



Belfast Waterfront Vulnerability Assessment Community Meeting

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Meeting Agenda

- Welcome/Introductions
- Project Overview
- Project Presentation
- Community Engagement Opportunities
- Next Steps
- Questions and Answers



Project Goals

- Understand broad risk to flood exposure to community facilities along the City of Belfast waterfront, including time horizons when flood inundation may occur.
- Elicit community feedback to understand priority areas of the Belfast waterfront.
- Provide general adaptation practices and strategies.
- Convey project methods and results in a final report.



Project Overview

1. Background Information Review and Site Assessment
2. Flood Scenario Modeling
 - How are we determining flood exposure for this study?
 - Maine Climate Council Sea Level Rise Projections
 - Storm Surge Overview
 - Proposed Flood Scenarios
3. Identification of Community Assets Vulnerable to Flooding
4. Preliminary Identification of Adaptation Strategies/Projects



Project Focus Area



January 2024 Flooding



Recent Flooding



Recent Flooding



Recent Flooding





Belfast City Wharf temporarily closed due to flooding



**'Wo Heavy damage along coastline as ocean inundates with powerful h of
sevi surf**



Belfast's harbor endures flooding, damages, and debris washed ashore



Flood Scenario Modeling

Sea Level Rise:

- Intermediate and High Rates

Flood Scenarios:

- Highest Astronomical Tide (HAT)
 - The elevation of the highest predicted astronomical tide at a specific tide station. No influence of storm action included.
- 1%-annual chance coastal storm (“100-yr” storm)

Time Horizons:

- Near-Term (Present Day)
- Medium-Term (2050, 2070)
- Long-Term (2100)

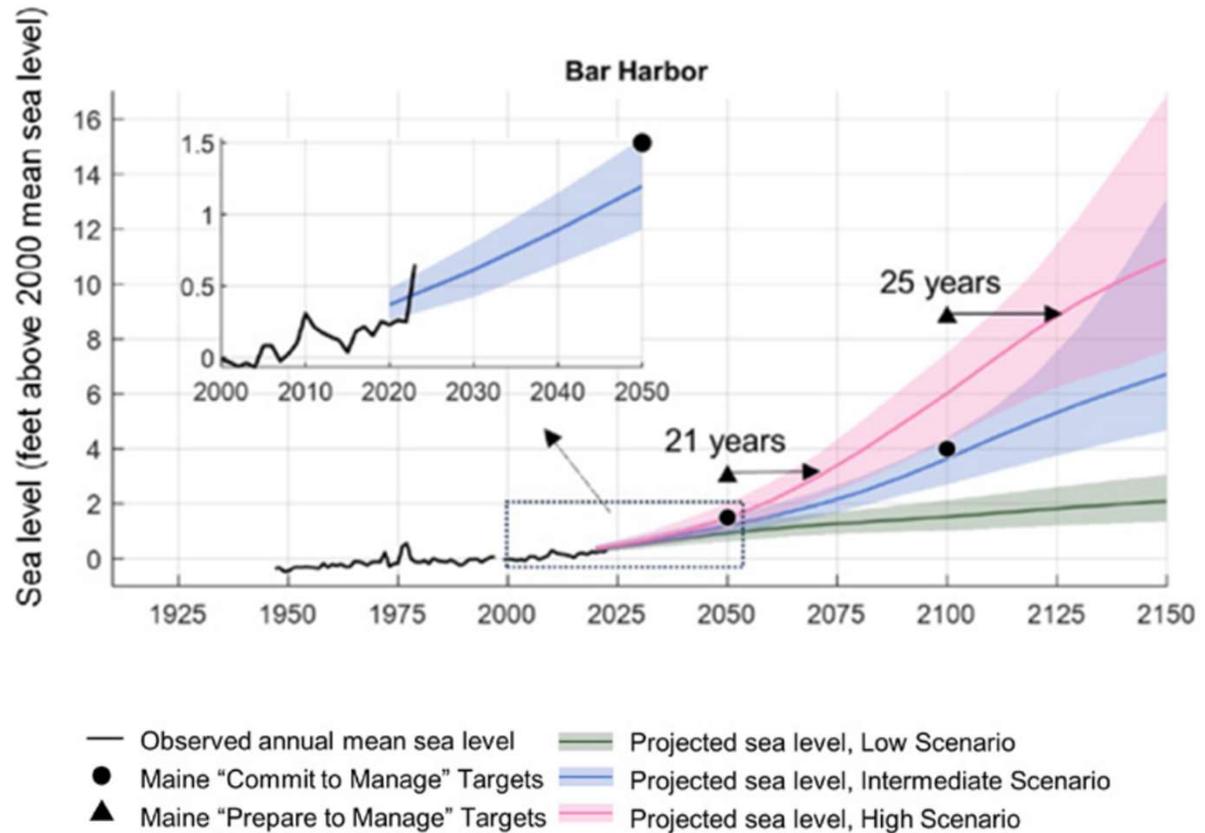
Maine Climate Council Recommendations:

- “Commit to Manage” - an [Intermediate Rate](#)
- “Prepare to Manage” - a [High Rate](#)

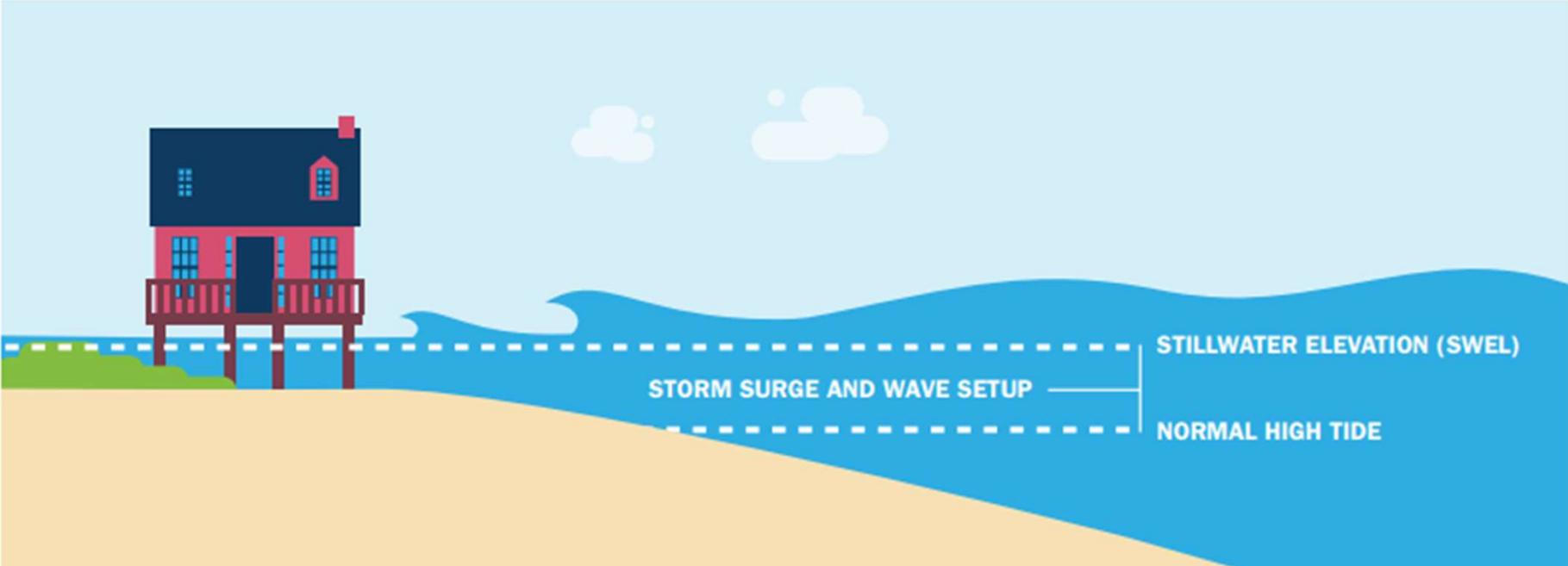


Sea Level Rise Scenarios

Year	Bar Harbor Median (likely range)	
	Intermediate	High
2020	0.4 (0.3-0.5)	0.4 (0.3-0.5)
2030	0.6 (0.4-0.8)	0.6 (0.4-0.9)
2040	0.9 (0.7-1.2)	1.0 (0.7-1.4)
2050	1.2 (0.9-1.5)	1.5 (1.0-2.0)
2060	1.5 (1.2-2.0)	2.1 (1.5-2.8)
2070	1.9 (1.5-2.4)	2.9 (2.2-3.7)
2080	2.4 (1.9-3.0)	3.9 (2.8-4.9)
2090	3.0 (2.3-3.6)	4.9 (3.5-6.2)
2100	3.6 (2.7-4.4)	6.0 (4.3-7.5)
2110	4.4 (3.1-5.4)	7.2 (5.2-8.9)
2120	5.0 (3.5-6.7)	8.3 (5.9-10.5)
2130	5.6 (4.0-8.4)	9.3 (6.5-12.4)
2140	6.2 (4.3-10.6)	10.2 (7.0-14.6)
2150	6.7 (4.7-13.1)	10.9 (7.6-16.9)



What is Storm Surge?



Flood Scenarios

Time Horizon (Year)	SLR - Commit to Manage	HAT	100 Yr Stillwater
Existing	0.0	7.5	9.7
2050	1.5	9.0	11.2
2070	2.4	9.9	12.1
2100	4.0	11.5	13.7



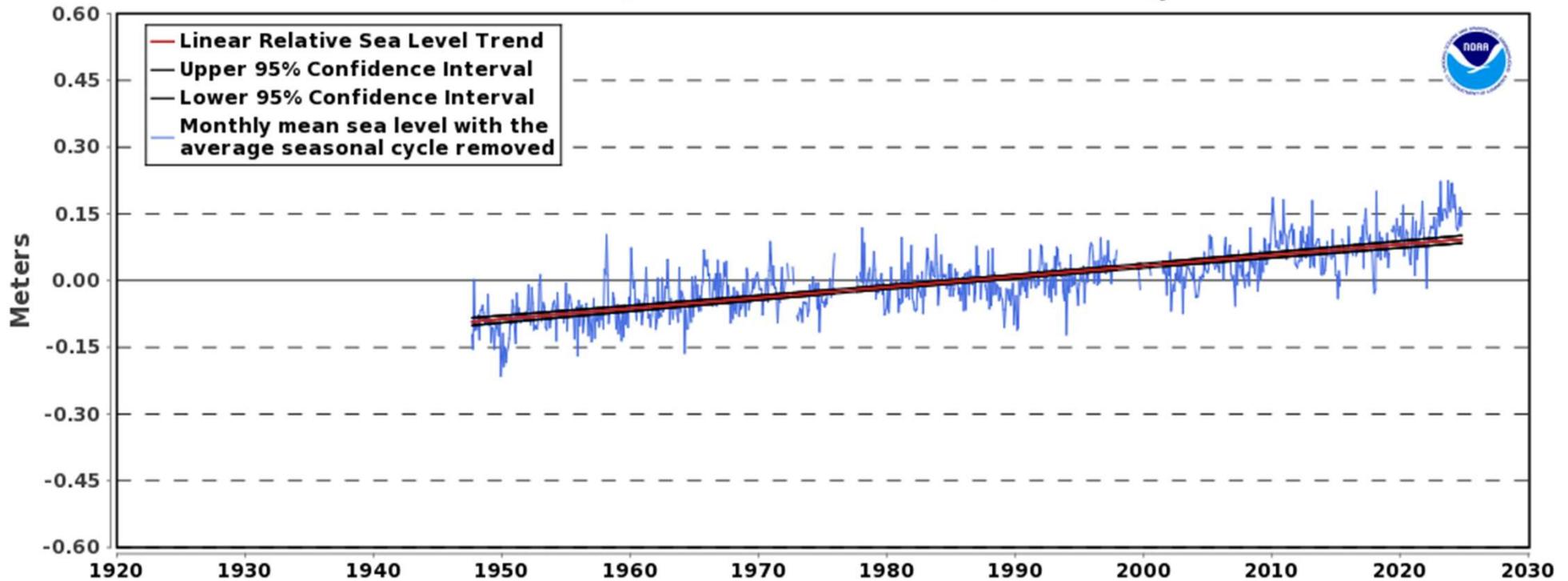
SLR values from MCC, Bar Harbor
HAT from MGS
100 Yr Stillwater from FEMA FIS for Waldo County



Relative Sea Level Trend 8413320 Bar Harbor, Maine

8413320 Bar Harbor, Maine

2.40 +/- 0.19 mm/yr



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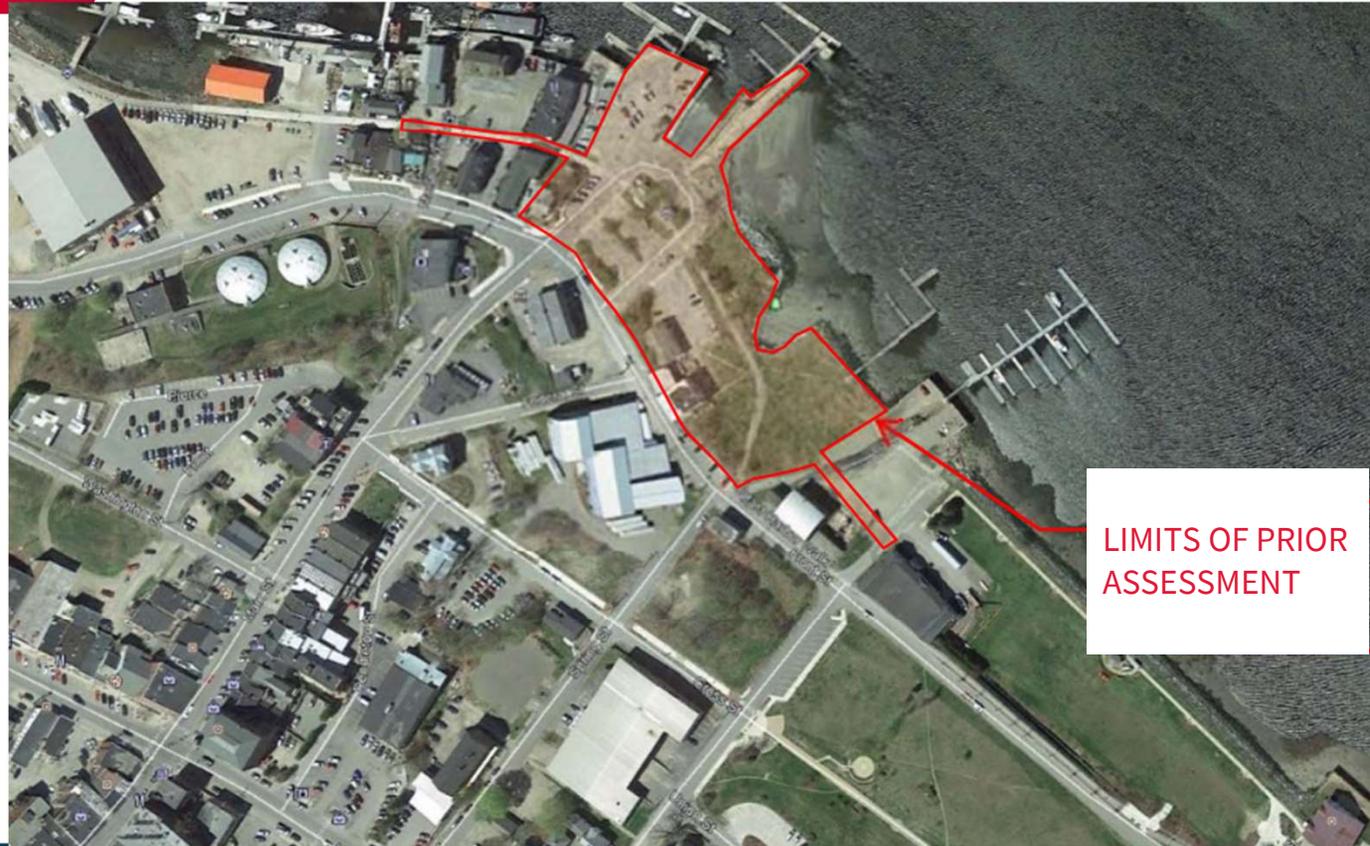
The relative sea level trend is 2.4 millimeters/year with a 95% confidence interval of +/- 0.19 mm/yr based on monthly mean sea level data from 1947 to 2023 which is equivalent to a change of 0.79 feet in 100 years.



Assets in Study

- **Survey Elevations from Wood Environment & Infrastructure Solutions for the following:**

- Wharf
- Floating Docks
- Harbor Master Office
- Vendor Office
- Fuel Storage Building
- Breakwater
- Shoreline Protection
- Boat Ramp



LIMITS OF PRIOR
ASSESSMENT



Assets in Study

- **GIS Data**
 - Roads
 - Walking Paths
 - ME DEP Registered Tanks
 - Remediation Sites
 - Boat House
 - Armistice Bridge



Example of Results:

Waterfront Assets Flood Exposure Summary (Depth Inundated, ft)								
Asset	Existing HAT	2050 HAT	Existing 100 Yr	2070 HAT	2050 100 Yr	2100 HAT	2070 100 Yr	2100 100 Yr
	7.5	9.0	9.7	10.5	11.2	11.5	12.7	13.7
Boat Ramp	0.5	2.0	2.7	3.5	4.2	4.5	5.7	6.7
Harbor Master's Office	-	1.3	2.0	2.8	3.5	3.8	5.0	6.0
Floating Dock 1	-	1.0	1.7	2.5	3.2	3.5	4.7	5.7
Wharf/Pier	-	0.8	1.5	2.3	3.0	3.3	4.5	5.5
Floating Dock 3	-	0.7	1.4	2.2	2.9	3.2	4.4	5.4
Floating Dock 2	-	0.4	1.1	1.9	2.6	2.9	4.1	5.1
Floating Dock 4	-	-	-	0.2	0.9	1.2	2.4	3.4
Vendor Offices	-	-	-	-	-	0.2	1.4	2.4
Shoreline Protection	-	-	-	-	-	-	0.7	1.7
Breakwater	-	-	-	-	-	-	-	0.05

Road Flood Exposure Summary (Length Inundated, ft)								
ROAD NAME	Existing HAT	2050 HAT	Existing 100 Yr	2070 HAT	2050 100 Yr	2100 HAT	2070 100 Yr	2100 100 Yr
	7.5	9.0	9.7	10.5	11.2	11.5	12.7	13.7
Route 1 Byp	34	40	40	41	43	44	46	49
Marshall Wharf	7	93	106	107	121	124	141	164
Main St	-	59	105	112	158	167	182	201
Carter Wharf	-	31	41	47	66	69	86	113
Front St	-	-	356	388	1,245	1,295	1,397	1,633
Commercial St	-	-	-	-	-	-	-	33



Present Day – 100 Year



2050 – 100 Year Storm



2070 – 100 Year Storm



2100 – 100 Year Storm



Asset Prioritization

What is considered for prioritization?

- How exposed to flooding is the asset?
- How many people could be impacted?
- Are critical facilities impacted?
 - Roads, Police, Fire/EMS, Hospitals, Utilities, Communication, Schools
- What is the asset's economic and cultural significance?
- What assets have the best opportunity for adaptation?



Adaptation Overview

(a) No response



(c) Protection



Revetments, Breakwater

(e) Accommodation



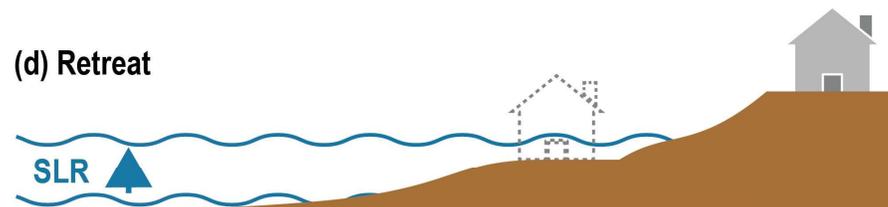
Building design (elevating, floodproofing), Zoning, offshore techniques

(b) Advance



Not a viable option

(d) Retreat



Relocate, Municipal Buyback

(f) Ecosystem-based adaptation



Living Shorelines, Living Seawall, Permeable Surfaces

Source: IPCC (2019) Chapter 4, Box 4.3, Fig. 1



Flood Adaptation

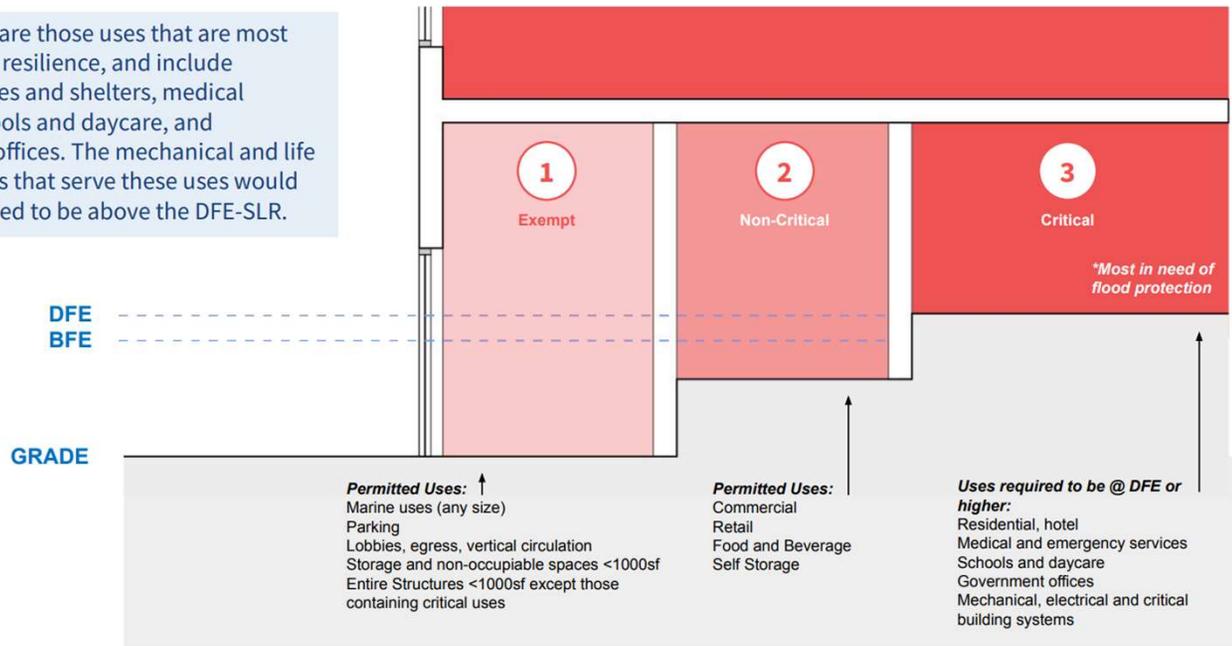
- Zoning Changes

City of Portland Coastal Flood Resilience Overlay Zone

- BFE – Base Flood Elevation
- DFE – 1’ above predicted future flood level

Proposed CFROZ Approach: Floor Elevation Based on Use - Critical Uses

Critical Uses are those uses that are most important for resilience, and include residential uses and shelters, medical services, schools and daycare, and Government offices. The mechanical and life safety systems that serve these uses would also be required to be above the DFE-SLR.

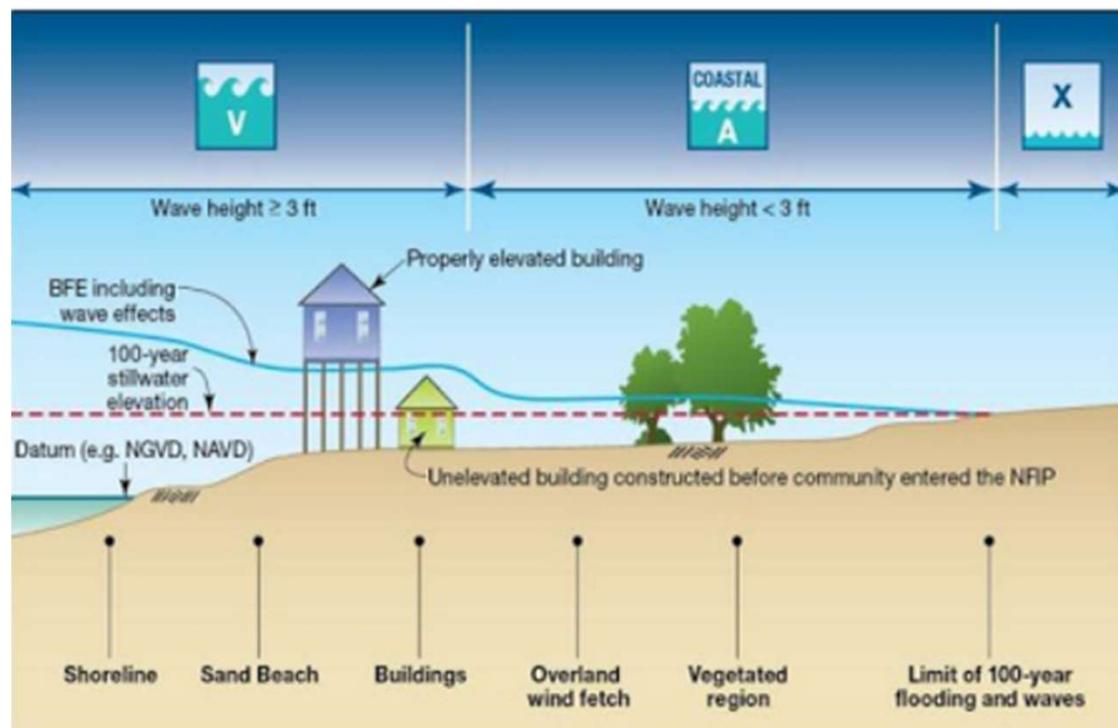


Source: City of Portland, Maine



Flood Adaptation

- **STRUCTURAL MEASURES**
- Permanent Flood Barrier (i.e., seawall, breakwater)
- “Wet” and “Dry” Floodproofing (structure by structure basis)
- Flood adaptive materials
- Wave Attenuation Device (WADs)



Source: FEMA Region II Coastal Analysis and Mapping, Coastal Mapping Basics



Flood Adaptation

Non-Structural Measures / “Green” Infrastructure

- Flood Warning System
- Flood Emergency Preparedness Plans
- High Water Rescue Vehicle
- Temporary Barriers / Temporary Floodwalls
- Municipal buy-out, rent-back program (retreat)
- Living Sea Wall
- Artificial Reef System



Living Sea Wall

Source: Stonelivinglab.org



Temporary Flood Protection



Flood Logs



Deployable Flood Barriers



Tiger Dams



HESCO Baskets



Temporary Flood Protection



ENHANCE THE SUSTAINABILITY OF MAINE'S COASTLINES



The Wave Screen Breakwater functions to reduce local wave environments from a up to 1 m wave height, to 0.6 m wave height. This adaptable technology was developed to support the sustainability of Maine's coastlines by creating temporarily deployable breakwaters to support shoreline activities or provide protection before devastating weather events. Originally funded by Army Corps Engineering Research and Design Center to create shelter in open-ocean environments, the Advanced Structures and Composites Center (ASCC) is dual use with this technology in its applications for coastal resiliency.

RAPIDLY DEPLOYABLE

52% of the energy from incoming waves was absorbed or reduced suggesting effectiveness in reducing wave impact and potential damage to coastal environments

IMPACT

- Field-Adaptable**
 Modularity of the structure allows for customizability for different wave environments, allowing for deployment in a variety of environments around the world.
- Floating**
 Wave Screen Breakwaters are floating, rapidly deployable, and can be easily deployed during unpredictable weather events. The floating structure self-adjusts with high tides and self-corrects to the environment.
- Lightweight**
 Lightweight structure makes the wave screen breakwater easy to transport, reducing the carbon footprint of its transportation and deployment.
- Sustainable**
 Lightweight structure reduces carbon footprint of transportation and deployment. The porous structure of the wave screen array has negligible impacts on local sediments and marine life, protecting local environments and reducing environmental disturbance.



WAVE SCREEN BREAKWATER INNOVATION

TECHNOLOGY

The structure utilizes modular porous panels to allow water to flow through, effectively reducing wave energy and minimizing wave height by dissipating energy. Panels can be vertically added for deeper water areas, extending into the water column to maintain efficiency, while strategic placement in the direction of wave propagation optimizes performance in higher energy environments. Arrays of panels can be installed to broaden the coverage area of reduced wave energy, ensuring comprehensive protection along coastlines or within marine environments by reducing the impact of the waves on coastal infrastructure.

FUTURE RESEARCH

The initial project was fabricated using traditional materials. As the technology is further developed, this will incorporate additively manufactured panels using bio-based or biodegradable materials, which would allow for panels to be manufactured quicker, and reducing the environmental impact of the project.

COASTAL RESILIENCE

The Advanced Structures and Composites Center (ASCC) is at the forefront of coastal resilience research, recognizing the urgent need to address the vulnerability of coastal areas to the impacts of climate change. With rising sea levels and increasing frequency and intensity of storms, coastal regions face significant threats such as erosion, flooding, and habitat loss. ASCC's work focuses on implementing green infrastructure solutions, utilizing bio-based materials and sustainable manufacturing processes like advanced manufacturing for culvert diffusers, composite sheet piling and novel breakwater solutions.

As Maine's 3,400+ miles of shoreline experience stronger, more frequent storms, we are committed to coastal resiliency solutions across our research portfolio including renewable energy sources, civil infrastructure innovations, collaborative efforts across sectors and a commitment to Maine's natural resources.



composites.umaine.edu

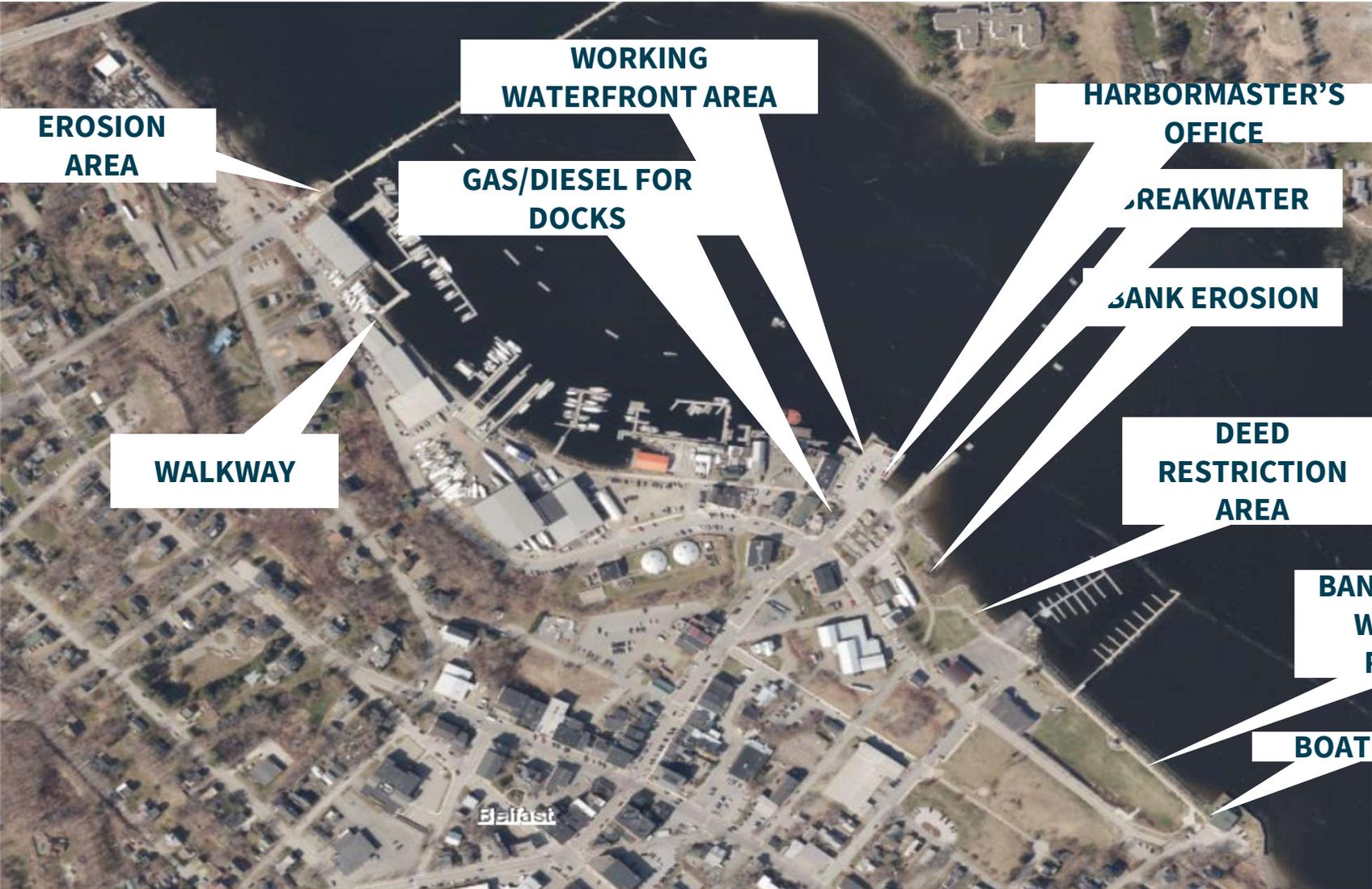
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We want to hear from you!

- How have you been impacted by flooding?
- What assets are important to you?
- What adaptation measures are you interested in?





**EROSION
AREA**

**WORKING
WATERFRONT AREA**

**GAS/DIESEL FOR
DOCKS**

**HARBORMASTER'S
OFFICE**

BREAKWATER

BANK EROSION

WALKWAY

**DEED
RESTRICTION
AREA**

**BANK EROSION
WALKWAY
REPAIRS**

BOATHOUSE

Halifax



Next Steps

- Finalize Flood Modeling
- Identify Adaptation Strategies with Asset Specific Recommendations, Ranking Matrix
- Community Workshop: TBD
- Final Report: June 2025



Thank you!
Questions?



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Consulting
Engineers and
Scientists

"The sea has always been a great teacher, showing us the importance of adaptability and resilience in the face of challenges."

The Sea Around Us
Rachel Carson