative Mean Sea Level for Nantucket, MA (feet NAVD88)					
Scenario	Probabilistic Projections	2030	2050	2070	2100
Intermediate	Unlikely to exceed (83% probability) given a high emissions pathway	0.7	1.5	2.4	4.2
Intermediate-High	Extremely unlikely to exceed (95% probability) given a high emissions pathway	0.9	1.8	3.0	5.2
High	Extremely unlikely to exceed (99.5% probability) given a high emissions pathway	1.2	2.5	4.3	7.9
Extreme (Maximum physically plausible)	Exceptionally unlikely to exceed (99.9% probability) given a high emissions pathway	1.4	3.1	5.5	10.5

Sea level rise projections for Nantucket adopted by the Commonwealth of Massachusetts. Elevations given in feet NAVD88 relative to the year 2000.

Sea-Level Rise Projections



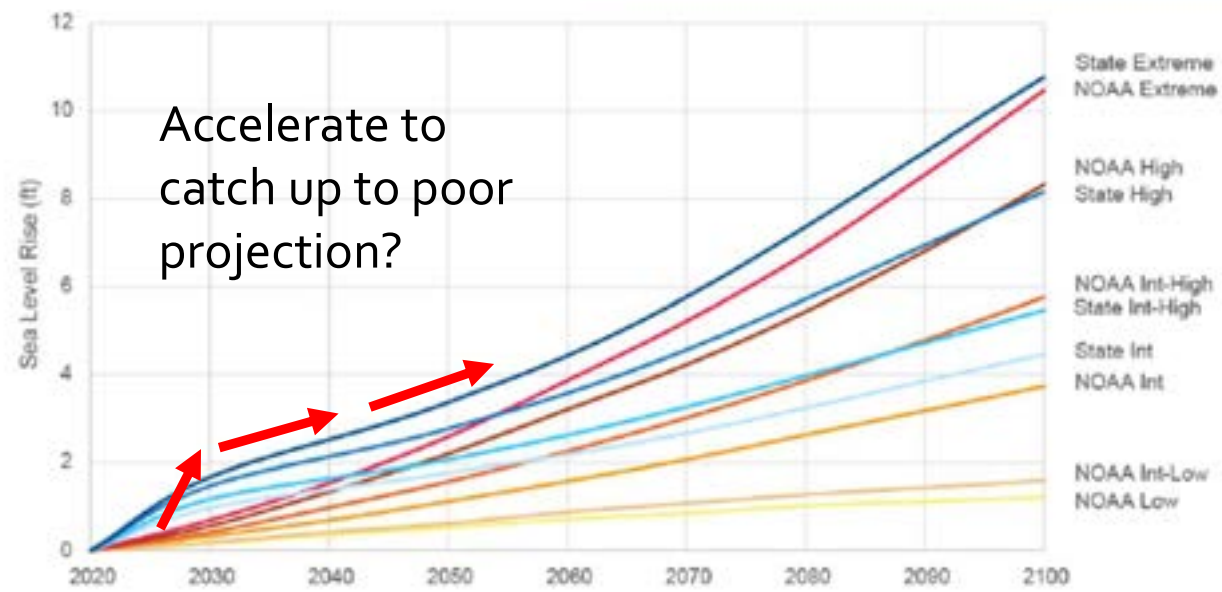
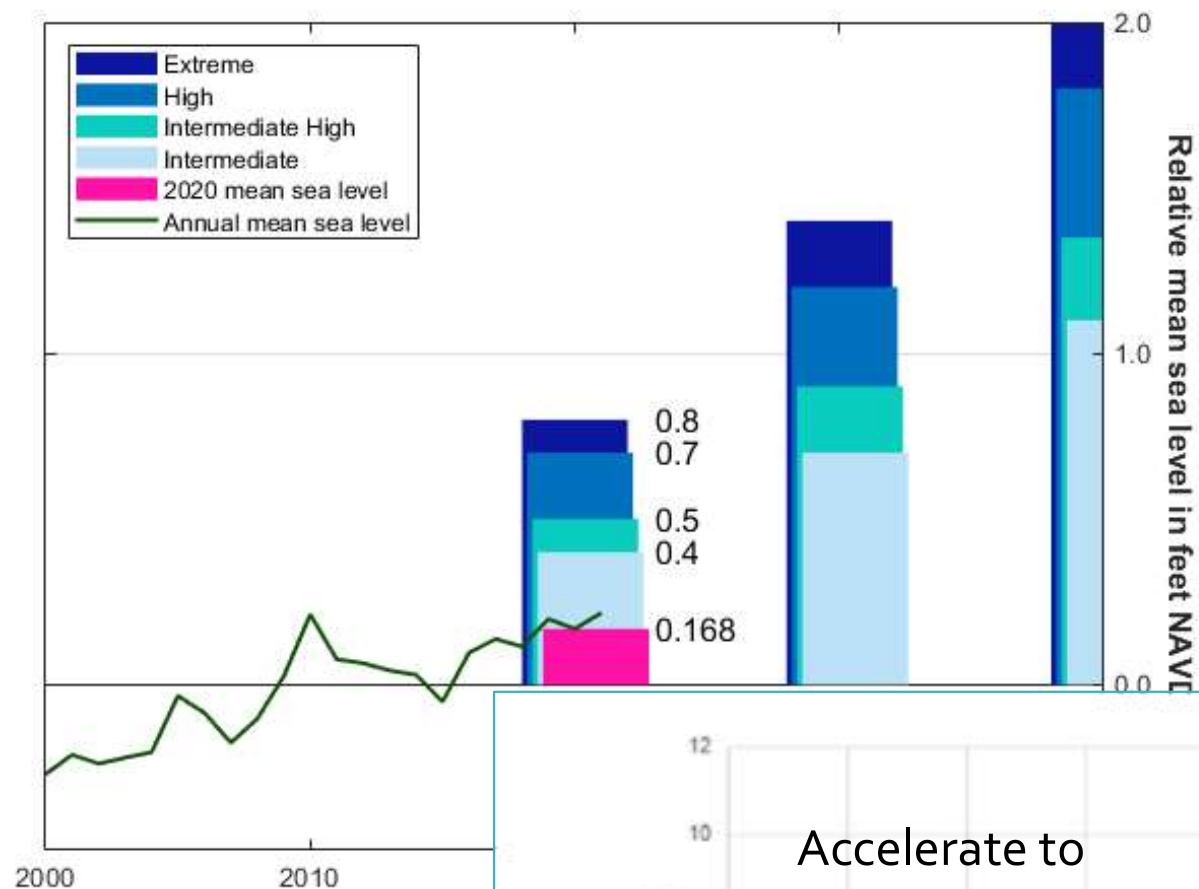
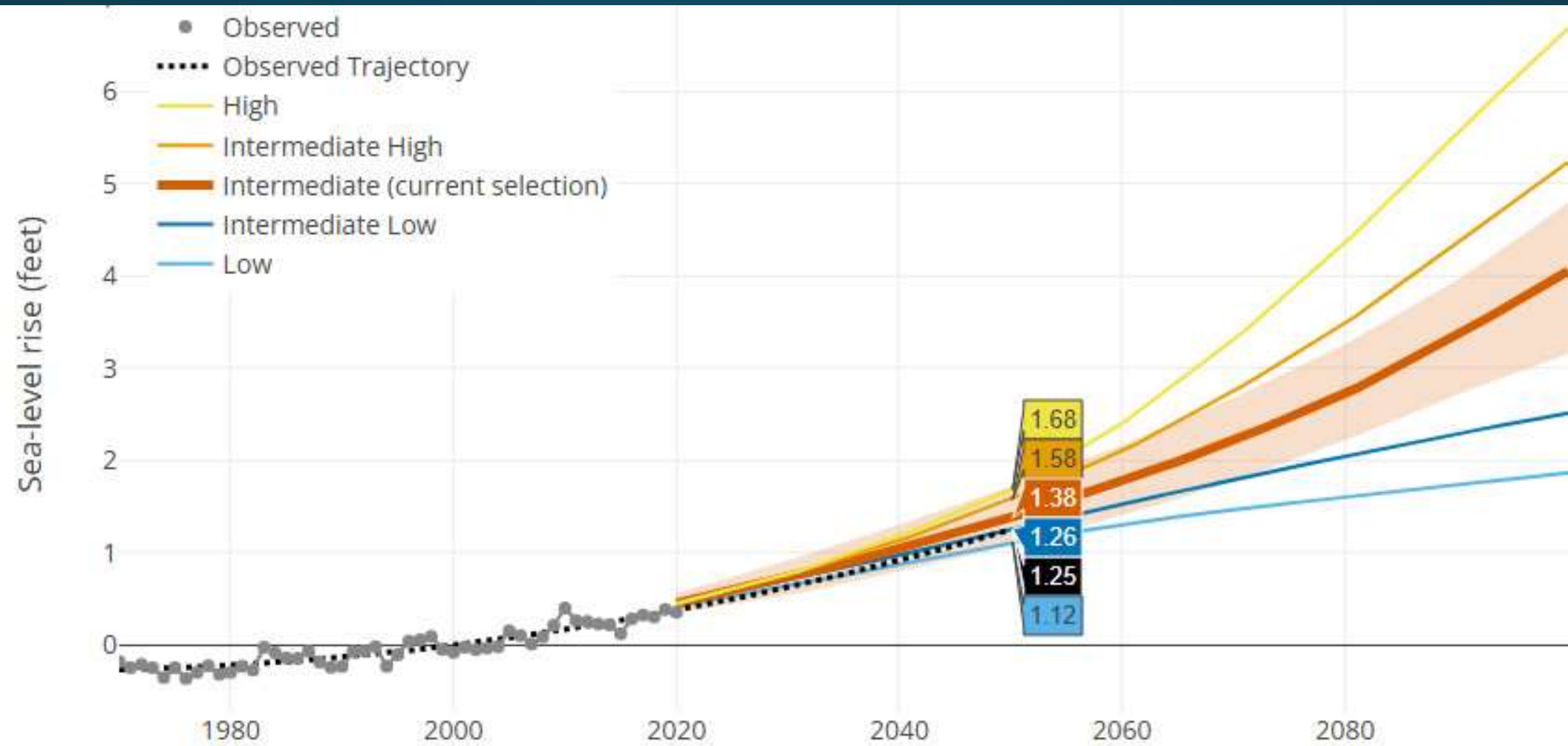


Figure 22. Nantucket SLR projections for NOAA and Massachusetts State methodologies normalized to 2020.

Sea-Level Rise Projections (NOAA, 2022)

CRAC recommended adoption of NOAA High Scenario for planning purposes



Subtract 0.31 feet to Adjust to NAVD88

NOAA High in 2050 ~ 1.4 feet NAVD

Table 3-1 Sea Level Rise Projections Used in the MC-FRM Climate Assessment, adopted by the Commonwealth of Massachusetts

Time Horizon	Assumed Sea Level Rise (feet) Relative to NAVD88
2008 Tidal Epoch*	-0.17
2030	1.2
2050	2.5
2070	4.3

*The Massachusetts Climate Change Assessment defines the 2008 tidal epoch as "present day"

2016 MC-FRM = 2.5 ft NAVD

2022 NOAA High = 1.4 ft NAVD

2022 NOAA Intermediate = 1.0 ft NAVD

Table 3-2 Sea Level Rise Increments

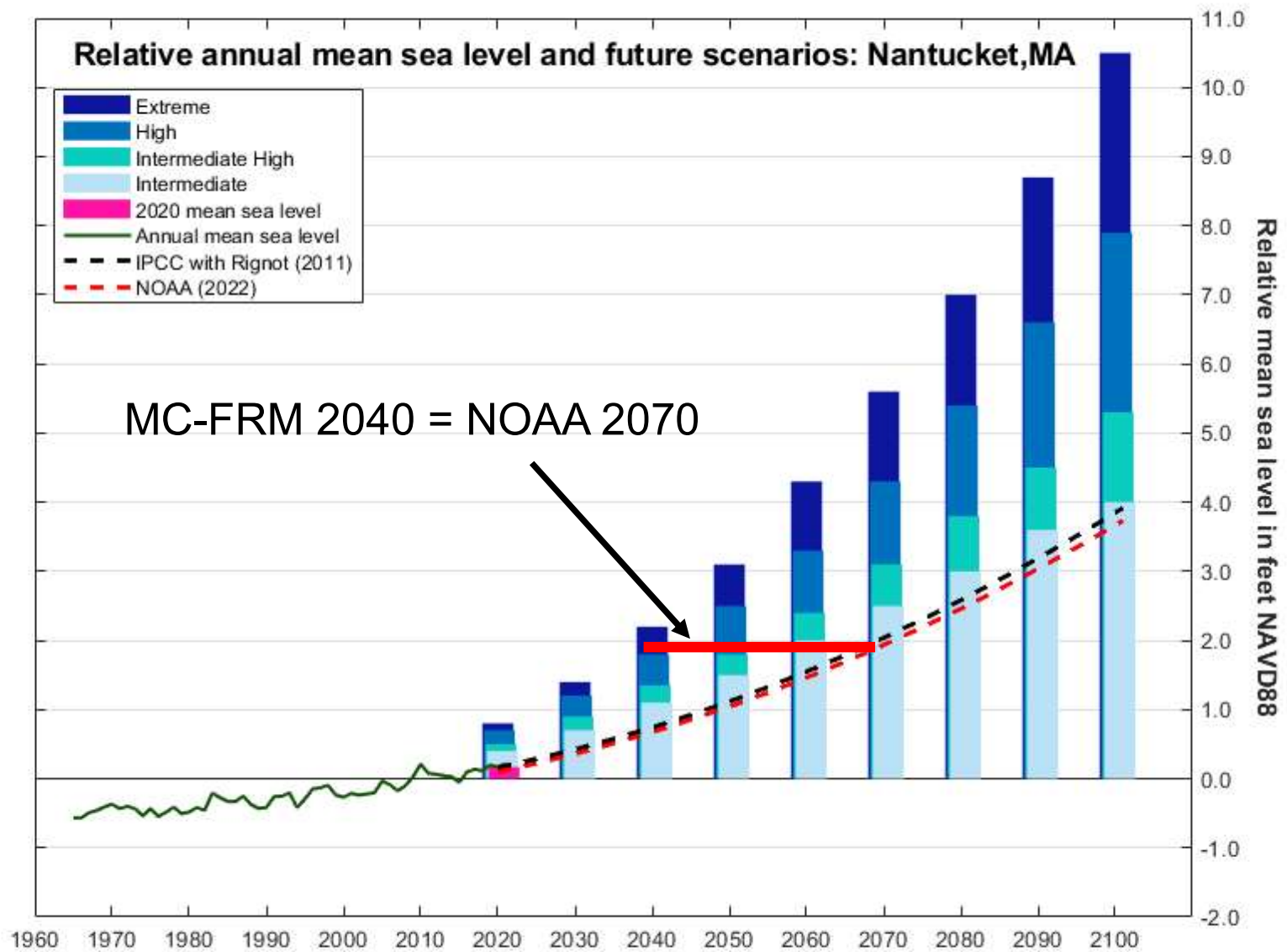
Time Horizon	<u>Assumed</u> Sea Level Rise (feet) Relative to 2008 Tidal Epoch
2024 (Present Day*)	1.00
2030	1.37
2050	2.67 (additional 1.3 feet)
2070	4.47 (additional 1.8 feet)

**The Flood Risk and Exposure Assessment defines 2024 as “present day”*

We don't need to assume – there is a local NOAA tide gage...

Actual SLR between 2008 and 2024 ~0.2 feet

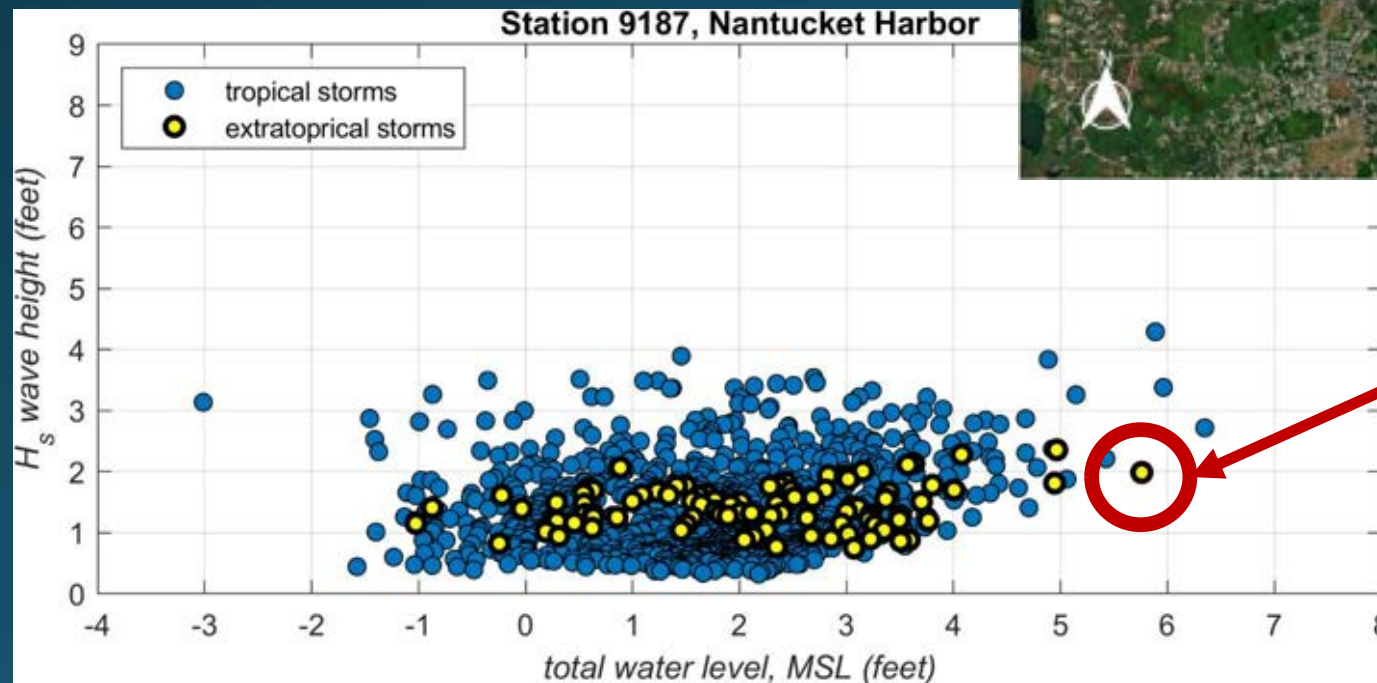
MC-FRM Short-Term is Actual Long-Term



... Also, Some Thoughts on Computed Storm Surge

- 1% AEP = “100-Year Storm”
- All methods for Evaluation include Storm Surge and Wave Setup
- Data-Driven Approaches are Most Scientifically-Defensible

USACE NACCS Study

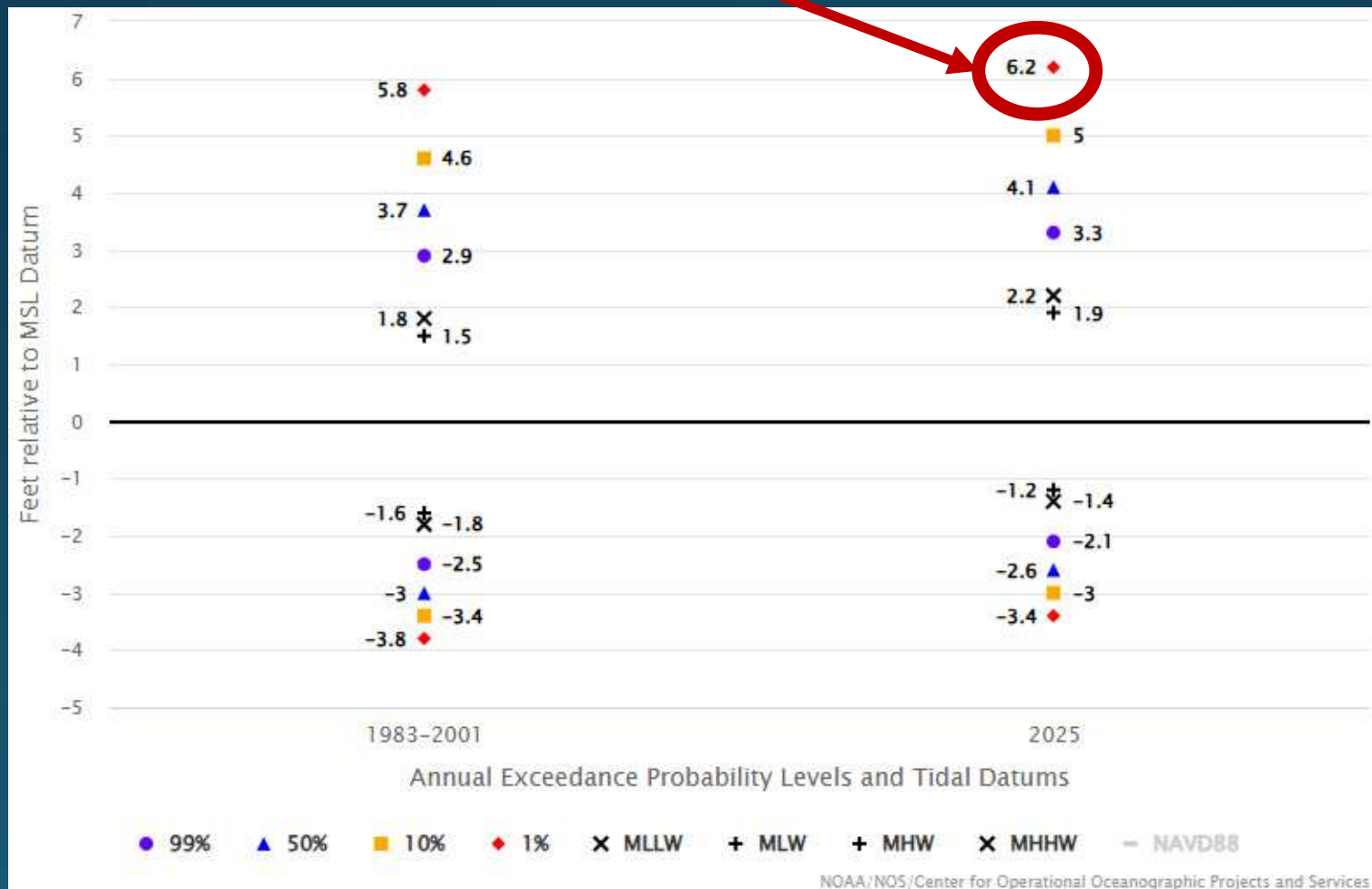


October 1991

... Also, Some Thoughts on Computed Storm Surge

- 1% AEP = “100-Year Storm”
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NOAA 1% AEP



... Also, Some Thoughts on Computed Storm Surge

- 1% AEP = “100-Year Storm”
- All methods for Evaluation include Storm Surge and Wave Setup
- Data-Driven Approaches are Most Scientifically-Defensible

Highest Storm Surge Recorded = 5.7 ft NAVD



Design Flood Elevations (DFE) and Levels of Protection

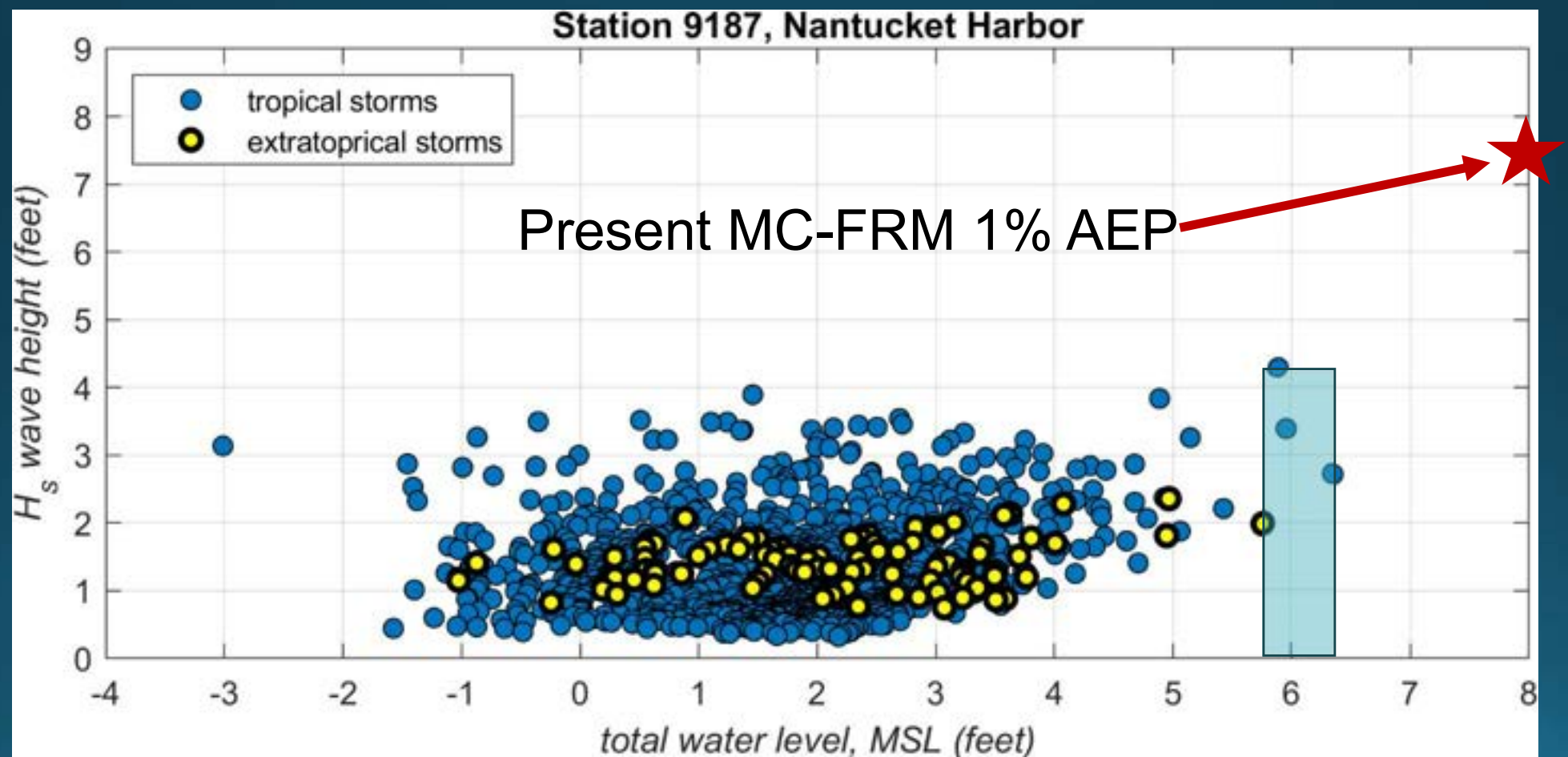
Target DFE (ft, NAVD88)	Present Day	2030	2050	2070
4.5	~40% AEP (2.5-yr)	~Flooding some Spring High Tides	Flooding almost every high tide	Flooding every high tide (for approximately half the tidal cycle)
5.0	~25% AEP (5-yr)	~100% AEP (Annual Storm)	~ Spring High Tides	Flooding every high tide
5.5	~20% AEP (5-yr)	~50% AEP (2-yr)	~ Highest Annual Tide	Flooding every high tide
6.0	~10% AEP (10-yr)	~30% AEP (3.3-yr)	~100% AEP (Annual Storm)	~ Mean High Water
6.5	~6.7% AEP (15-yr)	~20% AEP (5-yr)	~30% AEP (3.3-yr)	~ Spring High Tides
7.0	~3.3% AEP (30-yr)	~15% AEP (6.7-yr)	~20% AEP (5-yr)	~ Highest Annual Tide
7.5	~2% AEP (50-yr)	~8% AEP (12.5-yr)	~10% AEP (10-yr)	~ 100% AEP (Annual Storm)
8.0	~1% AEP (100-yr)	~5% AEP (20-yr)	~8% AEP (12.5-yr)	~50% AEP (2-yr)

Levels of protection based on MC-FRM

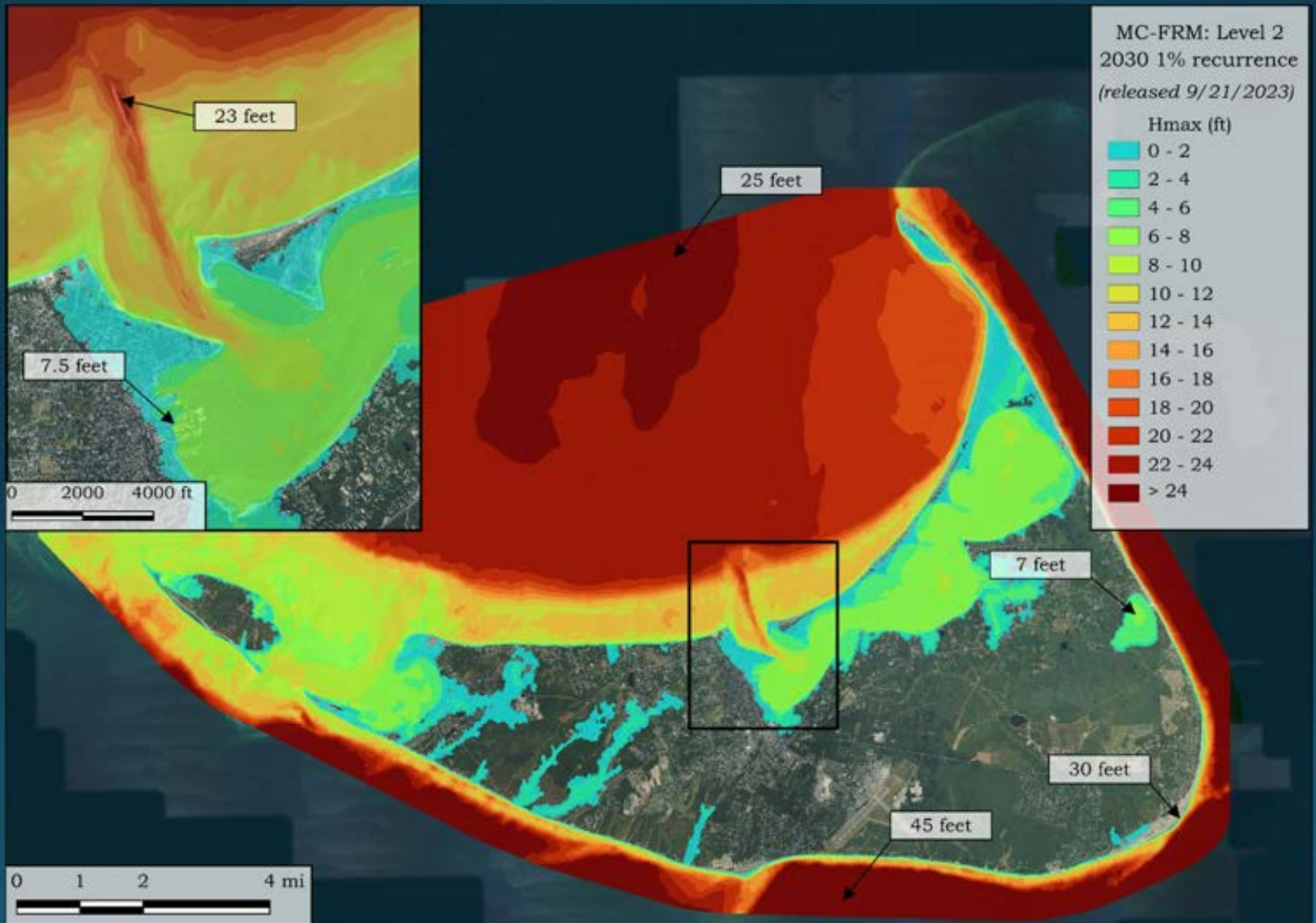
... Also, Some Thoughts on Computed Storm Surge

1% AEP (100-Year) Storm Surge Elevation Today

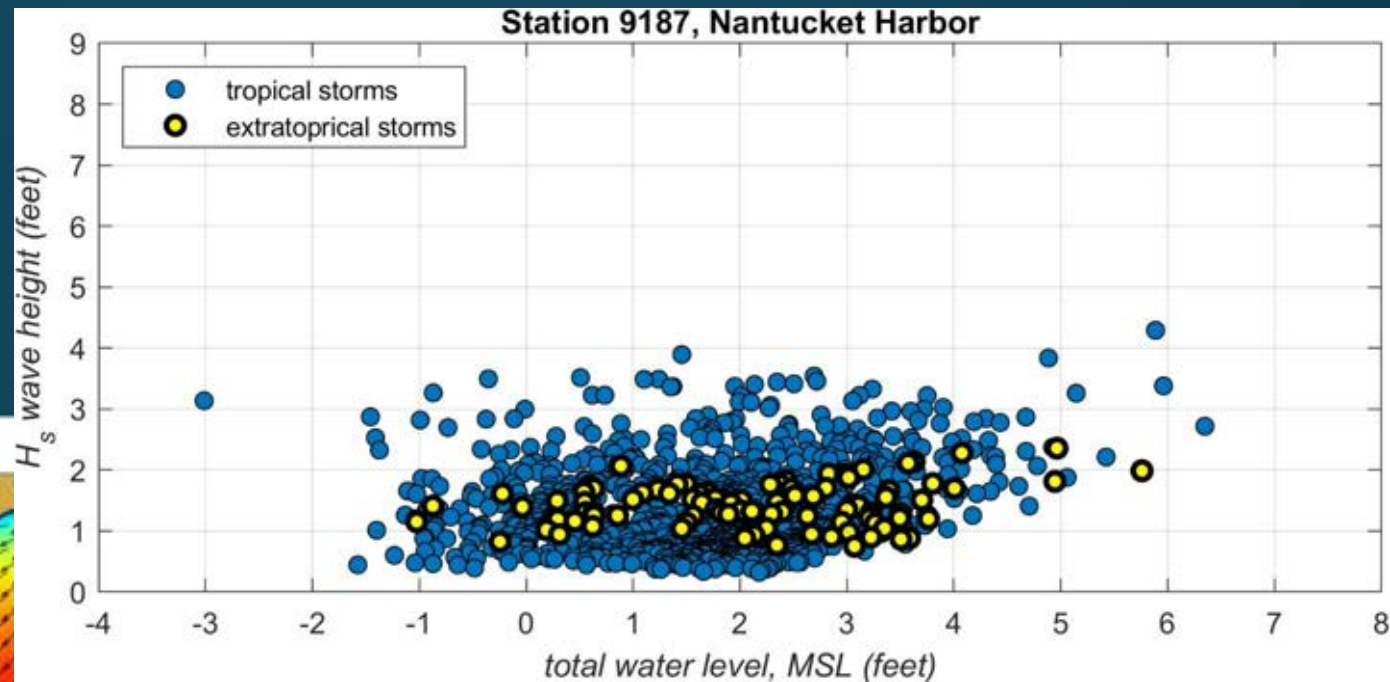
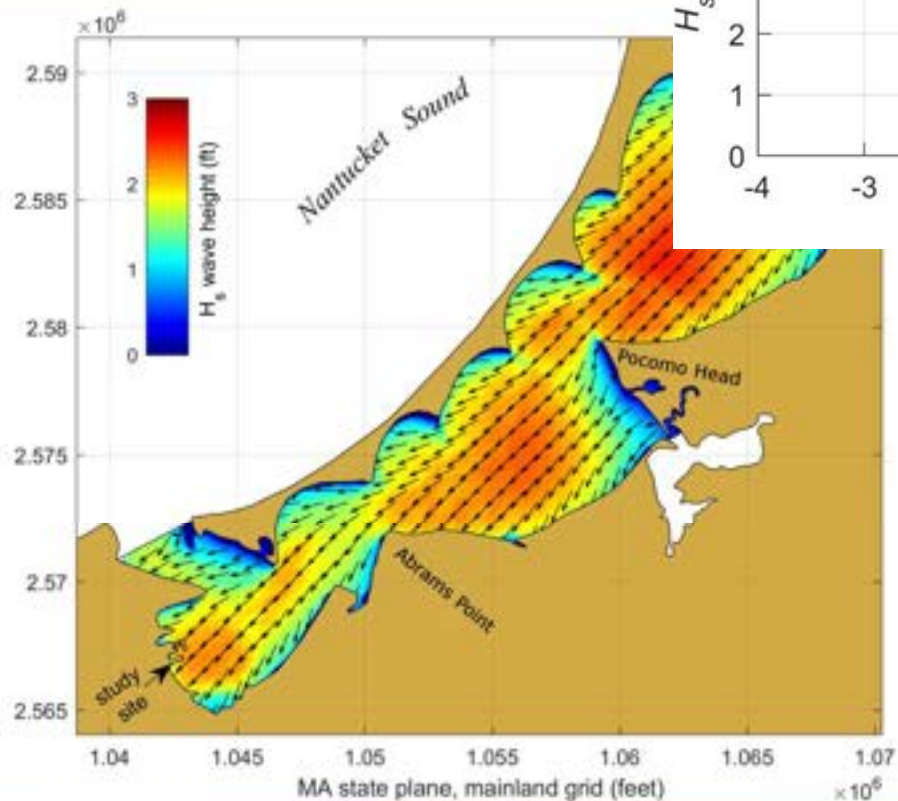
Method	NOAA (data)	FEMA (data)	NACCS (modeled*)	MC-FRM (modeled)
Elevation (feet, NAVD)	5.9	6.1	~6.0	8.0



MC-FRM Storm Waves



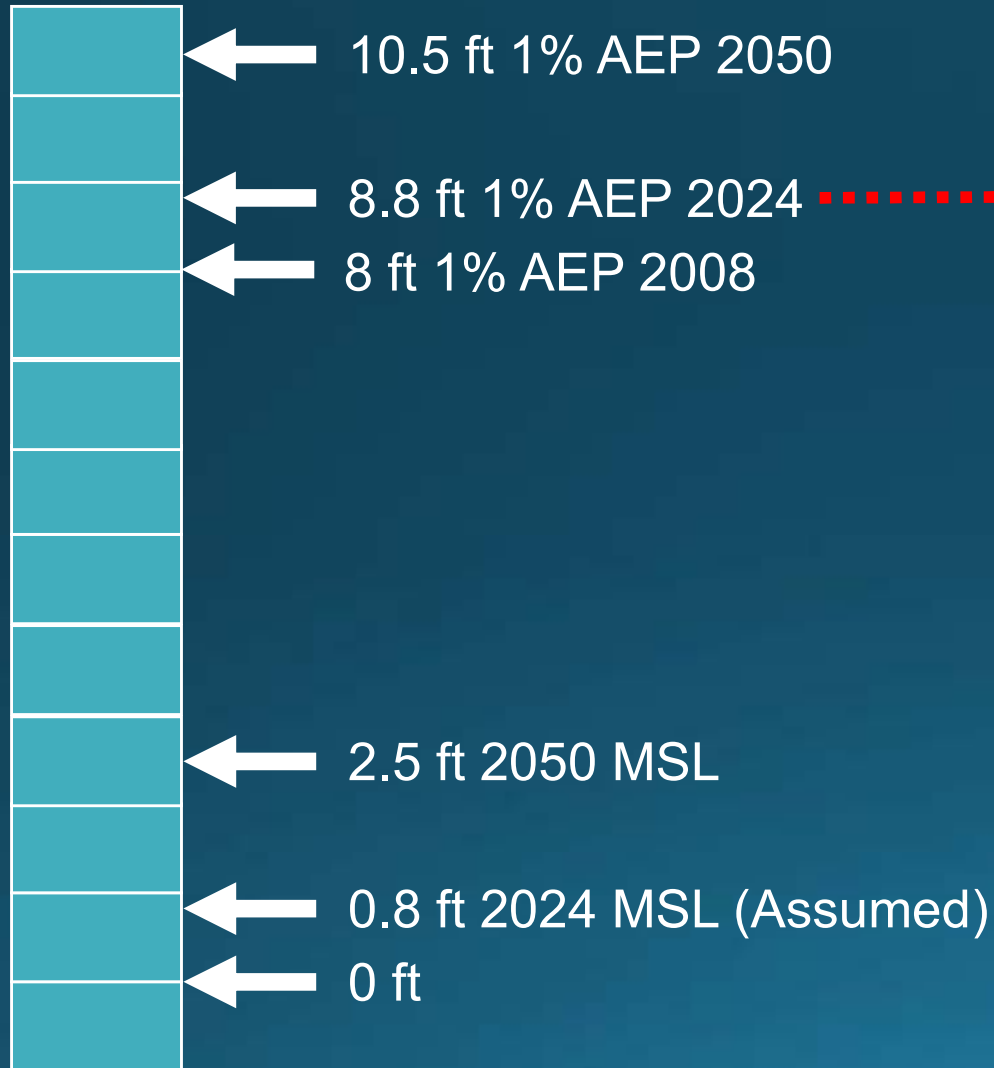
Other Storm Wave Analyses (FEMA, NACCS, SCS)



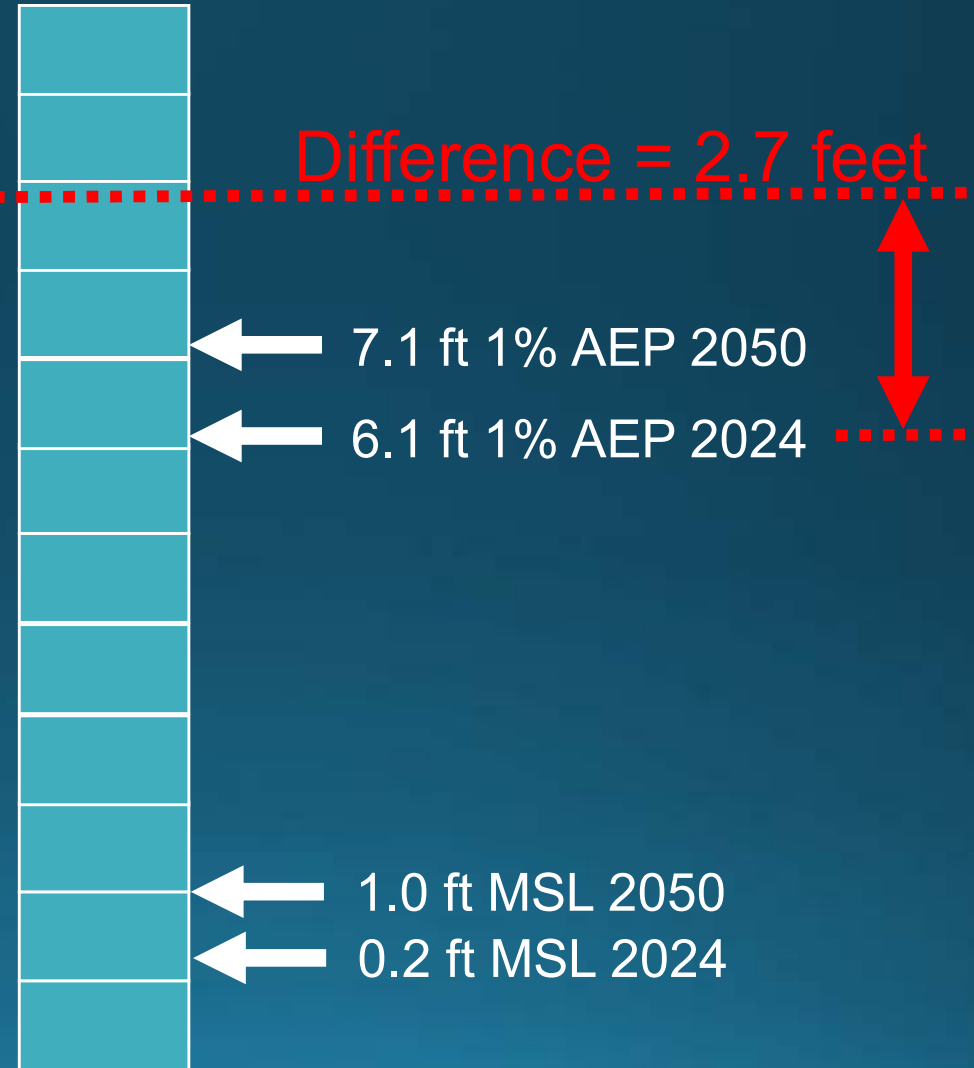
Mitigation Approach – Working with Updated Information

- Water Surface Elevations in NAVD88

MC-FRM

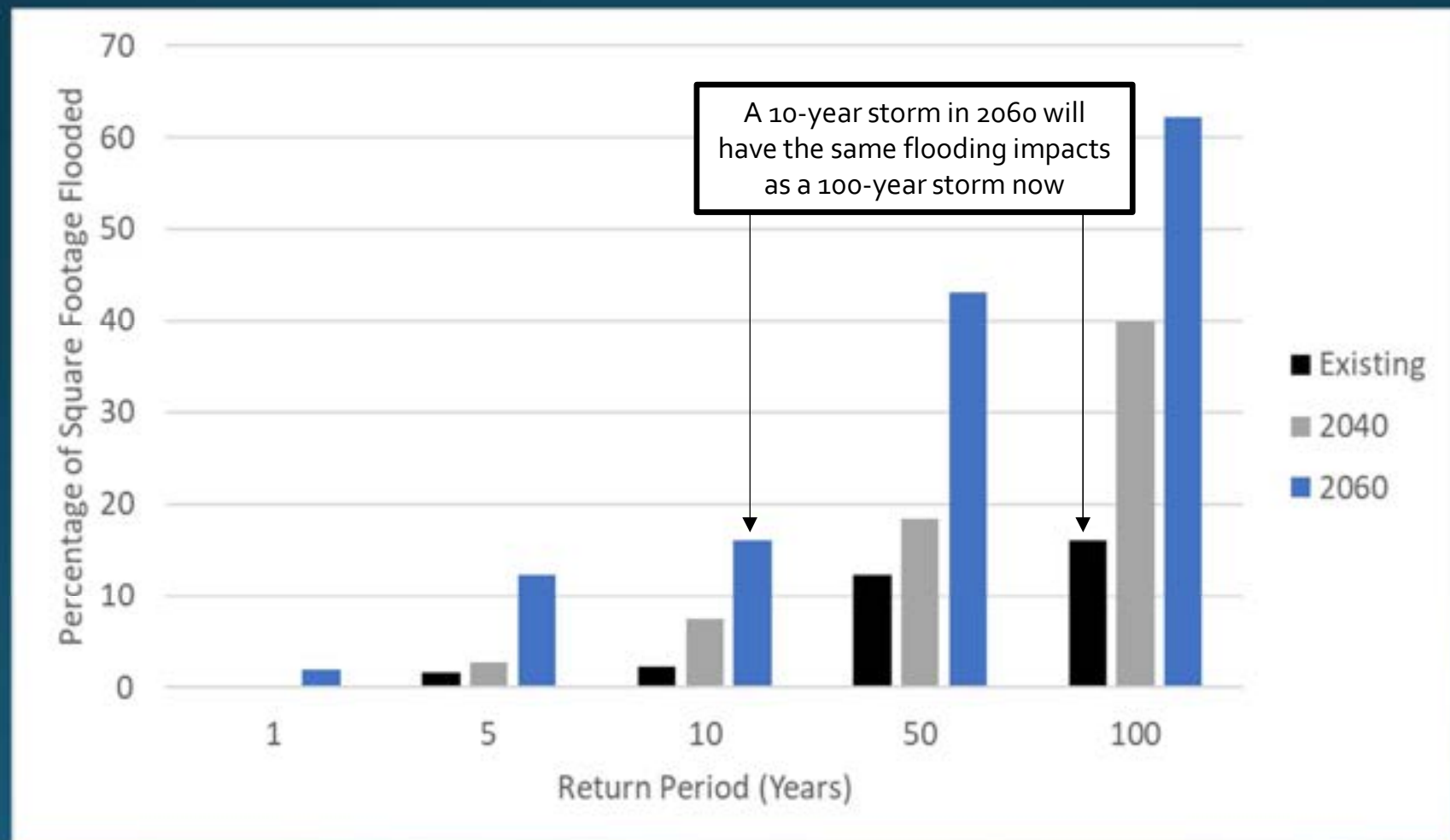


NOAA



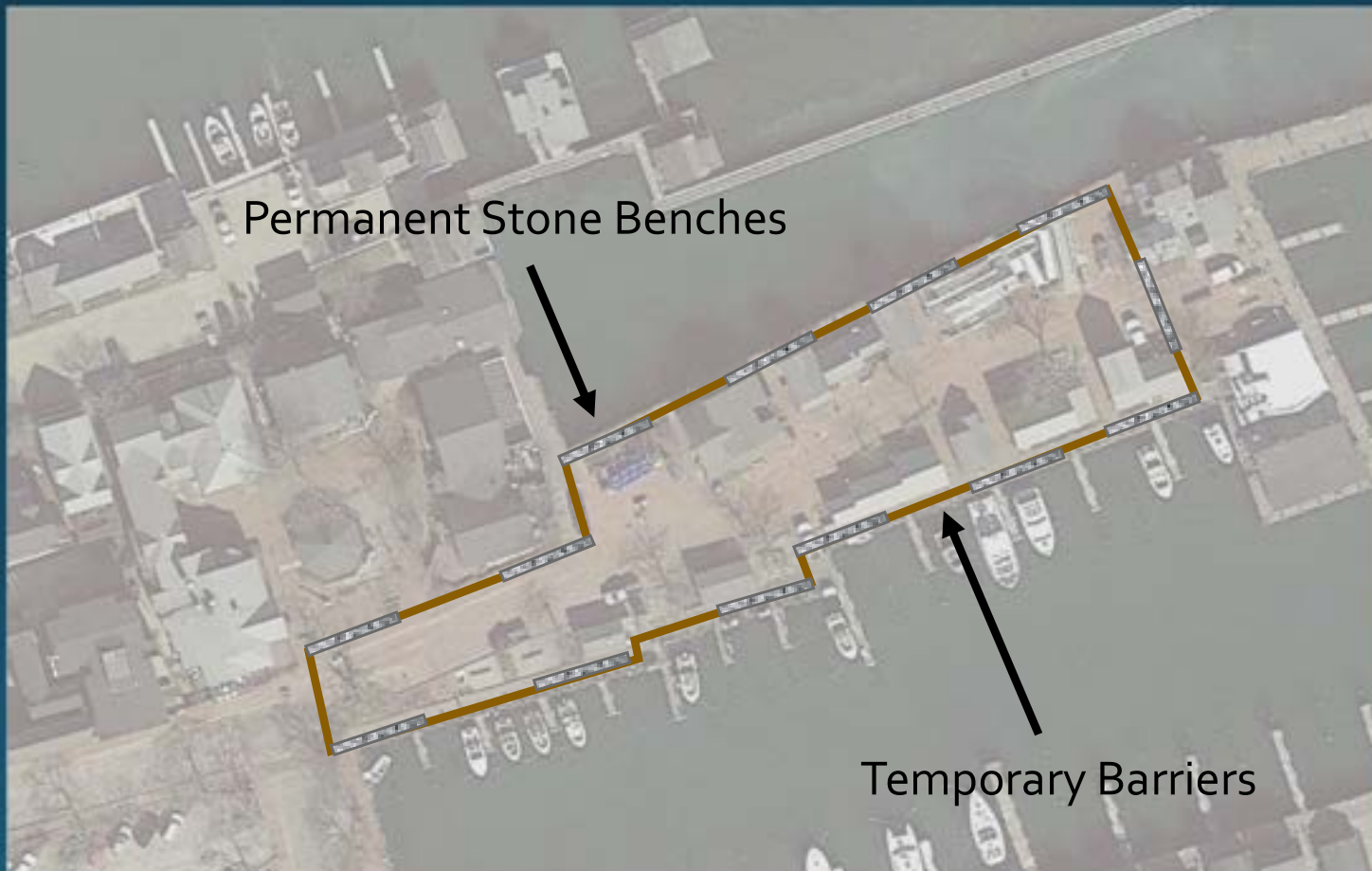
Mitigation Approach – Working with Updated Information

- Utilize NOAA Intermediate Projections for Sea Level Rise
 - 2050 = 1.0 ± 0.4 feet NAVD - matches observations in the near-term
- Use 6.1 feet NAVD as 1% AEP Flood Level in Harbor for Present Conditions



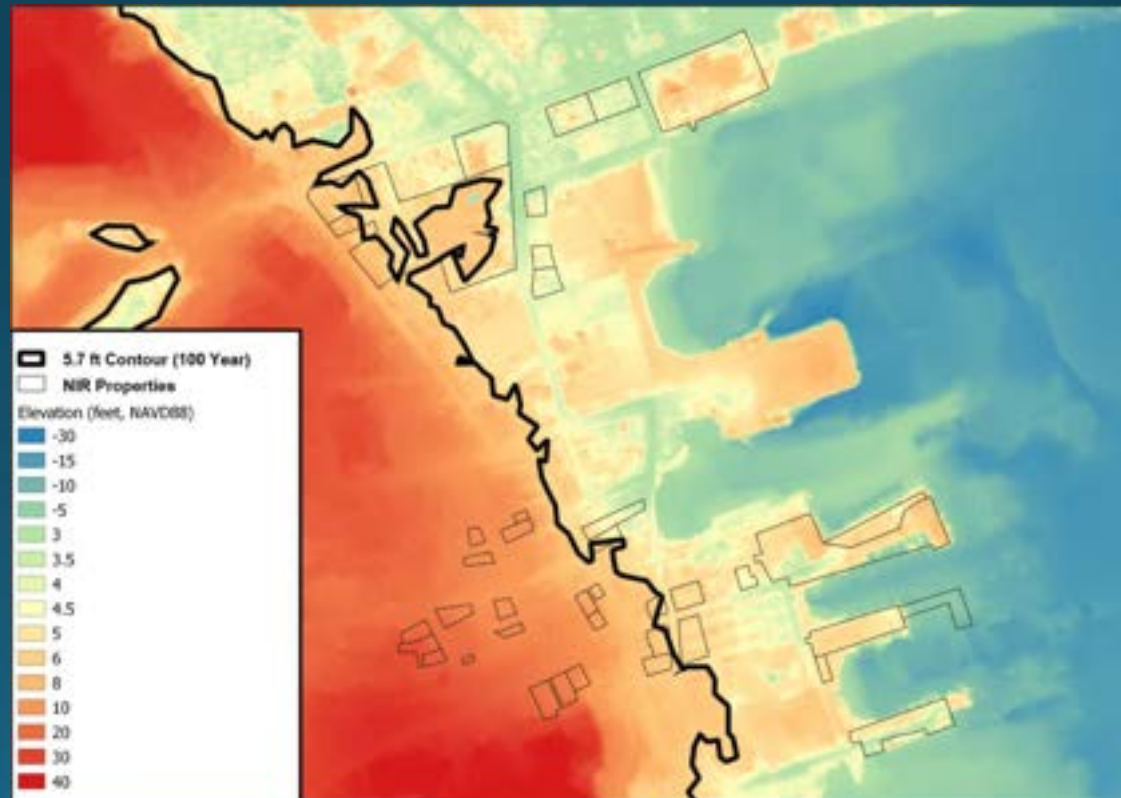
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- Raise bulkhead(s)
- Gated barriers between stone benches, as necessary
- Construct berm
- Temporary flood barrier (e.g., sand bags, fence)
- Incorporate White Elephant into flood protection



Overall Concerns with Utilizing MC-FRM as Baseline

- MC-FRM sea level rise projections appear outdated
 - 2050 MC-FRM = 2.5 feet NAVD
 - 2050 NOAA = 1.0 ± 0.4 feet NAVD - matches observations in the near-term
 - NOAA (2022) projections have served as baseline for other state-funded projects
- MC-FRM storm surge elevations are ~2 feet higher than other methods for computing the present 1% AEP
- MC-FRM modeled storm wave conditions are unrealistic for Nantucket



Questions?

