

# BALTIMORE COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

## Baltimore Regional Transportation Board Meeting

Presenters:

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U.S. Army Corps of Engineers

Baltimore District

23 August 2022



Flooding at Baltimore Inner Harbor, Hurricane Isabel (2003).

*Photo credit: Baltimore Sun*



US Army Corps  
of Engineers®



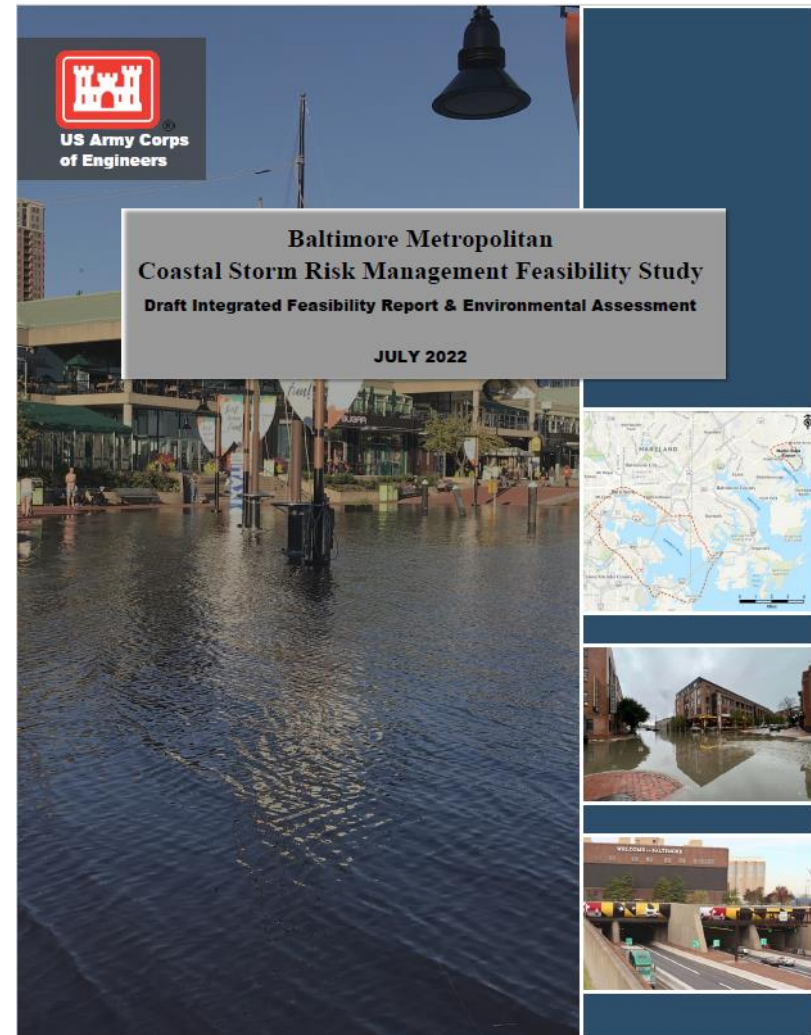
# NON-FEDERAL SPONSOR





# MEETING AGENDA

- Tentatively Selected Plan
- Study Purpose & Overview
- Study Schedule
- Alternatives Considered
- Draft Report
- Open Discussion with Q&A



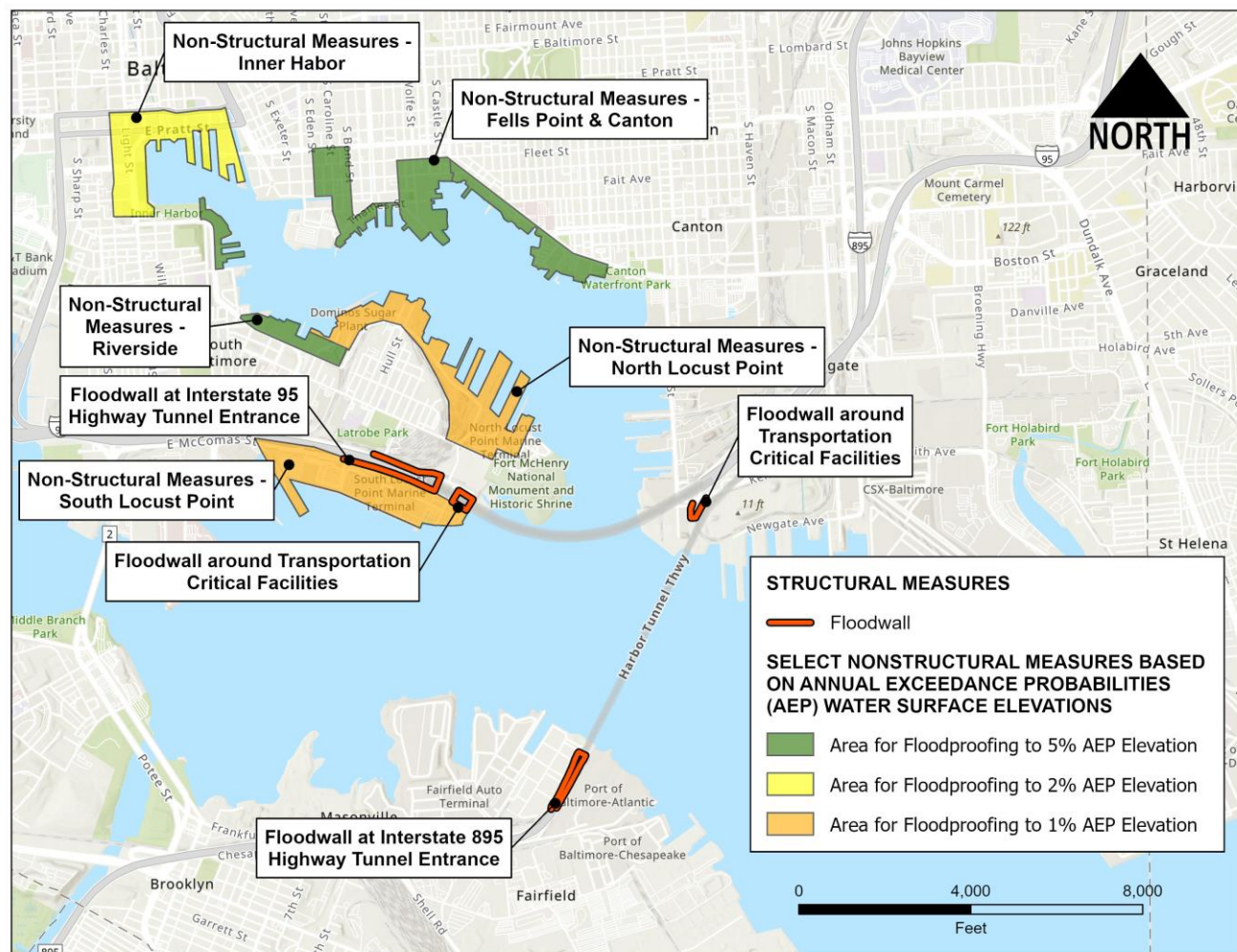
# TENTATIVELY SELECTED PLAN

## Alternative 5A: Critical Infrastructure with Select NS Plan

- I-95 and I-895 tunnel entrances and associated critical infrastructure (ventilation buildings)
- Nonstructural measures in Locust Point, Riverside, Inner Harbor, Canton and Fells Point

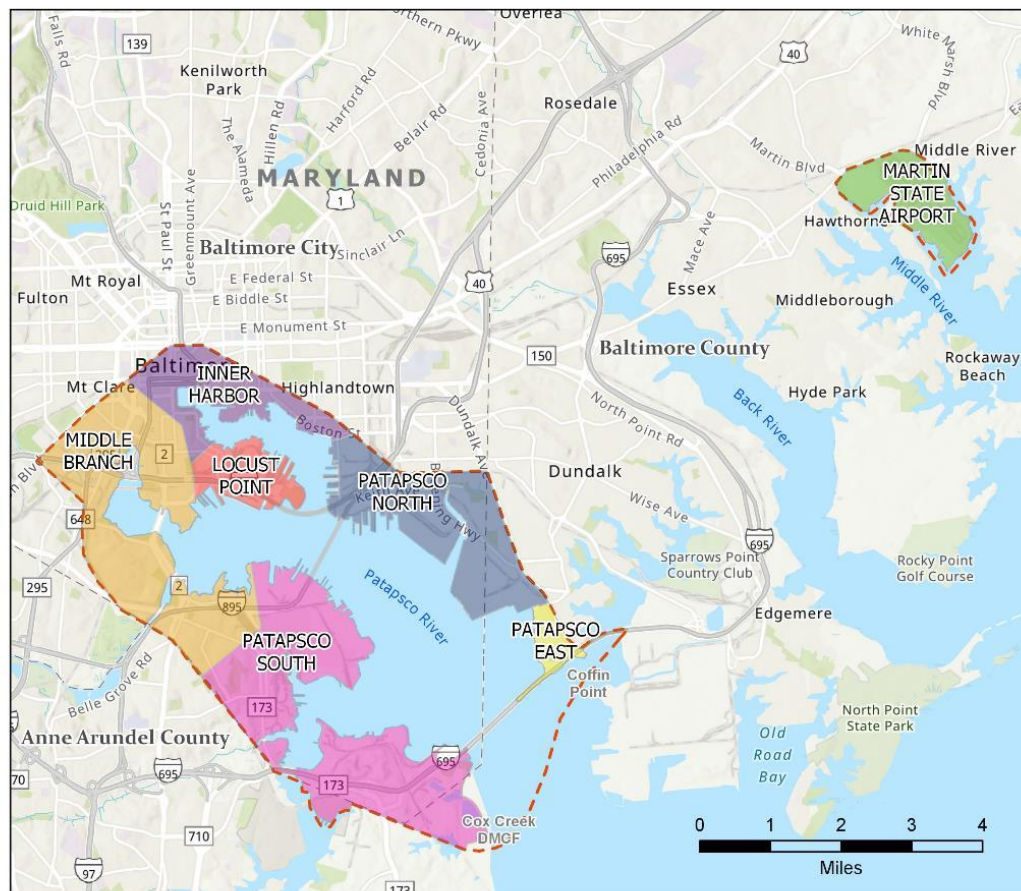
### Components:

- Concrete T-walls
- Stop Log structures
- Floodproofing





# Study Area and Planning Units



## BALTIMORE COASTAL STORM RISK MANAGEMENT FEASIBILITY STUDY

CITY OF BALTIMORE, ANNE ARUNDEL AND BALTIMORE COUNTIES



### VICINITY

### LEGEND

- STUDY AREA**
- PLANNING UNITS**
- INNER HARBOR
  - LOCUST POINT
  - MARTIN STATE AIRPORT
  - MIDDLE BRANCH
  - PATAPSCO EAST
  - PATAPSCO NORTH
  - PATAPSCO SOUTH



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# STUDY OBJECTIVES

## City of Baltimore:

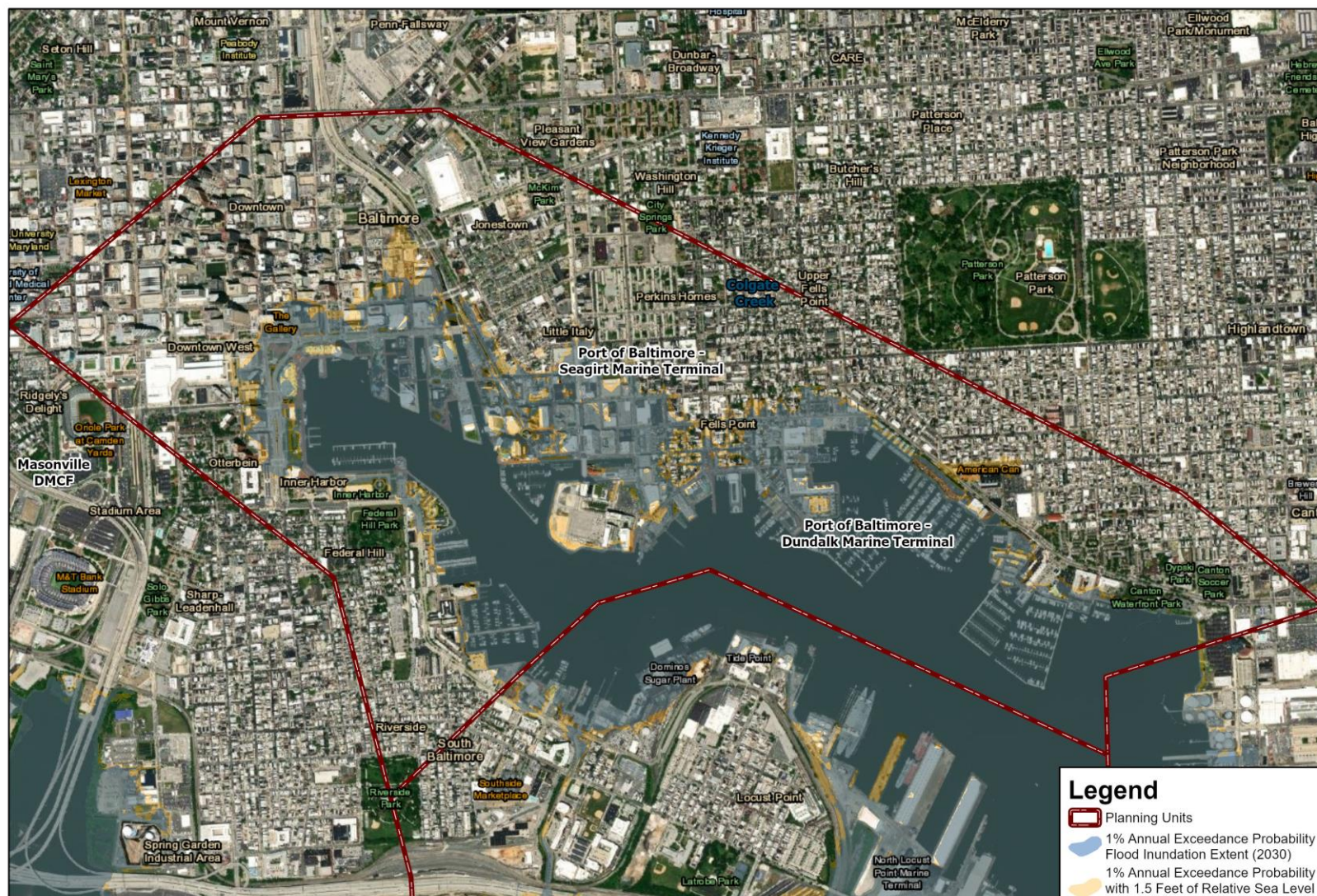
- Reduce risk to **human health and safety** from coastal storm impacts in the study area.
- Reduce **economic damages** from coastal flooding in the study area to residential, commercial, industrial, and government buildings.
- Reduce disruption of **critical infrastructure** assets, services, and interdependent systems caused by coastal flooding in communities throughout the study area.
- Improve the **resiliency of critical infrastructure** in the study area to impacts from coastal storms.
- Consider incorporation of **natural and nature-based features** in solutions.

## Martin State Airport:

- Reduce coastal flooding impacts that disrupt or damage **transportation and emergency service infrastructure** and assets at supporting operations at Martin State Airport.



# FLOOD INUNDATION MAPPING



## Legend

- Planning Units
- 1% Annual Exceedance Probability Flood Inundation Extent (2030)
- 1% Annual Exceedance Probability with 1.5 Feet of Relative Sea Level Rise (2080)\*



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Baltimore District

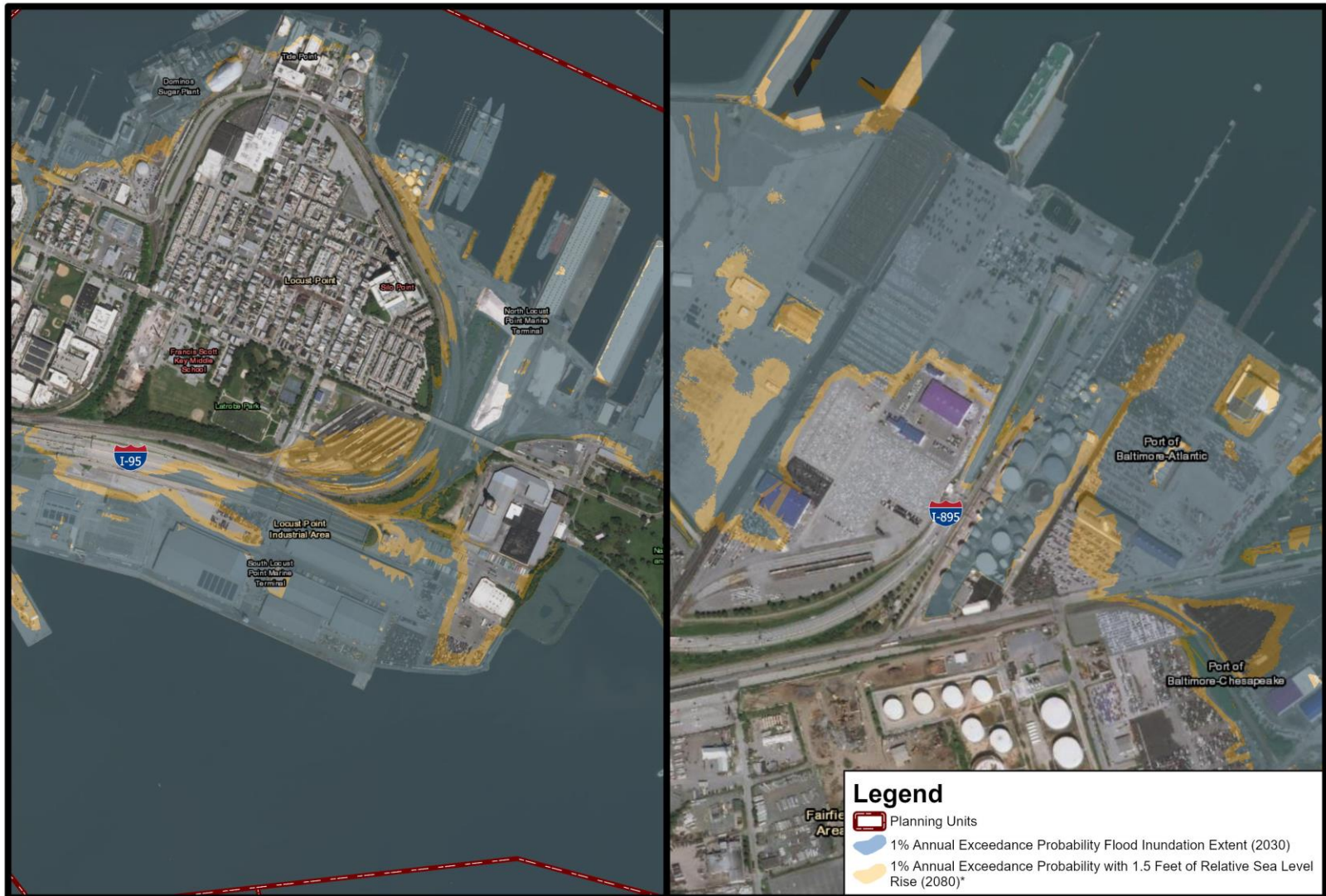
## Baltimore CSRM Feasibility Study Inner Harbor Planning Unit

0 1,000 2,000 3,000 4,000 Feet





# FLOOD INUNDATION MAPPING



US Army Corps  
of Engineers  
Baltimore District

**Baltimore CSRM Feasibility Study**  
Flood Inundation Mapping at Harbor Tunnel Entrances  
for the 1% AEP Storm Event

0 750 1,500 2,250 3,000 Feet





# STUDY SCHEDULE- TENTATIVE

Milestone	Date*
Preparing and Evaluating Alternatives	Nov 2019 to May 2022
<b>Start Public Review Period</b>	<b>01 July 2022</b>
<b>End Public Review Period</b>	<b>19 Aug 2022</b>
Respond to Comments and Revise Report	Aug 2022 – Oct 2022
<b>Agency Decision Milestone*</b>	<b>31 October 2022</b>
Continue Alternative Design and Optimization	Oct 2022 - Feb 2023
Feasibility Study Ends	March 2024
Start Design (pending funding)	2024 - 2026
Construction (pending funding)	Late 2020's

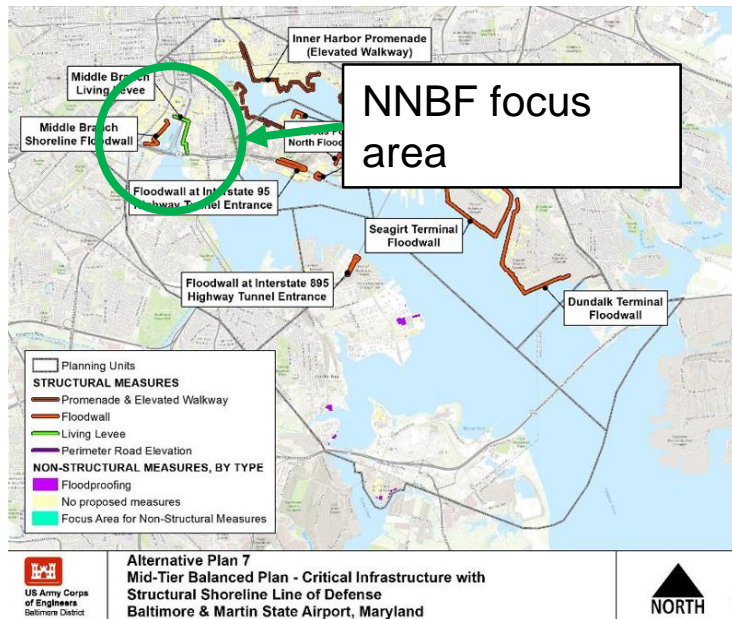
\*Agency Decision Milestone: Tentatively Selected Plan becomes Recommended Plan of USACE and Non-Federal Sponsor

# FINAL ALTERNATIVES

Alt. #	Description
0	<b>No Action</b>
4	<b>Critical Only</b> (I-95 & I-895 tunnel entrance floodwall, floodproofing: Ft McHenry Federal facilities, Patapsco WWTP, Martin State Airport facilities)
5	<b>Critical &amp; Nonstructural</b> (Alternative 4 + floodproofing: Inner Harbor, Canton, Fells Point, Locust Point)
5A	<b>Critical Infrastructure &amp; Select Nonstructural</b> (Alternative 5 with select floodproofing: Locust Point, Inner Harbor, Canton, Riverside, and Fells Point)
6	<b>Critical Balanced</b> (Alternative 5 + Seagirt Terminal floodwall)
7	<b>Mid-tier Balanced</b> (Shoreline floodwalls along Inner Harbor, Canton, Fells Point, Locust Point, Seagirt Terminal, and Wheelabrator Incinerator Plant. I-95 & I-895 tunnel entrance floodwall. Martin State Airport road elevation. Floodproofing: Patapsco WWTP, Martin State Airport)



# NATURAL AND NATURE-BASED FEATURES



NNBF can include:

- Beaches
- Wetlands
- Living levee



\* Locations and programs shown are approximate, to be confirmed in the Master Plan

## Reimagine Middle Branch:

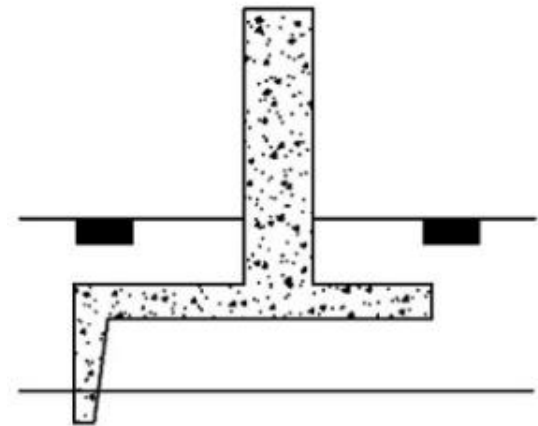
- Community-driven initiative to reconnect South Baltimore to its shoreline
- Funding received for living shoreline project in BGE's Spring Garden area of Ridgely's Cove.

For more info visit: [reimaginemb.com](http://reimaginemb.com)

Source: Reimagine Middle Branch, Project Brief Report

# STRUCTURAL ALTERNATIVE FORMULATION

- Study area was divided into planning units based on land use, zoning, shoreline type, and general setting.
- Water Surface Elevation Modeling
  - Level of Performance = Top of the wall/levee
  - Based on Coastal Storms + Sea Level Change through 2080 (1.55 feet)
- The level of performance is 12.2 feet NAVD88\*
- Concept Level Engineering Design was used to develop costs estimates



Typical Cross Section of a T-wall

\*NAVD88 = North Atlantic Vertical Datum of 1988

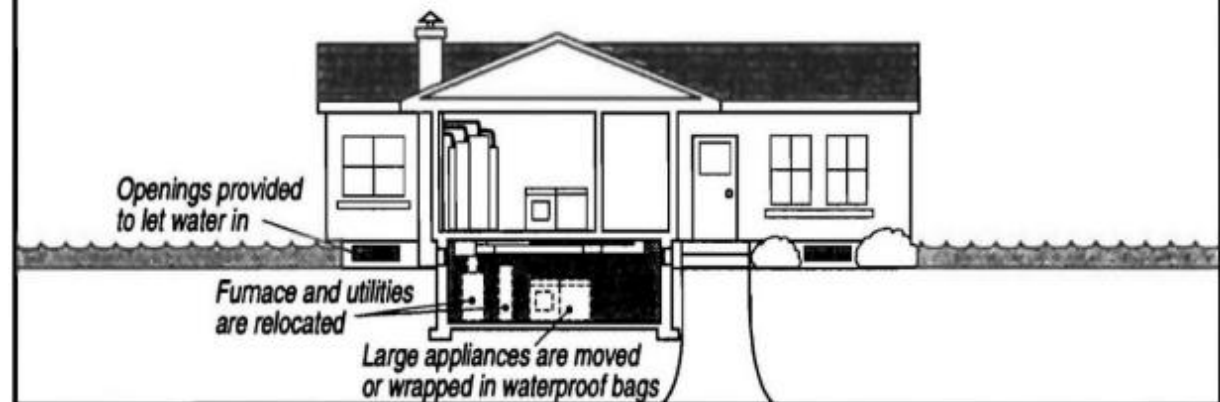


# NONSTRUCTURAL ALTERNATIVE FORMULATION

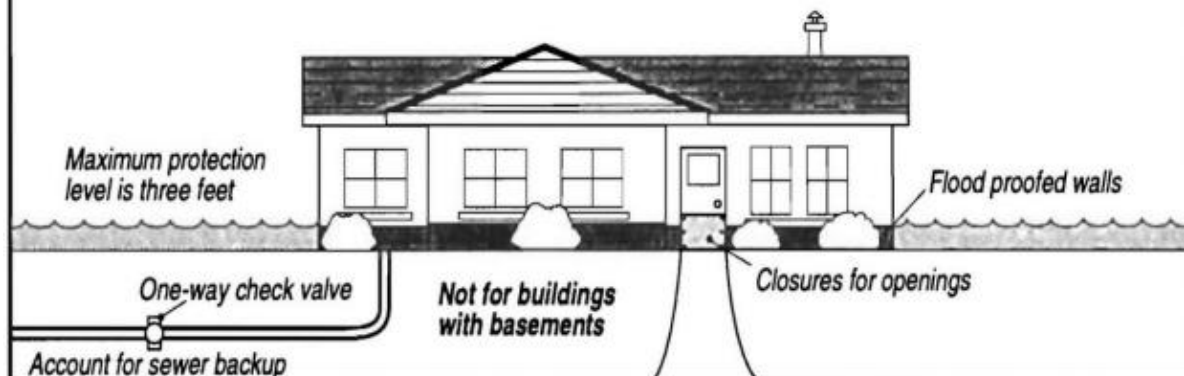
- Buildings were clustered or grouped by neighborhoods (as defined by Baltimore City), within the study area.
- Buildings in each grouping were evaluated based on location, flood inundation depth, first floor elevation, and building type.
- Groupings were evaluated under the 1% AEP (100-yr storm), 2% AEP (50-yr storm), and 5% AEP (20-yr storm) scenarios.
  - AEP = Annual Exceedance Probability
- Nonstructural measure proposed is flood proofing. Application of flood proofing (wet or dry) would be determined on a structure-by-structure basis. Participation in floodproofing would be voluntary.

# FLOOD PROOFING

## Wet Flood Proofing



## Dry Flood Proofing



Source: Federal Emergency Management Agency



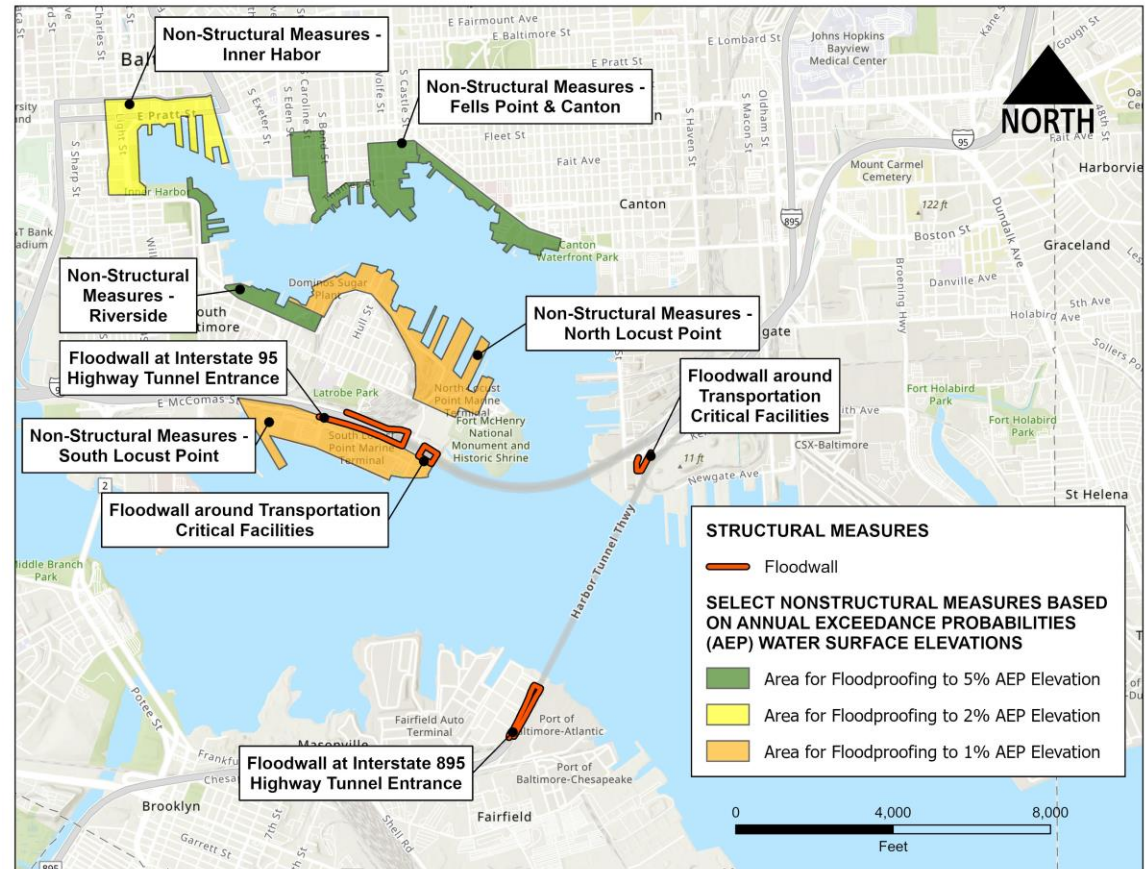
# ECONOMIC EVALUATION

## Alternative 5A: Critical Infrastructure with Select NS Plan

- I-95 and I-895 tunnel entrances and associated critical infrastructure (ventilation buildings)
- Nonstructural measures in Locust Point, Riverside, Inner Harbor, Canton and Fells Point

## Economic Summary

- Total Economic Cost: \$138M (includes 45% contingency)
- Average Annual Cost: \$4.6M
- Average Annual Benefits: \$9M
- Average Annual Net Benefits: \$4.4M
- Benefit to Cost Ratio: 2.0



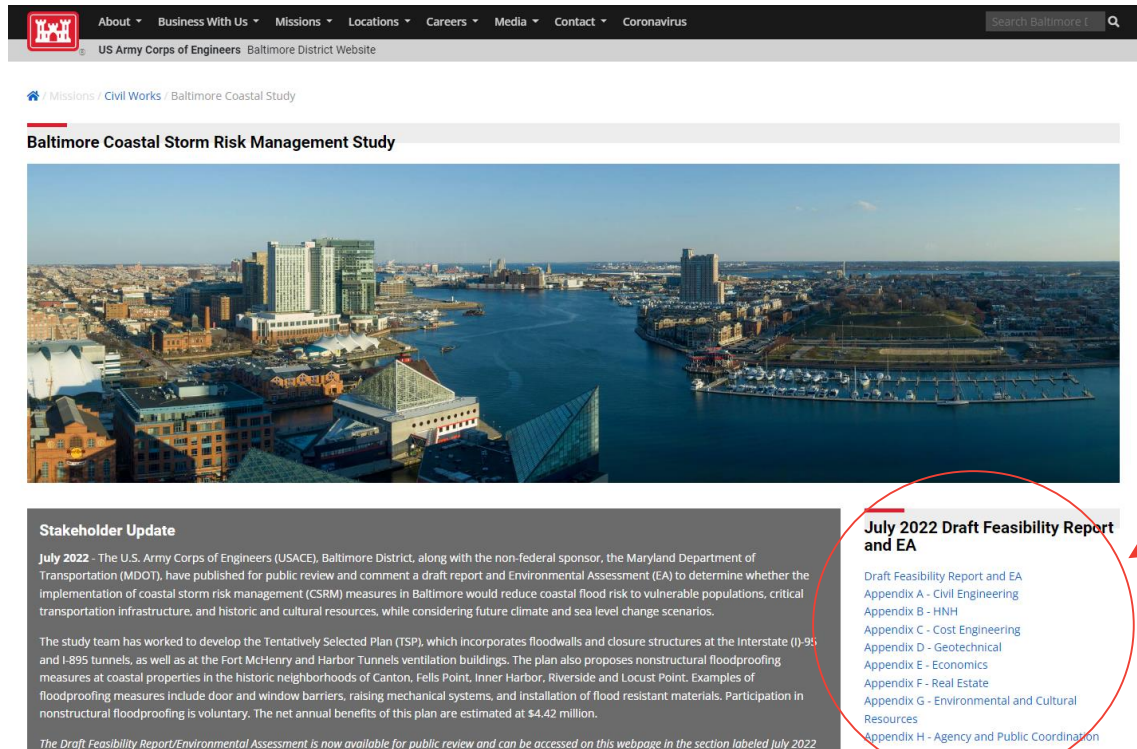
# IMPACTS TO THE HUMAN ENVIRONMENT

- Preserving of historical character of neighborhoods.
- Temporary impacts during construction (noise, soils, traffic).
- No in-water construction.
- Investigations to determine presence of contaminated soils and cultural resources during design phase.
- Beneficial impacts from improved resiliency.
- Floodwalls around the tunnel entrances would maintain access to transportation corridors and improve response times for flood preparation.



# PUBLIC REVIEW THROUGH 19 AUGUST

<https://www.nab.usace.army.mil/missions/civil-works/baltimore-coastal-study/>



**Baltimore Coastal Storm Risk Management Study**

**Stakeholder Update**

**July 2022** - The U.S. Army Corps of Engineers (USACE), Baltimore District, along with the non-federal sponsor, the Maryland Department of Transportation (MDOT), have published for public review and comment a draft report and Environmental Assessment (EA) to determine whether the implementation of coastal storm risk management (CSRM) measures in Baltimore would reduce coastal flood risk to vulnerable populations, critical transportation infrastructure, and historic and cultural resources, while considering future climate and sea level change scenarios.

The study team has worked to develop the Tentatively Selected Plan (TSP), which incorporates floodwalls and closure structures at the Interstate (I)-95 and I-895 tunnels, as well as at the Fort McHenry and Harbor Tunnels ventilation buildings. The plan also proposes nonstructural floodproofing measures at coastal properties in the historic neighborhoods of Canton, Fells Point, Inner Harbor, Riverside and Locust Point. Examples of floodproofing measures include door and window barriers, raising mechanical systems, and installation of flood resistant materials. Participation in nonstructural floodproofing is voluntary. The net annual benefits of this plan are estimated at \$4.42 million.

*The Draft Feasibility Report/Environmental Assessment is now available for public review and can be accessed on this webpage in the section labeled July 2022*

**July 2022 Draft Feasibility Report and EA**

- Draft Feasibility Report and EA
- Appendix A - Civil Engineering
- Appendix B - HNH
- Appendix C - Cost Engineering
- Appendix D - Geotechnical
- Appendix E - Economics
- Appendix F - Real Estate
- Appendix G - Environmental and Cultural Resources
- Appendix H - Agency and Public Coordination

Download  
Report

All Comments Welcome:  
[BaltimoreCoastalStudy@usace.army.mil](mailto:BaltimoreCoastalStudy@usace.army.mil)

## QUESTIONS & DISCUSSION



*Inner Harbor during high tide flooding, October 2019.  
Credit: USACE*