Wharf District Council
Conceptual District Protection
& Resiliency Plan

FINAL REPORT

May 31st, 2023
May 31, 2023

Members of the Wharf District Council, recognizing the importance of their role in protecting Boston from sea level rise, in 2019 formed a public/private partnership called the WDC Climate Resilience Task Force. Its charter is to create a conceptual district-scale protection and resiliency plan. In concert with the city, state, and federal agencies and the property owners from Christopher Columbus Park to the Congress Street Bridge, the goal is to provide for the safety of residents and visitors and to protect the billions of dollars in public and private assets both along the waterfront and inland from current and future coastal flood events and sea level rise.

The objective of this planning effort is to produce an equitable and inclusive conceptual plan that:

i. defines an engineering approach that provides effective flood protection at 2070 sea levels, leveraging previous studies by both public and private entities

ii. thoughtfully addresses connection points between properties to produce a connected barrier along the harbor’s edge

iii. identifies the costs, process and priority of actions and strategies for achieving those solutions.

This report is the result of the past three years’ discussions that have led to a consensus resilience solution for the Wharf District, allowing property owners to plan with confidence that their individual improvements are consistent with the district-wide approach. The next phase is to coordinate with governmental agencies on the larger-scale design and implementation, and to work with neighboring districts to link each of our plans.

What this plan is not (yet):

- A design for the public realm atop the identified resilient engineering solutions; much public discussion remains as to what the newly configured waterfront should look and feel like
- A clear pathway for permitting; regulations and legislation likely need to be clarified for Boston to create a resilient waterfront
- Specificity as to ownership, maintenance or regulation of use of newly created open space
- A full investigation of water transportation infrastructure; all existing docks and water-transit access remain unimpeded by the current plan, but a future study may result in a better configuration than the current one

Many thanks to the host of government leaders, the many volunteers, the generous funders, and the dedicated consultants who have helped us take this major step forward. There is a long way to go, but we are on the right path to a waterfront better suited to address the social and environmental challenges of the future.

Marc Margulies, FAIA
President, Wharf District Council
Rowes Wharf Residences Resident
Project Team

Wharf District Council Climate Resilience Taskforce and Management Team members have volunteered many hours of their time and a wealth of invaluable knowledge to this effort.

**Wharf District Council Climate Resilience Taskforce**

Aaron Michlewitz – MA House of Representatives  
Alice Brown – Boston Harbor Now  
Andy Coville – Brodeur  
Andrew Dankwerth – Pembroke  
Ann Lagasse – Ocean Havens  
Anne Rogan – Capital Properties  
Bill Zielinski – SKW Partners, Hook Wharf Project  
BJ Moriarty – Moriarty Partners, Hook Wharf Project  
Bob Gordon – Harbor Towers Resident  
Bob Gowdy – Harbor Towers Board  
Brian Abramson, Servidyne – for Rowes Wharf  
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Cathy Baker-Eclipse – Boston Park’s & Recreation  
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Cheryl Delgreco – North End Waterfront Residents Association  
Chris Bush – BPDA  
Chris Cook – Greenway Conservancy  
Chris Fincham  
Chris Osgood – Boston Mayor’s Office  
Doug Gribbel – Folio Condominium, WDC Executive Committee  
Fernando Bent-Mullin – Rasta Rootz  
Heidi Wolf – InterContinental Residences  
Joe Christo – Stone Living Lab  
Jack Clark – Pembroke  
John Rogers – MA House of Representative  
Kara Dominguez, Cushman Wakefield – for 400 and 470 Atlantic Ave  
Kate England – Director of Green Infrastructure – City of Boston  
Kathy Abbott – Boston Harbor Now  
Kelly Roche – Broadluxe Condominium  
Jack Clarke – Pembroke  
Joanne Hayes Rines – Friends of Christopher Columbus Park & Harbor Tower Board  
John Cleveland – Green Ribbon Commission  
John Larivee – Rowes Wharf Residences  
John Moriarty III  
Larry Coe – InterContinental Residences  
Marc Grossman – Harbor Towers I resident  
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Michael Travis – Boston Children’s Museum.  
Ray Green – InterContinental Residences  
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Project Team

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Kate Dineen – A Better City
Kristan McLaughlin – Pembroke
Luz Arregoces - New England Aquarium, Director of Community Relations
Marc Margulies – Wharf District Council President, Rowes Wharf Residences
Matthew Murphy – Boston Harbor City Cruises
Matt Rubins – Harbor Towers Board
Norman Meisner – Harbor Towers Board
Rick Musiol – New England Aquarium, WDC Executive Committee
Susanne Lavoie – WDC Executive Director
Steve Mitchell – Chiofaro Company
Wesley Stimpson – Harbor Towers Board

Consultant Team

ARUP
Resilience Engineering,
Civil Engineering, Coastal Structures
Engineering, Stakeholder Engagement & Outreach, Cost Estimating

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vhb
Permitting Consulting

Haley Aldrich
Geotechnical Engineering

Woods Hole Group
Coastal Flood Modeling
Acknowledgements

The Wharf District Council wishes to acknowledge and thank the many individuals and organizations who have contributed their support and time to help develop this plan.

The Wharf District Council would also like to thank the Commonwealth of Massachusetts for their generous support.
February 6, 2023

To Marc Margulies, Wharf District Council President:

It is a pleasure to recognize the work that you and the members of the Wharf District Council Climate Resilience Task Force are doing in the creation and development of a “Conceptual Resiliency Masterplan” for the protection of the Wharf District Boston neighborhood. It is encouraging to see residents, businesses, institutions, the City of Boston, and the Commonwealth of Massachusetts, all working together toward this common goal. This is why in 2021 and 2022 the State awarded earmarks of $250,000 each year to supplement your private fundraising of this important public/private partnership project.

We share your vision, that this process for creating a consensus-based resiliency solution will become a model for other Massachusetts communities. Utilizing a public/private partnership, will enable communities to play an active role in determining the necessary climate change planning and solutions, as well as participating in key process steps from development to funding for further design and construction of those solutions.

Everyone recognizes that this is a long-term challenge, but because the funding, permitting, and construction will also take a long time, we must maintain our sense of urgency to plan now.

Thank you and the WDC Task Force members for undertaking the effort of coordinating the many stakeholders along your neighborhood’s waterfront. The development of the Wharf District Conceptual Resiliency Masterplan is a good example of coming together to deal with a challenge and to come up with recommended solutions. This is an important initiative; you continue to have my support.

Sincerely,

AARON MICHLEWITZ
State Representative
Third Suffolk District
February 16, 2023

Mr. Marc Margulies, FAIA, LEED AP
Wharf District Council
85 East India Row, #16
Boston, MA 02110

Dear Mr. Margulies:

The Boston Planning & Development Agency (BPDA) supports the Wharf District Council’s efforts to advance the climate preparedness work conducted to date through the City’s Climate Ready Boston program. Since the issuance of the Climate Ready Boston report in 2016 there has been significant work conducted to understand current and future coastal flood vulnerability through flood modeling and assessment of district-wide flood protection measures for all of Boston’s waterfront communities. These plans were developed in cooperation with residents, businesses, waterfront stakeholders and neighborhood organizations, such as the Wharf District Council, to provide protection against coastal storm events while also supporting improved and equitable public access and enhanced coastal habitat. The Coastal Resilient Solutions Report for Downtown and North End notes that collective action from property owners along the waterfront is needed in order to provide complete flood protection and allow for the successful implementation of this long range plan. Property owners must work with the agreed upon design flood elevation, align their construction activities and cost contributions, and define and coordinate operations and maintenance responsibilities.

Also, for near term flood vulnerability, the flood risk and potential damage is anticipated to have a short duration and remain restricted to the wharf areas. The impacts of these flood events on private property will result in recurrent losses due to the inundation of basements, mechanical systems, and parked cars, as well as limiting ground floor access, business disruption, and the structural stability of the wharves. Therefore, property-level actions are critical regardless of the district-level design strategy. These actions create redundancy in the system and allow property owners to protect critical assets in advance of implementation of district-wide protections.

Below are answers to questions raised by the Council regarding flood modeling developed with the Boston Harbor Flood Risk Model, and related design flood elevations.

Question 1: In order to protect district-wide infrastructure, what is the recommended 2050 design flood elevation (City of Boston and NAVD numbers).

- The Coastal Resilient Solutions Report for Downtown and North End did not develop design flood elevations for the 21-inches of sea level rise scenario which we expect by 2050. The Wharf District Council’s consultant - ARUP may be able to access the data from Woods Hole Group from the flood risk model to develop base flood elevations for 2050.

Question 2: What is the district-wide recommended 2070 design flood elevation (City of Boston and NAVD numbers)

- The Coastal Resilient Solutions Report establishes a Target Design Flood Elevation of 15’ (NAVD88); 21.46’ (Boston City Base) for the Wharf District to protect to the 1% storm event with 40-inches of sea level rise (2070), and a Modular Design Flood Elevation of 16.5’ (NAVD88); 22.96’ (Boston City Base). The Target DFE is considered the minimum protective elevation and the modular provides for a higher level of protection with sea levels anticipated to rise beyond 2070. We generally expect coastal protection to be designed to accommodate the modular level in the future. The DFE’s also include 1-foot of freeboard, or margin of safety as recommended by FEMA.

Question 3: Separately, we understand that there are required elevations for new construction

- The Coastal Flood Resilience Zoning Overlay (Zoning Article 25A) establishes separate design flood elevations for buildings which are different from the design flood elevations in the Coastal Resilient Solutions Reports, which are specific to district scale shoreline protection measures. The property specific base flood elevations can be referenced through the BPDA's Zoning Viewer.

The BPDA looks forward to the results of the Council’s current coastal resilience planning effort and future work to implement the Climate Ready Boston recommendations for district-scale coastal flood protection. Please feel free to reach out with any additional questions.

Sincerely,

Richard McGuinness
Deputy Director for Climate Change
And Environmental Planning.

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Michelle Wu, Mayor | James Arthur Jemison, Director | Priscilla Rojas, Chair
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1. Introduction

   Context
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Introduction

Context

The Wharf District

As a home, a workplace, and a destination to people of varied backgrounds, ages, incomes, and abilities, the Wharf District hosts a wonderful wealth of culture and experiences. From ground floor restaurants and shops to high rise businesses and hotels, from parks to waterfront activities and transportation, from residences to world-famous historic sites – the Wharf District truly is one of the most historically significant and active waterfronts in New England.

The Wharf District Council (WDC) is a 501(C)3 non-profit neighborhood organization, recognized by the Mayor’s Office and the City of Boston as representing the community on matters relating to planning, development, construction, programming events and transportation in the District. The Wharf District Council membership is made up of residents, hotels, non-profit institutions, small businesses and A Better City, representing the major businesses in the District. It serves as the neighborhood's voice in matters that require a community opinion and/or action. Its purpose is to help the decision makers make the right decisions on our community related issues.
Flood Hazards

On January 4, 2018, Winter Storm Grayson pushed the waters of Boston Harbor up to elevation 9.6 feet NAVD88 (16.1 feet Boston City Base), impacting the Wharf District community with flood waters lapping hundreds of feet inland up State Street and along Atlantic Avenue. Inundating the MBTA Blue Line at Aquarium Station, the storm surge caused millions of dollars in damages and resulted in an extended reduction of accessibility along this critical transportation route for the residents of Boston.

While this flood caused significant damage, it did not even rise to the elevation of FEMA’s present-day 100-year (1% annual chance) base flood level. Grayson provided a visual baseline of today’s flood hazard, and also a stark reminder of our vulnerability to the rising tides expected in the near future.
Flood Projections

With sea levels projected to rise up to 51.5-inches by 2070, storms such as Winter Storm Grayson are likely to cause more widespread flooding throughout the Wharf District in the coming years, resulting in significantly greater impacts to the community’s homes, businesses, and critical infrastructure. The following maps illustrate the flood extents and depths expected to impact the Wharf District during a 1% storm surge flood event (aka a ‘100-year storm) in 2030, 2050, and 2070 if the proposed district-wide flood protection system is not constructed.

Why Protect Against a 100-Year Flood?

A 100-Year Flood is an event that has a 1-in-100 chance of occurring in any single year. The likelihood of one of these floods occurring over the period of a decade or more is significantly greater.

There is a 10% chance the Wharf District will experience a 100-Year Flood in the next 10 years, and a 40% chance such a flood event will occur over the next 50 years.

Current climate change projections also indicate these types of extreme storms are likely to occur more frequently in the future.

Wharf District Flood Projections

Flood Depths:

Image Source: Arup Massachusetts Flood Viewer; Flood Layer Data Source: Massachusetts Coast Flood Risk Model (MC-FRM)
Flood Extents – 2030 1% Storm Surge Flood Event
Flood Extents – 2070 1% Storm Surge Flood Event
Additionally, projected sea level rise is anticipated to increase ‘sunny-day’ flooding throughout the district during high tides events, even when no storms are present. While Boston saw 7 high-tide flood days in 2021, the National Oceanic and Atmospheric Administration (NOAA) projects 11 to 18 high-tide flood days to impact Boston this year, and 50 to 70 high-tide flood days by 2050. Sunny-day tidal flooding is projected to impact critical infrastructure including the Central Artery Tunnel and the MBTA’s Blue Line by the 2040s.

**Sunny-Day Tidal Flood Projections**

- **By the 2040s:** Critical Infrastructure including the Central Artery Tunnel and MBTA Blue and Orange Lines will be exposed to flooding during sunny-day tides.

- **By the 2060s:** Widespread flooding throughout the Wharf District will expose dozens of buildings located inland of Atlantic Avenue to flooding during sunny-day tides.

**Building-Level Flood Resiliency Guidelines**

To protect people and property in the Wharf District, flood protection strategies are necessary at all buildings in flood prone areas – including those located inland of Atlantic Avenue. These building-level protections are needed to provide a second line of defense to reduce the risks to the community associated with single points of failure in the district-scale flood protection system proposed along the waterfront.

Strategies for protecting individual buildings from flooding are provided in Appendix C.

*Image Source: Coastal Resilience Solutions for Downtown Boston and North End, with revised time horizons to reflect current sea level rise projections.*
These sunny-day tidal floods and storm surge events will expose much of the Wharf District community and its important community assets to flood risks. **Without a district-wide flood protection system, all assets indicated on the map below will be exposed to flooding during a 1% Storm Surge Event in 2030.**
Prior Flood Resiliency Planning Initiatives

After Superstorm Sandy caused widespread damage in New York City on October 29, 2012 and spared Boston with a near-miss, Boston undertook numerous flood resilience planning studies aimed at developing a comprehensive approach to protecting its communities.

Two of these studies – Climate Ready Boston (2016) and Coastal Resilience Solutions for Downtown Boston and North End (2020) – developed the following key considerations for designing coastal flood resiliency projects for the Wharf District Community, including:

- **Design Flood Elevations:** A “Target” Design Flood Elevation (DFE) is established as the minimum elevation district-wide flood protection systems are required to meet. A “Modular” DFE is also defined as a higher elevation that flood protection systems may need to be raised to in the future as sea levels rise.

- **Alignments:** Several flood protection options were identified indicating locations, or ‘alignments’ where a district flood protection system may be located.

- **Evaluation Criteria:** A set of evaluation criteria, developed through extensive community engagement efforts, were created to help guide and rank proposed climate resilience strategies.

- **Strategies:** A resilience toolkit summarizing possible design approaches that may be applied along the alignments is provided for guidance.

Refer to Appendix A for a full list of definitions and abbreviations used in this report.

In 2019, the Wharf District Council engaged with Wharf District stakeholders in the Wharf District Public Realm Visioning Study to define community preferences associated with resiliency, planning for change, connections and access, and enhancing quality of life.

Since this time, numerous property owners have also undertaken planning, design, and installation of flood resiliency measures to reduce flood hazards on their property.

### Timeline of Wharf District Resiliency Planning Initiatives

<table>
<thead>
<tr>
<th>Year</th>
<th>Initiative</th>
</tr>
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<tbody>
<tr>
<td>2016</td>
<td>Climate Ready Boston</td>
</tr>
<tr>
<td>2017</td>
<td>Imagine Boston 2030</td>
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<tr>
<td>2017</td>
<td>Resilient Boston</td>
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<tr>
<td>2018</td>
<td>Resilient Boston Harbor Vision</td>
</tr>
<tr>
<td>2018</td>
<td>Climate Resilient Design Standards &amp; Guidelines for Protection of Public Rights-of-Way</td>
</tr>
<tr>
<td>2019</td>
<td>Coastal Flood Resilience Design Guidelines</td>
</tr>
<tr>
<td>2019</td>
<td>City of Boston Climate Action Plan Update</td>
</tr>
<tr>
<td>2019</td>
<td>Wharf District Public Realm Visioning Study</td>
</tr>
<tr>
<td>2020</td>
<td>Coastal Resilience Solutions for Downtown and North End</td>
</tr>
<tr>
<td>2021</td>
<td>Coastal Flood Resilience Overlay District</td>
</tr>
</tbody>
</table>
**Design Flood Elevations (DFEs)**

Boston’s prior flood resiliency studies were based on the Boston Harbor Flood Risk Model (BH-FRM) developed by Woods Hole Group for MassDOT in 2015. Woods Hole Group recently developed an updated flood model with the latest sea level rise projections for MassDOT: the Massachusetts Coast Flood Risk Model (MC-FRM). MC-FRM outputs underpin the Design Flood Elevations used for the Wharf District Council project. For more details regarding the DFE, refer to Appendix B.

**Why use MC-FRM Sea Level Rise & Flood Projections?**

Flood projections from MC-FRM are integrated with Massachusetts’ ResilientMA Climate Resilience Design Standards Tool – the state’s standard tool for assessing vulnerabilities and informing resilient design for future coastal flood hazards. State agency projects and projects undergoing review under the Massachusetts Environmental Policy Act are required to use ResilientMA tool. Municipal resilience grant recipients are also encouraged to use the ResilientMA tool. This project uses the sea level rise and flood projections from the MC-FRM to align with regulatory requirements and maximize opportunities for funding.

**Conceptual District Protection & Resiliency Plan – Design Flood Elevations**

**Target DFE** – Consistent with the City of Boston’s Target DFE, this is the minimum elevation that district-wide flood protection systems are recommended to meet.

**Strategic DFE** – We recommend flood protection systems be designed to be incrementally raised over time from the Target DFE to the Strategic DFEs. The Strategic DFEs vary based on location, with higher DFEs at the waterfront due to wave impacts near the water’s edge, and lower DFEs for inland areas, as indicated in the image below:

<table>
<thead>
<tr>
<th>Target DFE Assumptions:</th>
<th>Strategic DFE Assumptions:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BH-FRM Model</strong>, 2070, 100 - year storm event + 1-ft Freeboard</td>
<td><strong>MC-FRM Model</strong>, 2070, 100 - year storm event + 2-ft Freeboard</td>
</tr>
<tr>
<td>Coastal flood risk model used by the Climate Ready Boston reports</td>
<td>Most up-to-date coastal flood risk model starting to inform statewide permit requirements</td>
</tr>
<tr>
<td>50-year time-horizon</td>
<td>50-year time-horizon</td>
</tr>
<tr>
<td>This indicates the potential flooding from a projected 1% storm with 40&quot; sea level rise and storm surge caused by major coastal storms</td>
<td>This indicates the potential flooding from a projected 1% storm with 51.5&quot; sea level rise and storm surge + wave crests caused by major coastal storms</td>
</tr>
<tr>
<td>Industry standard freeboard for non-essential and non-residential buildings</td>
<td>Aligned with Army Corps levee requirements; Industry standard freeboard for critical infrastructure and residential buildings</td>
</tr>
</tbody>
</table>

*Boston Harbor Flood Risk Model*

*MC-FRM Model*
This graphic compares the **existing ground elevations along the Harborwalk** (shown in grey) to the proposed Design Flood Elevations (Target DFE shown in orange, Strategic DFE in green) at each property from Christopher Columbus Park (left) to Atlantic Wharf in the Fort Point Channel (right). Flood protections located along the Harborwalk would need to close the gap in elevation between the existing ground elevation and the Target DFE at a minimum.
This graphic compares the **First Floor Elevations of the waterfront buildings** (shown in grey) to the proposed Design Flood Elevations (Target DFE shown in orange, Strategic DFE in green) at each property from Christopher Columbus Park (left) to Atlantic Wharf in the Fort Point Channel (right). Flood protections located at the waterfront buildings would need to close the gap in elevation between the existing ground elevation and the Target DFE at a minimum.
Purpose

With funding from the waterfront property owners and the Commonwealth of Massachusetts, the Wharf District Council collaborated with the City of Boston and Wharf District Stakeholders to provide this engineering assessment to **integrate and advance the prior flood resiliency planning initiatives** by the City of Boston, the Wharf District Council, and individual property owners.

The Conceptual District Protection & Resiliency Plan (the Plan) aims to **define a preferred flood resiliency system along the Wharf District’s waterfront that has broad support from the Wharf District community**. This plan goes beyond protecting individual buildings – protecting all the Wharf District from current and future flooding while providing an integral component of a larger contiguous flood protection system extending beyond the borders of the Wharf District.

This plan is not intended to prescribe the public and private land improvements of areas impacted by the proposed flood resiliency system. Instead, it aims to support meaningful conversations about what waterfront access, equity, diversity, and inclusion look like in subsequent resiliency and land improvement planning efforts.

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*Long Wharf*
Process

The Project was conceived in 2019 and Arup was engaged in April 2022. The project team consisted of the Wharf District Council Climate Resilience Task Force Management Team and an interdisciplinary consultant team led by Arup, with support from Halvorson, Haley & Aldrich, VHB, and Woods Hole Group.

The Conceptual District Protection & Resiliency project approach centers the direct involvement of Wharf District Stakeholders as well as Equity, Diversity, and Inclusion Partners (EDI Partners) in the planning and design process, with a goal of developing a resiliency plan that would be broadly supported by the Wharf District Community. A summary of the project’s approach to designing for social equity and access is provided on the following page.

A detailed summary of the overall project approach is provided in Appendix B. This process included:

- **Stakeholder and EDI Partner Engagement**
  Wharf District Stakeholders and EDI Partners were engaged to: share knowledge of flood hazards, site-specific considerations, and prior resiliency initiatives; develop a set of Evaluation Criteria for ranking and prioritizing resiliency strategies; assess the impacts of the flood resiliency strategies; and identify a set of preferred resiliency strategies for the waterfront properties.

- **Building on Prior Planning Initiatives**
  A Due Diligence assessment was performed to collect, catalogue, and review relevant prior planning, technical and regulatory information, and access considerations. Design Flood Elevations, alignments, strategies, and evaluation criteria from the City’s prior planning initiatives were updated to incorporate findings of the Due Diligence assessment, recent flood predictions, and Stakeholder and EDI Partner feedback.

- **Resiliency System Design**
  A preferred district-scale flood resiliency system design was developed, along with a flood resiliency guidelines for individual buildings, permitting considerations, cost estimates, a Cost Benefit Analysis, an implementation timeline, and a list of potential funding sources.

June 21, 2022 Due Diligence Site Visit
Design for Social Equity & Access

The flood protection system design aims to provide equitable access to the waterfront, safe transportation into, out of, and around the waterfront, and create opportunities for new public recreational and cultural amenities. To achieve these goals, the Plan:

- Identifies opportunities for new accessible routes to the Harborwalk
- Maintains or increases the width of the existing Harborwalk at all locations
- Results in an overall increase in existing Harborwalk and public open space areas, including identifying opportunities for new public open space areas to compensate for potential impacts to existing open space programming by the proposed resiliency strategies
- Maintains emergency access routes to all buildings and Harborwalk locations
- Minimizes impacts on views of the Harbor, and identifies new opportunities for public viewing of the water
- Identifies new opportunities for direct access for the public to ‘touch’ the water

EDI Partners and Wharf District Stakeholders were also provided opportunities to inform the Plan through review and comment periods on the Project deliverables.
What’s Next?

Building off prior planning and guidance from the City of Boston, and developed in close coordination with Boston Planning and Development Agency (BPDA) staff, this Plan is based on resiliency approaches endorsed by the City of Boston. Incorporating the Wharf District Stakeholders and EDI Partners directly in the process, the Plan leverages the local community’s deep personal knowledge of the specific hopes and needs of the district’s people, organizations, and infrastructure to define a vision that enables the Wharf District not just to survive, but to thrive in the years to come.

In creating a district-wide resiliency plan that is supported by the Wharf District Community, this concept plan takes an important step in the Wharf District’s journey towards a thriving and resilient future. The success of this plan will ultimately depend on continued engagement and support from the Wharf District Community, the City of Boston, and public and private stakeholders.

Next steps in the Wharf District’s resiliency journey:

- Directly engage with Water Transportation Providers and Marina Operators to identify additional opportunities to improve water transportation infrastructure in the District.
- Coordinate with governmental agencies on the larger-scale design and implementation.
- Work with neighboring districts to link each of our plans.
- Expand our engineering analyses to further investigate opportunities to manage inland flooding associated rain falling on the ‘dry-side’ of the proposed flood protection systems.
- Develop a Funding and Financing Strategy that will identify potential sources of public and private funding necessary to fully fund the district’s flood resiliency plan, and assess the viability of various procurement and operating models that may be employed to advance the plan through final design, construction, and long-term operation.

Areas of Opportunities Map

Image Source: 2016 Wharf District Public Realm Vision, Halvorson
2. Flood Resiliency Solutions for the Wharf District

- Wharf District Flood Resiliency Plan
- Sub-District Projects
- Implementation Timeline
- Regulatory Considerations
- Cost Estimate, Benefit-Cost Analysis, and Funding Opportunities
Wharf District Flood Resiliency Plan

Designed to optimize the Evaluation Criteria of Effectiveness, Feasibility, Adaptability, Social Equity and Access, and Environmental and Additional Benefits, the proposed flood resiliency plan for the Wharf District provides a contiguous line of protection along the district’s entire waterfront. This plan also creates three Resiliency Zones within the district to protect all Wharf District properties from flood pathways originating outside the district while mitigating wide-spread flood risks associated with single points of failure.

The proposed plan integrates multiple resiliency strategies into a cohesive flood protection system informed by the findings of a Multicriteria Assessment, a multi-disciplinary engineering assessment, and an extensive stakeholder engagement process. Importantly, the proposed resiliency system has the support of each of the district’s Waterfront Property owners.

A detailed summary of the project’s approach to each of the Evaluation Criteria is provided in Appendix B.

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**Wharf District Resiliency Project Evaluation Criteria**

**Effectiveness**
- Meets Design Flood Elevations (DFEs)
- Facilitates continuous line of protection/resilience across the entire district
- Minimizes deployment complexity
- Protects critical infrastructure
- Avoids increasing rainfall-based flooding at abutting properties

**Feasibility**
- Minimizes ground settlement & coastal erosion
- Minimizes impacts to seawalls & structural decks
- Minimizes permitting risks
- Minimizes construction cost
- Minimizes long term operations & maintenance costs

**Adaptability**
- Compatible with existing property-specific plans and land use
- Compatible with district-wide and abutting-property resiliency strategies
- Provides opportunities for phased implementation

**Social Equity & Access**
- Preserves & enhances the Harborwalk, including welcoming & inclusive access and signage
- Preserves & enhances outdoor public spaces, including welcoming & inclusive access and signage
- Preserves & enhances view of the Harbor
- Preserves & enhances emergency access
- Preserves & enhances non-emergency access to the waterfront, public

**Environmental & Additional Benefits**
- Preserves & enhances environmental resources
- Preserves & enhances docks & water transportation functionality and access
- Minimizes outdoor private land use impacts
- Compatible with the district’s architectural & urban context, including the functionality & visibility of wharves and historic resources
Along with the district-scale waterfront strategies, Building-Level Flood Resiliency Guidelines are provided in Appendix C. These guidelines summarize flood resiliency recommendations recommended to be implemented by building owners throughout the Wharf District to create a second layer of resiliency for the Wharf District community at each building located within a flood prone area.

The following section provides an overview of the key design elements of the Wharf District Flood Resiliency Plan. For further detail into the due diligence and multi-criteria assessment findings refer to Appendix D.

**Phased Construction**
The flood protection system is designed to be built in phases, constructed to the Target Design Flood Elevation (DFE) in the near-term and mid-term to prioritize protection of the most at-risk areas within the Wharf District, and then incrementally raised to the Strategic DFE in the long-term as sea levels rise.

Refer to the Sub-District Project descriptions and Implementation Timeline for additional construction phasing recommendations.

**Multiple Flood Pathways**
The proposed flood protection system protects the Wharf District from flooding from the three major potential flood pathways of storm surge, rainfall, and groundwater.

- **Coastal Storm Surge** – A combination of seawalls, elevated landforms, and floodwalls are proposed to protect the district from overland flooding from coastal storm surges up to the Design Flood Elevations (DFEs).

- **Rainfall** – New storm drainage infrastructure is proposed to mitigate the risks of rainfall causing flooding on the ‘dry-side’ of the flood protection system, including:
  - New major underground stormwater storage
  - New stormwater pump systems
  - New storm drainpipes to convey overflows from the City’s existing sewers to the new stormwater storage and pump systems
  - New manual gate valves and automatic tide gates on all existing storm and combined sewer outfalls to the Harbor

- **Below-Ground Flood Pathways** – Groundwater cutoff walls are proposed to reduce the influence of tides and storm surges on inland groundwater levels. New groundwater management systems consisting of underdrain systems to collect and convey groundwater to storage and pump systems are also proposed to maintain safe groundwater levels without exposing existing wood piles to rot and degradation by marine borers.
Building Consensus
The proposed district-wide flood resiliency system was developed in close coordination with the waterfront property owners – on whose property the flood resiliency systems must be installed. **The resulting proposed flood resiliency plan represents a consensus resilience solution supported by each of the district’s Waterfront Property owners.**

The status of the project’s engagement with each waterfront property is summarized in the table below.

<table>
<thead>
<tr>
<th>Waterfront Property</th>
<th>All Workshops Complete</th>
<th>Preferred System Identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marriott Long Wharf</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Boston Harbor City Cruises</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>255 State / Frog Pond Park</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>New England Aquarium</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Harbor Garage</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Harbor Towers</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Rowes Wharf</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>400 Atlantic</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Williams Building (US Coast Guard)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>James Hook &amp; Company</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Independence Wharf</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Intercontinental Hotel Condos</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Atlantic Wharf</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Public Works Department / PIC</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Rose Kennedy Greenway</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Christopher Columbus Park / Long Wharf</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Wharf District Flood Resiliency Plan
Resiliency Strategies

The proposed resiliency plan is comprised of the five following resiliency strategies, which are integrated into a single cohesive flood protection system to provide a contiguous line of protection along the Waterfront that will protect the entire Wharf District. Before each strategy was run through the multi-criteria assessment, a Coastal Structures Assessment was conducted, and the results can be found in Appendix F.

Over Water – This strategy elevates the ground elevation at the existing seawall location and cantilevers a new decking system for the Harborwalk over the water.

Elevated Dock – This strategy is identical to the Over Water strategy except it incorporates floating docks on the water to facilitate water transportation and access.
Elevated / Constructed Harbor Walk – This strategy infills the Harbor outboard of the existing seawall and creates new elevated open space and Harborwalks.

Elevated / Constructed Land – This strategy elevates the existing ground to create a flood protection landform. Surface materials vary and include landscaped berms as well as hardscape walkways and Harborwalks.

Floodwall – The use of floodwalls for the district-wide system is limited to roadways and immediately adjacent to existing walls and solid building facades.

The resiliency strategy images in this section are from the Coastal Resilience Solutions for Downtown and North End Report, except for the Floodwall image which was created by Arup and Halvorson.
The Wharf District Flood Resiliency Plan is indicated in the image to the right.

This comprehensive, district-wide plan is divided into the six Sub-District Resiliency Projects indicated hereon and described in further detail in the subsequent section of this report.
Resilience Zones

The Wharf District Flood Resiliency Plan includes the creation of several Secondary Flood Protection Systems that connect the flood protection system at the waterfront to inland high points – creating three self-contained Resilience Zones within the district to reduce risks of widespread flooding associated with single points of failure anywhere in the system.

The Secondary Flood Protection systems indicated in green in the diagram to the right create the three Resilience Zones identified on the following page.
Flood Resilience Zones
Waterfront Access

To provide equitable access to the waterfront, safe transportation into, out of, and around the waterfront, and create opportunities for new public waterfront recreational and cultural amenities, the Plan maintains or increases the width of the existing Harborwalk at all locations and increases existing Harborwalk areas, public open space areas, and dock areas within each Sub-District Project, as shown on the table below.

Across the entire district, the Plan creates 21,150 square feet of new Harborwalk, 90,890 square feet of new publicly-accessible open space area, and 2,190 linear feet of new docks.

### Preserving and Improving Waterfront Access

<table>
<thead>
<tr>
<th>Sub-District Project</th>
<th>Harborwalk Area</th>
<th>Publicly-Accessible Open Space Area</th>
<th>Dock Length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing (SFT)</td>
<td>Proposed (SFT)</td>
<td>Difference (%)</td>
</tr>
<tr>
<td>Long Wharf</td>
<td>60,840</td>
<td>78,150</td>
<td>128%</td>
</tr>
<tr>
<td>Central Wharf</td>
<td>26,900</td>
<td>27,070</td>
<td>101%</td>
</tr>
<tr>
<td>Harbor Towers</td>
<td>11,160</td>
<td>11,190</td>
<td>100%</td>
</tr>
<tr>
<td>Rowes Wharf</td>
<td>15,950</td>
<td>16,060</td>
<td>101%</td>
</tr>
<tr>
<td>Northern Ave.</td>
<td>3,250</td>
<td>6,190</td>
<td>190%</td>
</tr>
<tr>
<td>Fort Point Channel</td>
<td>17,420</td>
<td>18,010</td>
<td>103%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>135,520</strong></td>
<td><strong>156,670</strong></td>
<td><strong>116%</strong></td>
</tr>
</tbody>
</table>
Multiple Benefits

Many potential opportunities to better connect our community to the Harbor and enhance our environment may be unlocked with the implementation of this Plan, as illustrated on this page. **We anticipate that these opportunities will need to be further discussed, planned, and designed through subsequent community engagement initiatives.**

Opportunities for Multiple Benefits
Stormwater Storage

New storm drainage infrastructure – shown on the following page – is proposed to mitigate the risks of rainfall causing flooding on the ‘dry-side’ of the flood protection system. The proposed drainage infrastructure includes extensive new underground stormwater storage and pump systems, drainage pipes, and tide gates on municipal drainage outfall pipes to the Harbor.

These new drainage systems are proposed to manage rain falling within the Wharf District’s rainfall catchment areas indicated on the image to the right.
Stormwater Storage Areas
Sub-District Projects

The following pages provide additional details for each of the six Sub-District Flood Resiliency Projects, including rendered plans and sections, a summary of key considerations and multicriteria assessment findings, and conceptual engineering plans specific to each Project.
Long Wharf Flood Resiliency Plan
Long Wharf Existing Conditions
**Long Wharf**

The BPDA and Parks and Recreation Department are planning to initiate separate flood resiliency projects for Long Wharf and Christopher Columbus Park. These projects will include public engagement in the design of the flood protection and urban realm improvements.

The Long Wharf Sub-District Flood Resiliency Project will need to be closely coordinated with the Central Wharf Flood Resiliency Project and resiliency initiatives for the North End. Stormwater management needs to be considered as major overland rainfall pathways for the Wharf District run through the Project Area. The project will need to avoid adding structural loads to the MBTA’s Blue Line tunnel. Vehicle access must be maintained to the Harborwalk, all seawalls, around all sides of all buildings, and truck access to the Marriott loading dock must be maintained. Water transportation operations should be maintained or improved, including providing new switchback gangway systems from the elevated Harborwalk to floating docks, and phasing construction to occur during the off-season.

The Proposed Flood Protection System is designed to be constructed in two phases. **Phase 1** is proposed to provide district-wide flood protection in the near-term before the more intensive Phase 2 Flood Protection system is constructed in the mid-term. The Phase 1 system proposes to elevate the existing grade within Christopher Columbus Park, install a floodwall along the existing solid north and east walls of the Marriott, and elevate the Long Wharf driveway above the elevation of the 2070 Highest Astronomical Tide elevation. A deployable flood barrier is proposed across this elevated Long Wharf driveway to protect the Wharf District from storm surge flooding. As this system does not protect buildings located east of the Marriott, wet- and/or dry-floodproofing strategies will need to be employed at each of these buildings.

**Phase 2** extends the flood protection system installed during Phase 1 to provide a full line of protection along the water’s edge to the east end of Long Wharf. A small area of fill is proposed outboard of the existing seawall adjacent to the Customs House Block to construct new public land needed to avoid creating a vertical flood wall along this historic property, as well as to maintain access to the adjacent marina. To accommodate this fill area, several boat berths will be relocated to new floating breakwaters.

The Proposed Flood Protection System includes:
- Opportunities for Nature Based Solutions, such as living shorelines, outboard of the seawall at the Park.
- Opportunities to expand water transportation, including floating breakwaters with walkways and boat moorings, and options for a new water transportation terminal.
- New shade trees and structures along the southside of Long Wharf to improve heat resilience for visitors and workers at this active water transit hub.
- A groundwater management system, stormwater storage system, and pump station to mitigate flood risks associated with rainfall and rising groundwater.

**A Secondary Flood Protection System** is proposed to compartmentalize flood protection between the North End and the Wharf District. This system consists of elevated land in Christopher Columbus Park, deployable barriers at roadways and walkways, and waterproofing several existing retaining walls along the Greenway.
Long Wharf Flood Protection System – Phase 1

This plan summarizes Phase 1 of the preferred flood protection system for Long Wharf. Phase 1 is intended to be installed in the near-term (2020s-2030s).

**NOTES:**

1. Install new underdrain system in State Street.
2. Install drain pipe to convey excess rainfall from the Major Rainfall Path at Old Atlantic Ave to new stormwater storage systems at the Aquarium, Harbor Towers, and Rowes Wharf.
3. Reconstruct Boston Harbor City Cruises structures to meet raised grades.
4. Reduce width of Long Wharf roadway to 21-feet wide minimum. Maintain tractor trailer truck access to Marriott loading dock. Facilitate delivery, maintenance, and emergency vehicle access on raised Harborwalk to east end of pier.
5. Maintain existing docks and dock access.
6. Provide wet- and/or dry-flood-proofing strategies at the Chart House, Custom House, and MBTA Emergency Egress.
7. Potential opportunity area for inland water transportation terminal / public open space / parking.
8. Potential opportunity area for floating water transportation terminal.
9. Provide Redundant Flood Protection System to compartmentalize flood protection between the North End and the Wharf District. System to consist of elevated land in the Park, deployable barriers at roadways / walkways, and existing retaining walls along the Greenway.
10. Install an underground stormwater storage and pump system at Christopher Columbus Park to capture and manage storm flows from municipal outfall pipes during storm surge events.
11. Install manual sluice gates and automatic tide gates on storm sewer outfall pipes in the Park.
12. Coordinate transition to North End flood protection systems.
This plan summarizes Phase 2 of the preferred flood protection system for Long Wharf. The solution can be broken down into two phases: mid-term (2040s - 2060s) and long-term (2070s) to meet the increasing flood elevations.

**PLAN VIEW**

- **Long Wharf Flood Protection System – Phase 2**

**SITE ELEVATION, FLOOD DEPTHS & PHASING CONSIDERATIONS**

- **19.3’ (5.88) Significant wave action**
- **18.6’ (5.66) Moderate wave action**
- **17.4’ (5.28) Minimal wave action**
- **15.0’ (4.57) Target DFE (Near-Term)**
- **11.8’ (3.60) +/- 1.0’ 2070 Estimated Highest Astronomical Tide (HAT)**
- **10.8’ (3.29) +/- 1.0’ 2070 Estimated Sunny-day high tide**
- **9.0’ (2.74) +/- 1.0’ 2050 Estimated Sunny-day high tide**

**NOTES:**

1. Install new groundwater management underdrain system around Long Wharf.
2. Install drain pipes to connect groundwater management system to storage and pump station at Christopher Columbus Park.
3. Relocate two (2) existing ship berths to new floating breakwaters.
4. Reduce width of Long Wharf roadway to 21-feet wide minimum. Facilitate delivery, maintenance, and emergency vehicle access to east end of pier.
5. Potential opportunity area for floating water transportation terminal / public open space.
6. Potential opportunity area for inland water transportation terminal / public open space / parking.
North Resilience Zone Secondary Flood Protection System Plan

Install 5-foot tall flood wall or seating wall to elevation 15.0’ along vegetation area at the Armenian Heritage Park (near-term). Install 23-inch tall glass flood wall on top of wall to elevation 16.9’ (long-term).

Raise existing wall adjacent to existing ramp to elevation 15.0’ (near-term). Increase wall height by 23-inches to elevation 16.9’ (long-term).

Install 5-foot tall deployable flip-up flood gates across Atlantic Avenue and adjacent sidewalks (near-term).

Elevate lawn and walkway areas within Christopher Columbus Park to by 2-feet to 5-feet to elevation 15.0’ (near-term). Raise an additional 23-inches or install 23-inch tall seating wall or flood walls to elevation 16.9’ (long-term).

Wharf District Council Conceptual District Protection & Resilience Plan

Flood Protection System Redundant Alignment Armenian Heritage Park

Plan Status: Draft Conceptual Sketch
Date: March 20, 2023

Plan Intent:
This plan summarizes a redundant district scale flood protection system in the vicinity of the Armenian Heritage Park.

Resiliency System Description:
System to consist of elevated land in the Park, deployable barriers at roadways / walkways, and existing retaining walls along the Greenway.

LEGEND:

- FLOOD PROTECTION SYSTEM REDUNDANT ALIGNMENT
- DEPLOYABLE FLOOD BARRIER
- ELEVATED LAND
- PROPOSED SPOT GRADE ELEVATION

ARUP
Central Wharf Existing Conditions
Central Wharf Flood Resiliency Plan
Central Wharf Existing Conditions
Central Wharf Flood Resiliency Plan
**Central Wharf**

The Central Wharf Sub-District Flood Resiliency Project will need to be closely coordinated with the Long Wharf Flood Resiliency Project. Vehicle access must be maintained to the Harborwalk at the east end of Central Wharf, to the Aquarium loading dock, and around all sides of all buildings in the project area. Stormwater management needs to be considered as a major overland rainfall pathway for the Wharf District runs through the Project Area. An existing 72”x72” box stormwater culvert located under Central Wharf may need to be reconstructed or rehabilitated to accommodate additional structural loading associated with the elevated Harborwalk.

Old Atlantic Avenue must be narrowed to provide the land necessary to install a gentle transition from existing grades up to the elevated Harborwalk at the Design Flood Elevation, such that the existing Harborwalk is not narrowed, existing public open space is not reduced, and water transportation is not negatively impacted. Options for narrowing Old Atlantic Avenue are included on the Old Atlantic Avenue Reconstruction Sketches, and includes converting Old Atlantic Avenue and Central Street to a “shared street” by raising roadway surfaces to match sidewalk elevations and incorporating Complete Street strategies to prioritize pedestrian safety in the area.

The majority of the Proposed Flood Protection System is proposed along the water’s edge at Central Wharf. Three areas of fill are also proposed outboard of the existing seawall to accomplish the following objectives:

- Protect the existing theater, which is currently located on a decking system over the water.
- Construct new wave attenuation islands to reduce wave heights and erosion impacting the area.
- Relocate and improve outdoor programmable area impacted by the construction of the new flood protection systems in the project area.

The Flood Protection System includes:

- Opportunities to expand water transportation and access, including new floating breakwaters with walkways and boat moorings.
- Wave attenuation islands to reduce wave heights, while providing opportunities for Nature Based Solutions such as living shorelines and floating wetlands, access to ‘touch’ the water, and outdoor educational programs associated with resiliency and marine ecosystems.
- A net increase of approximately 1,000 square feet of new outdoor programmable space at Central Wharf, not including potential programmable space on the proposed wave attenuation islands.
- Opportunities for new shade trees and structures along the southside of Central Wharf to improve heat resilience for visitors and workers.
- A groundwater management system and underground stormwater storage system to mitigate flood risks associated with rainfall and rising groundwater.
- A stormwater treatment system to improve water quality of stormwater discharged to the Harbor.
Central Wharf Flood Protection System Plan

This plan summarizes the preferred flood protection system. The solution can be broken down into two phases: near-term (2020s-2030s) and long-term (2040s-2070s) to meet the increasing flood elevations.

**PLAN VIEW**

- **ELEVATED DOCK @ WATER’S EDGE ALIGNMENT**
  - Raise Harborwalk and install flood wall on top of seawall to elevation 17.4-ft (Long-term).
  - Raise harborwalk 6 to 8 feet to elevation 15.0-ft and cantilever walkway deck over water to maintain existing Harborwalk width (Near-term).
  - Remove existing Harborwalk. Install new steel sheetpile wall in front of existing seawall to mudflats. Install new seawall to elevation 15.0-ft (Near-term).
  - Construct new floating breakwater with walkway for access to water and relocated ship mooring at locations indicated on plan (Near-term).
  - Install glass flood wall on top of seawall to elevation 17.4-ft (Long-term).
  - Raise harborwalk 7 feet to elevation 15.0-ft with planting soil below surface for future shade trees. Provide dock access (Near-term).
  - Install social/stepped landform and/or planting beds to soften transition to elevated Harborwalk. Width and design of landform to vary to integrate ADA access and local programming. Provide intermittent shade structures (Near-term).
  - Reduce width of Old Atlantic Avenue (Near-term).
  - Provide 10-ft wide, 5% sloped walkway up to Harborwalk (Near-term).
  - Remove existing Harborwalk dock and seawall, install new seawall to elevation 15.0-ft (Near-term).
  - Install glass flood wall on top of seawall to elevation 17.4-ft (Long-term).
  - Install decking to raise harborwalk 5 feet to elevation 15.0-ft. Provide dock access (Near-term).
  - Install social/stepped landform and/or planting beds to soften transition to Elevated Harborwalk. Width and design of landform to vary to integrate ADA access and local programming (Near-term).
  - Install new seawall in front of old to elevation 15.0-ft (Near-term).
  - Install revetment or living shoreline (Near-term).

**EXISTING SITE ELEVATIONS & TARGET DESIGN FLOOD ELEVATION**

- **NOTES:**
  1. Relocate vehicle drop-off spaces and bus stop from Old Atlantic Avenue to adjacent roadways.
  2. Install new underdrain system around the Aquarium, and an underground stormwater storage and treatment system at the Aquarium plaza to manage groundwater levels and provide water quality treatment of stormwater. Install overflow connection from existing 72" x 72" stormwater culvert to the new system.
  3. Install drain pipe to convey excess rainfall from the Major Rainfall Path at Old Atlantic Avenue and Aquarium storage system to new stormwater storage systems at the Harbor Towers and Rowes Wharf.
  4. Maintain access to all existing docks.
  5. Reconstruct or rehabilitate existing 72" x 72" stormwater outfall pipe to accommodate additional structural loading, and install manual sluice gate and automatic tidegate at outlet.
  6. Facilitate delivery and emergency vehicle access on raised Harborwalk to east end of pier.
  7. Construct new flood protection islands to mitigate wave action at the existing wharfs and componecna for reduced programmable open space associated with the Elevated Dock strategies.
  8. Proposed plaza space to replace the programmable space lost from Elevated Dock strategies.
Central Wharf Flood Protection System Plan – Old Atlantic Avenue Reconstruction

RELOCATE VEHICLE PICK-UP / DROP-OFF SPACES AND MBTA LONG WHARF BUS STOP FROM OLD ATLANTIC AVENUE TO STATE STREET AND/OR ATLANTIC AVENUE

HARBORWALK; WIDTH VARIES (15’ - 18’)

10-FOOT WIDE, 5% SLOPE SIDEWALK UP TO HARBORWALK.

CONVERT OLD ATLANTIC AVENUE AND CENTRAL STREET TO SHARED STREETS BY RAISING ROADWAY SURFACES TO MATCH SIDEWALK ELEVATIONS

10-FOOT WIDE, 5% SLOPE WALKWAY WITH PERMANENT EASEMENT FOR SIDEWALK
Harbor Towers Flood Resiliency Plan
Harbor Towers Existing Conditions
Harbor Towers Flood Resiliency Plan
Harbor Towers Existing Conditions
**Harbor Towers**

The Harbor Towers Sub-District Flood Resiliency Project will need to be closely coordinated with the Central Wharf and Rowes Wharf Flood Resiliency Projects.

The Flood Protection System is proposed at the water’s edge along the north side of the property, maintaining access to the India Wharf Marina. Fill is proposed outboard of the existing seawall along the eastern edge of the property to accomplish the following objectives:

- Create new public open space with Harbor views.
- Create land necessary for a subsurface stormwater storage and pump system to reduce rainfall-based flooding for a significant area of the Wharf District (the North Resilience Zone).
- Minimize impacts to views of the Harbor from existing public open spaces by creating the land necessary to provide a gentle transition from existing grades up to the elevated Harborwalk at the Design Flood Elevation.
- Increase the width of the Harborwalk.
- Replace the existing seawalls, which were observed to have localized areas of deterioration.

The proposed Flood Protection System includes:

- A living shoreline and new public water access between Harbor Towers and the Aquarium.
- New public open space along the waterfront.
- Opportunities to improve water access and recreation, including new floating breakwaters with walkways and boat moorings.
- A stormwater storage and pump system to reduce flood risks within the North Resilience Zone associated with rainwater falling on the ‘dry-side’ of the flood protection system.

**Secondary Flood Protection System** is proposed to create self-contained Resilience Zones within the Wharf District to reduce risks of wide-spread flooding associated with single points of failure. This Secondary Flood Protection System forms the southern leg of the proposed North Resilience Zone, and includes a new floodwall between Harbor Towers and Rowes Wharf, a deployable flood gate across Atlantic Avenue, and elevating land within the Greenway by 1 – 2 feet on average.

Refer to the Rowes Wharf Secondary Flood Protection System Plan provided in the Rowes Wharf Sub-District Flood Resiliency Project section of this report for additional details associated with the Secondary Flood Protection System.
Harbor Towers Flood Protection System Plan

This plan summarizes the preferred and redundant flood protection systems. The solution can be broken down into two phases: near-term (2020s-2030s) and long-term (2040s-2070s) to meet the increasing flood elevations.

### PLAN VIEW

**LEGEND:**
- PREFERRED SYSTEM, WATERS EDGE
- PREFERRED SYSTEM, OUTBOARD
- ALTERNATIVE SYSTEM, WATERS EDGE
- ALTERNATIVE SYSTEM, OUTBOARD
- REDUNDANT ALIGNMENT
- FLIP UP FLOOD BARRIER
- NEW PUBLIC OPEN SPACE
- BREAKWATER
- STORM DRAIN PIPE
- HARBOURWALK
- ADA ACCESS TO HARBOURWALK

**EXISTING SITE ELEVATIONS & TARGET DESIGN FLOOD ELEVATION**

- **Distance from Waterfront**
  - Depth of Flooding
  - 19.3' (26.0') Significant wave action
  - 18.0' (24.0') Moderate wave action
  - 17.2' (23.4') Minimal wave action
  - 15.0' (21.5') Target DFE (Near-term)
  - 10.8' (17.3') +/-1.0' 2070 Sunny day high tide
  - 5.0' (15.5') +/-1.0' 2050 Sunny-day high tide

**NOTES:**
1. New public open space behind flood protection system. Southern limit connection of fill to be coordinated with Rowes Wharf.
2. New below ground stormwater storage tank with above-grade pump house built into flood protection berm to manage water levels in the stormwater storage systems at the Central Wharf, Harbor Towers, and Rowes Wharf.
3. New drain pipe to convey excess rainfall from the Major Rainfall Path at Old Atlantic Avenue to new stormwater storage systems at Central Wharf, Harbor Towers, and Rowes Wharf.
4. Floating breakwater to include walkway for public access to water and moorings for boats. Locations are indicative and are to be determined during detailed design. (Near-term)
5. Provides redundant flood protection system to compartmentalize flood protection from Christopher Columbus Park to Harbor Towers. System to consist of a new elevated berm along the North Building of Rowes Wharf, a new floodwall abutting existing retaining walls north of the walkway between Harbors Towers and Rowes Wharf, a deployable flood gate across Atlantic Avenue roadway and sidewalks, and elevated land and seating walls through the Greenway. Replace trees impacted by installation of new walls and elevated land. (Near-term)
Rowes Wharf Flood Resiliency Plan
Rowes Wharf Existing Conditions
Rowes Wharf Flood Resiliency Plan
**Rowes Wharf**

The Rowes Wharf Sub-District Flood Resiliency Project will need to be closely coordinated with the Harbor Towers and Northern Avenue Flood Resiliency Projects. The project should facilitate building-level flood protection measures currently being planned by Rowes Wharf to address immediate and near-term flood risks to the buildings. These building-level protections will also provide a secondary level of protection for each building once the district-scale flood protection system is implemented in the mid-term. Emergency vehicle access to all buildings and the Harborwalk will need to be maintained.

The Flood Protection System is proposed outboard of the existing Harborwalk along the north side of the property where a new flood protection landform will be constructed. Along the south side of the property, a new seawall is proposed along the edge of the existing Harborwalk, outboard of the existing seawall. A series of new stormwater storage tanks are proposed to be installed beneath the three Wharf Buildings, and backfill will be placed to fill the area around these tanks between the existing seawall and new seawalls and flood protection landforms – creating a new outdoor plaza area between the North and Central Wharf buildings. Water levels in the stormwater storage tanks will be controlled by a new pump system at the Harbor Towers site. The floor of the gazebo will be raised above the height of the 2070 tidal elevations, and a new walkway will be provided to the gazebo. The existing MBTA commuter ferry and floating stage will be maintained. Existing docks located between the North and Central Wharf Buildings will be relocated to a new floating breakwater outboard of the new flood protection landform.

The proposed Flood Protection System includes:
- New open space along the waterfront.
- Opportunities to improve water access and recreation, including new floating breakwaters with walkways and boat moorings.
- Extensive stormwater storage to reduce flood risks within the entire Wharf District associated with rainwater falling on the ‘dry-side’ of the flood protection system.
- Secondary flood protection systems to add resiliency to the district as a whole by preventing flood pathways between the North and South Resilience Zones.

A **Secondary Flood Protection System** is proposed to create self-contained Resilience Zones within the Wharf District to reduce risks of wide-spread flooding associated with single points of failure. This Secondary Flood Protection System forms the northern leg of the proposed South Resilience Zone. Mid-term components of this system include modifying existing walkway ramps and walls to serve as flood protection systems within the alley between Rowes Wharf and Atlantic Avenue, a deployable flood gate across Atlantic Avenue, and elevating land within the Greenway by 1 – 2 feet on average. The remainder of the Secondary Flood Protection System is intended to be installed in the long-term, and includes raising the height of the existing retaining walls along the I-93 tunnel ramps, and providing deployable flood gates across High Street and Purchase Street.
Rowes Wharf Flood Protection System Plan

This plan summarizes the preferred flood protection system. The flood protection system can be installed in two phases: mid-term (2040s-2060s) and long-term (2070s) to meet the increasing flood elevations. Building-level flood resiliency strategies are also recommended in the near term (through the 2030s) to protect individual buildings from flood hazards prior to the installation of the district-wide flood protection system.

**LEGEND:**
- **PREFERRED SYSTEM @ OUTBOARD ALIGNMENT**
- **PREFERRED SYSTEM @ WATER’S EDGE ALIGNMENT**
- **REDUNDANT ALIGNMENT**
- **FLIP-UP FLOOD BARRIER**
- **BREAKWATER**
- **MAGENTA ZONE BOUNDARY**
- **NEW OPEN SPACE OVER NEW STORMWATER STORAGE SYSTEM**
- **HARBORWALK**
- **ADA ACCESS TO HARBORWALK**
- **REFER TO NOTES**

**EXISTING SITE ELEVATIONS & TARGET DESIGN FLOOD ELEVATION**

**PREFERRED FLOOD PROTECTION SYSTEM NOTES:**
1. Install new vegetated open space on new fill. Install new stormwater storage tanks below open space and North Wharf Buildings to provide storage to manage rainfall for the Wharf District. Water levels within the new stormwater storage area to be maintained by a pump system to be installed at Harbor Towers (Mid-term).
2. Floating breakwater with walkway for relocated ship mooring & access to water (mid-term).
3. Relocate existing docks to outside of flood protection berm (mid-term).
4. Relocate Ticketing Office and provide new ramp from the elevated harborwalk to the South Wharf Building in alley between Rowes Wharf and 400 Atlantic (mid-term).
5. Maintain existing Gazebo and floating stage. Raise Gazebo floor above 2070 Highest Astronomical Tide. Replace existing bridge to the Gazebo with a new pedestrian bridge from the elevated Harborwalk (mid-term).
6. Raise Harborwalk to elevation 12.2 ft adjacent to the Wharf Buildings, and to 12.9 ft adjacent to the plaza area between Atlantic Avenue building and the Wharf Buildings (mid-term).
7. Install 4.5-ft floodwall on top of capping beam to elevation 19.5 ft, where there is no breakwater (long-term).
8. Maintain access to the existing tourist and ferry boat.
9. New drain pipe to convey excess rainfall from the Major Rainfall Path at Old Atlantic Avenue to new stormwater storage systems at Central Wharf, Harbor Towers, and Rowes Wharf.

**REdundANT FLOOD PROTECTION SYSTEM NOTES:**
1U Provide redundant system from 4UW Atlantic Avenue to the Hone Kennedy Greenway (mid-term).
Rowes Wharf Secondary Flood Protection System Plan

- Install a new 4-ft to 5-ft floodwall to Elevation 15.0’ abutting the existing north face of the existing landscape wall (near-term).
- Raise wall 26-inches to elevation 17.2” (long-term). Replace trees impacted by installation of new walls and elevated land.

- Install 5-foot tall deployable flip-up flood gates across Atlantic Avenue and adjacent sidewalks (near-term).

- Elevate landscape area by 3-feet to elevation 15.0’ (near-term). Install 26” tall flood wall on top of landscape to elevation 17.2” (long-term).

- Elevate walkway 3-feet to elevation 15.0’ (near-term). Install 26-inch tall flood wall / seating wall along one side of walkway and 26-inch tall deployable flood gate across walkway (long-term).

- Elevate plaza 2-feet to elevation 15.0’ at alignment (near-term).

- Install 26-inch tall deployable flip-up flood gates across High Street and Purchase Street and adjacent sidewalks/plazas to elevation 17.2’, and connect to I-93 ramp retaining walls; alternatively consider raising roadways with lightweight fill to elevation 17.2’ (long-term).

- Elevate walkway and landscaping between I-93 ramps 1-foot to elevation 16.9’ at location indicated by spot grade (long-term).

- Extend I-93 ramp retaining walls to elevation 16.9’ (long-term).

- Elevate landscape area by 3-feet to elevation 15.0’ (mid-term). Install 23-inch tall flood wall on top of landscape to elevation 16.9’ (long-term).

- Raise existing wall adjacent to existing ramp to elevation 15.0’, full length of alleyway, with deployable flood gate at entrance to new ramps for access (mid-term). Increase deployable flood gate height by 23 inches to elevation 16.0’, and increase wall height with glass flood wall full length of alleyway (long-term).

- Install 5-foot tall deployable flip-up flood gates across Atlantic Avenue and adjacent sidewalk (mid-term).

- Replace existing ramp with new ramp down to elevation 9.0’ to tie into existing Harborwalk at Rowes Wharf (mid-term).

- Raise existing ramp to elevation 15.0’ to tie into elevated Harborwalk at 400 Atlantic Avenue (mid-term).

Wharf District Council Conceptual District Protection & Resiliency Plan

Flood Protection System Redundant Alignment
Central Resiliency Zone

Date: March 27, 2023

Plan Intent:
This plan summarizes a redundant district-scale flood protection system in the vicinity of Rowes Wharf.

Resiliency System Description:
The City of Boston has planned for district-scale flood protection systems from Christopher Columbus Park to Harbor Towers to be constructed by 2030, and from Rowes Wharf to the Fort Point Channel to be constructed from 2050 to 2070. The northern half of the redundant resiliency system identified hereon (from Harbor Towers to the intersection of Purchase Street and High Street) is therefore proposed to prevent flood pathways through Rowes Wharf from flanking those flood protection systems proposed north of Rowes Wharf prior to construction of the district-scale flood protection system at Rowes Wharf.

The southern half of the redundant resiliency system identified hereon is intended to provide redundancy with the district-scale flood protection system at Rowes Wharf, to protect properties and infrastructure in the Wharf District.

LEGEND:
- FLOOD PROTECTION SYSTEM
- REDUNDANT ALIGNMENT
- DEPLOYABLE FLOOD BARRIER
- ELEVATED LAND
- PROPOSED SPOT GRADE ELEVATION
- PRIMARY FLOOD PROTECTION SYSTEM ALIGNMENT
Northern Avenue Flood Resiliency Plan
Northern Avenue Existing Conditions
Northern Avenue

The Northern Avenue Sub-District Flood Resiliency Project will need to be closely coordinated with the Rowes Wharf Flood Resiliency Project and future development plans for the Northern Avenue bridge. Existing intake pipes from the Harbor to the James Hook + Company pump system will need to be maintained. The elevated Harbor walk along the Williams Building will need to be constructed of non-flammable materials to facilitate emergency egress from the building. Coordination with equipment and loading dock access at the Williams Building will need to be considered. Privacy screening will need to be provided between the Harborwalk and the existing private deck at 400 Atlantic Avenue.

Refer to the Fort Point Channel Sub-District Flood Resiliency Project summary on the subsequent pages of this report for further discussion related to the potential conversion of Northern Avenue Bridge to a flood gate.

The Flood Protection System is proposed along the existing seawalls from Seaport Boulevard the Williams Building at 406 Atlantic Avenue. A new cut-off wall is proposed along the edge of the existing Harborwalk, outboard of the existing seawall at 400 Atlantic Avenue. The area between the existing seawall and new cut-off wall is proposed to create a stormwater storage area, with water levels controlled by a new pump system in Northern Avenue or the new public open space at the James Hook + Company site. A deployable flood gate is proposed at Seaport Boulevard, and a second deployable flood gate is proposed at the Northern Avenue Bridge to provide flexibility for the future redevelopment of this bridge.

The proposed Flood Protection System includes:
• New public open space on a new decking system at the James Hook + Company site.
• A new pedestrian bridge to public access and visibility of the Harborwalk, creating a new inviting ‘gateway’ from the Seaport Boulevard bridge sidewalk to this new public waterfront open space.
• Opportunities to improve water access and recreation, including new floating breakwaters with walkways and boat moorings.
• A stormwater storage and pump system to reduce flood risks within the South Resilience Zone associated with rainwater falling on the ‘dry-side’ of the flood protection system.
Northern Avenue Flood Protection System Plan

This plan summarizes the preferred flood protection system. The solution can be broken down into two phases: mid-term (2040s-2060s) and long-term (2070s) to meet the increasing flood elevations.

### PLAN VIEW

ELEVATED DOCK @ WATER’S EDGE ALIGNMENT
- Install 2.5-ft tall flood wall on top of new cutoff wall to elevation 17.5-ft (long-term).
- New necking system to elevate Harborwalk 6 ft. feet to elevation 13.0-ft to 15.0-ft (mid-term).
- New floating breakwater with walkway for access to water and relocated ship mooring (mid-term).

OVER WATER @ WATER’S EDGE ALIGNMENT
- Raise solid flood wall 3.5-feet above existing floodwall to elevation 17.5-ft, and install additional 2-foot tall glass flood wall to elevation 19.5-ft (long-term).
- New suway cut-off wall beneath existing seawall, with flood wall above ground. Height of wall above existing ground = 2.0-ft. Top of wall elevation 14.0-ft (mid-term).
- New pier-supported deck system with open plaza space and Harborwalk. Top of deck elevation to vary from existing deck elevation at 12.5-ft to top of new cutoff wall at elevation 14.0-ft (mid-term).
- Install fill or deck system to transition from existing ground to new deck system at elevation 14.0-ft (mid-term).

### SITE ELEVATION, FLOOD DEPTHS & PHASING CONSIDERATIONS

- Install new pedestrian bridge from Seaport Blvd sidewalk to Harborwalk on new deck system.
- Install manual sluice gate and automatic tidegate at existing combined sewer overflow.
- Install drain pipes to convey overflow from the combined sewer to the stormwater storage system between the existing and new seawalls. Install underdrain system along inland side of new cut-off walls with discharge to the new drain pipe to convey flows to the stormwater storage system.
- Install a new pump system in Northern Avenue or new public space to manage water levels in the stormwater storage system.
- Provide privacy screening between elevated Harborwalk and existing private deck at 400 Atlantic Avenue.
- Connect cut-off wall to existing seawall if constructed prior to Rowes Wharf project.
- Alternative Flood Protection System: Convert Northern Avenue bridge into a flood gate to protect all upstream properties along the Fort Point Channel.
Fort Point Channel Flood Resiliency Plan
**Fort Point Channel**

All flood protection systems investigated for this sub-district project area scored “Poor” in the Multi-Criteria Assessment for construction feasibility due to challenges and costs associated with constructing flood protection systems over the MBTA’s Silver Line tunnel and adjacent to the existing Harborwalk over-water decking system, as well as permitting challenges for new construction in the navigable waters of the Fort Point Channel. Additionally, all waterfront building’s first floor elevations and critical infrastructure identified in this area are higher than the anticipated 2070 Highest Astronomical Tide elevation, and therefore are anticipated to only require protection from storm surge – but not ‘sunny-day’ tidal flooding. **With the support of each waterfront property owner from Rowes Wharf to Atlantic Wharf, we therefore strongly recommend the City of Boston further investigate the construction of a Fort Point Channel Storm Surge Barrier at the current Northern Avenue Bridge location in lieu of constructing a waterfront flood protection system between Northern Avenue and Congress Street.** A conceptual illustration of this Fort Point Channel Storm Surge Barrier prepared by the BWSC is provided on the following page.

Regardless of the district-scale resiliency system ultimately implemented, near-term building-level flood protections are recommended to be installed at each waterfront building to provide a secondary level of protection for each building.

The following narrative and subsequent plans describe the recommend flood protection system for the Fort Point Channel Sub-District Flood Resiliency Project if a Fort Point Channel Storm Surge Barrier is not constructed.

The Fort Point Channel Sub-District Flood Resiliency Project will need to be closely coordinated with resiliency initiatives south of Congress Street along Dorchester Ave.

The Fort Point Channel Flood Protection System Plan illustrates the flood protection system proposed if the Fort Point Channel Storm Surge Barrier is not constructed. The system is proposed along the existing seawall at the north side of Independence Wharf. A new cut-off wall is proposed along the edge of the existing Harborwalk, outboard of the existing seawall for the remainder of the project area. The area between the existing seawall and new cut-off wall is proposed to provide a stormwater storage, with water levels controlled by a new pump system at the Intercontinental Hotel Condos site. Access for maintenance of Harborwalk and building piles will need to be maintained. A deployable flood gate is proposed at the Congress Street bridge.

The Flood Protection System includes:
- A new decking system to widen the Harborwalk and provide views of the Harbor at Independence Wharf
- New opportunities for water access and recreation, including new breakwaters with walkways and moorings.
- A stormwater storage and pump system to reduce flood risks within the South Resilience Zone from rainwater falling on the ‘dry-side’ of the flood protection system.

A **Secondary Flood Protection System** is proposed to compartmentalize flood protection between the Wharf District and the neighborhoods to the south. This system consists of deployable barriers along the Congress Street sidewalk from the Fort Point Channel to the Greenway, and a deployable barrier across Atlantic Avenue.
Conceptual Solution – Alternate Location

The above graphic depicts an alternate concept for the FPC SSB that is integrated with the planned Northern Avenue Bridge Replacement. The mechanical systems are similar to the other concepts shown previously. This alternate location combines planned renovations to the Northern Avenue Pedestrian Bridge with the FPC SSB into one project. This alternative mitigates the viewshed impact of the SSB on the planned viewing platform of the bridge. Although this concept has not been advanced to the design stage at this time, and it is anticipated that both structures would need to be significantly redesigned, integration of these structures would reduce construction impacts from separate projects. In addition, an integrated project would offer an opportunity for Boston and the Commission to implement an iconic adaption project, with multiple community benefits, that could catalyze funding and coordination for further adaptation efforts.
This plan summarizes the preferred flood protection system. The solution can be broken down into two phases: mid-term (2040s-2060s) and long-term (2070s) to meet the increasing flood elevations. Building-level flood resiliency strategies are also recommended in the near-term (through the 2030s) to protect individual buildings from flood hazards prior to the installation of the district-wide flood protection system.

**PLAN VIEW**

- **PREFERRED SYSTEM**
- **PREFERRED SYSTEM - FLIP-UP FLOOD GATE**
- **PREFERRED SYSTEM - NEW HARBORWALK ON NEW DECKING SYSTEM**
- **REDUNDANT AI / ENMPNT**
- **BREAKWATER WITH WALKWAY FOR MOORING SHIPS**
- **HARBORWALK**
- **DRAIN PIPE**
- **REFER TO NOTES**

**SITE ELEVATION, FLOOD DEPTHS & PHASING CONSIDERATIONS**

**NOTES**

1. Seawall to be sheet pile wall at Atlantic Wharf and InterContinental Hotel, and king pile wall at Independence Wharf. Protect Independence Wharf building from settlement during wall installation.
2. Install sheet pile and king pile walls to approximately 30 feet below mudline either side of MBTA tunnel. Install slurry wall to top of MBTA tunnel, and protect tunnel during installation.
3. Install culverts through seawall and stone wall to allow water to flow through under deck area during normal conditions. Install manual gate valves to close culverts during storm surge events.
4. Install new pump station to control water levels under deck area, and discharge to the Fort Point Channel during storm surge events.
5. Install new Harborwalk at elevation 17.1-feet, located between Independence Wharf and new seawall (mid-term).
6. Provide Redundant Flood Protection System to compartmentalize flood protection between the Wharf District and the neighborhoods to the south. System to consist of deployable barriers along the Congress Street sidewalk and Atlantic Avenue to the existing retaining wall and landfill at the Greenway.
7. Alternative Flood Protection System: Convert Northern Avenue Bridge into a flood gate to protect all upstream properties along the Fort Point Channel. Provide building-level flood protection systems to protect each individual building.
Implementation Timeline

The Wharf District Flood Resiliency Plan is divided into six Sub-District Resiliency Projects. Each project is designed to phase the construction of the proposed resiliency strategies, incrementally increasing the height of the flood protection system as sea levels rise. Strategies are identified to be implemented during near-, mid-, or long-term time horizons, as indicated on the Sub-District Flood Resiliency Project plans, and in the Implementation Timeline on the following page.

District-Scale Flood Protection: District-scale flood protection projects are recommended to be implemented prior to the date when flooding from a 1% flood event is anticipated to impact buildings and critical infrastructure located inland of Atlantic Avenue, as indicated on the Implementation Timeline. Where such buildings and critical infrastructure are already at risk, we recommend district-scale flood protection projects be initiated immediately.

Building-Level Flood Protection:

- **Inland Buildings** – Buildings in the Wharf District located inland of Atlantic Avenue adjacent the Long Wharf, Central Wharf, and Harbor Towers project areas are strongly encouraged to implement building-level resiliency strategies immediately, as most of these properties are at risk of being impacted by over 2 feet of flooding from a 1% flood event this decade. Additionally, such building-level resiliency strategies will create a critical second layer of resiliency for the Wharf District community at each building to protect people and property from risks associated with single points of failure in the district-scale flood protection system.

- **Waterfront Buildings** – Waterfront buildings are recommended to implement building-level resiliency strategies prior to the date when flooding from a 1% flood event is anticipated to impact the waterfront buildings or inland buildings and critical infrastructure, as indicated on the Implementation Timeline.

Building-Level Flood Resiliency Guidelines are provided in Appendix C.
Implementation Timeline

Notes:
- Building Adaptations at individual buildings are recommended to protect waterfront structures anticipated to be exposed to flooding during a 1% storm surge event prior to the construction of the district-wide flood protection system. Building-specific flood adaptations should be identified and implemented by individual property owners based on site-specific conditions, and are not included in the plans or cost estimate provided in this report.

- Long-term strategies for all projects include raising the height of the flood protection system as sea levels rise by raising portions of the Harborwalk, installing glass and/or solid flood walls, and replacing flood gates and stormwater valves installed during the 2020s-2030s as they reach end of their useful life.

- Sea Level Rise is based on Massachusetts specific analysis (DeConto and Kopp, 2017), and consistent with projections being used by the Commonwealth of Massachusetts (Mass. Coastal Zone Management and the Massachusetts Coast Flood Risk Model).
Regulatory Considerations

The following regulatory analysis prepared by VHB is intended to support the processes of securing regulatory approvals for the Wharf District Flood Resiliency Plan (the “Resilience Plan”) based on the conceptual-level plans for each of the Sub-District Resiliency Projects (the “projects”).

Key Findings

- All projects must file a Notice of Intent (NOI) with the Boston Conservation Commission.
- All projects require approval under Chapter 91, most likely in the form of a new or amended license.
- All projects could potentially be approved under the existing Chapter 91 regulations at 310 CMR 9.00. However, specific changes (identified in Table 2 below) would clarify and confirm licensing eligibility.
- All projects are likely to be subject to review under the Massachusetts Environmental Policy Act (MEPA), pending final design, because they require a Chapter 91 License, and they exceed at least one Environmental Notification Form (ENF) threshold (see Table 1 below).
- While no Environmental Impact Report (EIR) thresholds are likely to be exceeded, EIRs would be required due to the projects’ proximity to Environmental Justice (EJ) populations in compliance with MEPA’s EJ Protocols.
- The projects for Long Wharf, Rowes Wharf, Northern Ave, and Fort Point Channel impact historic resources and will require review by the Massachusetts Historical Commission (MHC).
- All projects include work within the FEMA 1% annual chance floodplain. The Long Wharf Phase 1 project includes measures that would be subject to the flood-related portions of the MA Building Code (wet and/or dry floodproofing strategies at the Chart House and Customs House).
- All projects include at least one element in the public right-of-way, and as such would require review by the City’s Public Improvement Commission (PIC).
- The projects at Long Wharf and Central Wharf will require review by and coordination with the Boston Transportation Department (BTD).
- The Long Wharf project will require review by and coordination with the Boston Fire Department (BFD).
- All projects have at least one element within 100 feet of land considered to be a park, and as such would require review by the Boston Parks Commission.
- Consultations with the Massachusetts Department of Environmental Protection (DEP) Waterways Department and MEPA Office are recommended as next steps.
**Cost Estimate, Cost-Effectiveness Assessment, and Funding Opportunities**

**Cost Estimate**

*Summary of Probable Costs*

A rough-order of magnitude estimate of probable construction costs for the Wharf District Flood Resiliency Plan are summarized below. As the Sub-District Resiliency Project plans are at the conceptual level of detail, the accuracy range of this estimate has been determined to be -40% and +65%, reflecting likely bid prices if the project was issued to tender at this current stage. A detailed cost estimate is provided in Appendix E.

### Summary of Probable Construction Costs

<table>
<thead>
<tr>
<th>Total Project Cost Estimate</th>
<th>Long Wharf</th>
<th>Central Wharf</th>
<th>Harbor Towers</th>
<th>Rowes Wharf</th>
<th>Northern Ave</th>
<th>Fort Point Channel</th>
<th>Total Term Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near Term (2030)</td>
<td>$ 70,294,100</td>
<td>$ 114,605,300</td>
<td>$ 64,701,800</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>$ 249,601,200</td>
</tr>
<tr>
<td>Mid Term (2050)</td>
<td>$ 151,364,000</td>
<td>-</td>
<td>-</td>
<td>$ 214,288,100</td>
<td>$ 102,179,200</td>
<td>$ 125,370,100</td>
<td>$ 593,201,400</td>
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<tr>
<td>Long Term (2070)</td>
<td>$ 8,823,500</td>
<td>$ 10,154,400</td>
<td>$ 4,535,000</td>
<td>$ 6,604,100</td>
<td>$ 1,703,500</td>
<td>$ 2,762,400</td>
<td>$ 34,582,900</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$ 230,481,600</strong></td>
<td><strong>$ 124,759,700</strong></td>
<td><strong>$ 69,236,800</strong></td>
<td><strong>$ 220,892,200</strong></td>
<td><strong>$ 103,882,700</strong></td>
<td><strong>$ 128,132,500</strong></td>
<td><strong>$ 877,385,500</strong></td>
</tr>
</tbody>
</table>

![Project Cost by Area and Phase](image)
Comparable Project Costs

The following flood resiliency projects have recently been issued for bid or are currently under construction. The construction cost budgets for each of these projects is broken down per linear foot of protected coastline to provide a point of comparison with the linear foot costs estimated for the Wharf District Flood Resiliency Plan.

<table>
<thead>
<tr>
<th>Project Title</th>
<th>City</th>
<th>Total Project Construction Budget</th>
<th>Linear Feet of Coastline</th>
<th>Cost per Linear Foot of Coastline</th>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>North &amp; West Battery Park City Resiliency Project</td>
<td>NYC</td>
<td>$ 631,000,000</td>
<td>8,000</td>
<td>$ 79,000</td>
<td>Elevated walkways and floodwalls along the coast. Elevated park space with social stairs and walking paths up the elevated flood protection berm.</td>
</tr>
<tr>
<td>Brooklyn Bridge-Montgomery Coastal Resilience (BMCR) Project</td>
<td>NYC</td>
<td>$ 522,000,000</td>
<td>4,800</td>
<td>$ 109,000</td>
<td>Deployable floodwall and gate system with plaza space for pedestrians and bicyclists.</td>
</tr>
<tr>
<td>South Battery Park City Resiliency Project</td>
<td>NYC</td>
<td>$ 221,000,000</td>
<td>2,000</td>
<td>$ 111,000</td>
<td>Integrated flood barrier along the coast, and stormwater system upgrades.</td>
</tr>
<tr>
<td>Wharf District Flood Resiliency Project</td>
<td>Boston</td>
<td>$ 877,385,500</td>
<td>7,800</td>
<td>$ 112,500</td>
<td>Improved park space and facilities, pedestrian bridges, infill, landscaping, and deployable flood gates. Work is located 300 feet or more from the waterfront.</td>
</tr>
<tr>
<td>East Side Coastal Resiliency Project</td>
<td>NYC</td>
<td>$ 1,450,000,000</td>
<td>6,600</td>
<td>$ 220,000</td>
<td></td>
</tr>
</tbody>
</table>
Cost-Effectiveness Assessment

The following Cost-Effectiveness Assessment is intended as a high-level decision-making tool to help stakeholders prioritize impactful projects by weighing the project’s benefits against its costs. One output of this Cost-Effectiveness Assessment is the Benefit-Cost Ratio (BCR). The BCR is calculated by dividing the benefits of project by its costs. If this ratio is greater than one, the project’s benefits are found to be greater than its costs, and the project is deemed cost-effective.

A high-level Cost-Effectiveness Assessment was prepared for the Wharf District Flood Resiliency Plan based on data from the City of Boston’s Climate Ready Boston report released in 2016. Despite being released in 2016, this study offers a comprehensive approach to assessing the avoided losses of a storm event and understanding the benefits that a resilient Wharf District could offer.

Findings

As summarized in the table below, this analysis found that the project would have an approximate net project benefit of $2.6 billion and a 3.2 Benefit-Cost Ratio (BCR), indicating that the proposed project would provide a net positive return on investment.

This BCR is assumed to be conservative due to the following limitations in the data available at the time of this study:

- Sea level rise projections and associated flood extents, depths, and damages have significantly increased since the 2016 Climate Ready Boston study data which underpins this assessment.
- Costs associated with transportation assets that are not buildings (such surface roads and infrastructure located within the Central Artery Tunnel and MBTA tunnels) are not included.
- Business interruption was not included, and all impacted businesses are assumed to reopen despite FEMA estimating 25% of all businesses will never reopen.
- Social and environmental benefits are excluded.

<table>
<thead>
<tr>
<th>ITEMS</th>
<th>COST</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL COST</td>
<td>$1.2 Billion</td>
<td></td>
</tr>
<tr>
<td>AVOIDED LOSSES</td>
<td>$3.9 Billion</td>
<td>Includes annualized direct physical damage, stress factors, and displacement costs</td>
</tr>
<tr>
<td>NET PROJECT BENEFIT</td>
<td>$2.6 Billion</td>
<td>Excludes economic output losses, such as sales and revenues lost associated with business disruptions.</td>
</tr>
</tbody>
</table>

Benefit-Cost Ratio

<table>
<thead>
<tr>
<th>ITEM</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit-Cost Ratio (BCR)</td>
<td>3.2</td>
</tr>
</tbody>
</table>
Process
Avoided losses used in this assessment are based on those identified in the City of Boston’s Climate Ready Boston report released in 2016, which aggregated losses due to coastal flooding experienced by the Wharf District, the West End, the North End, the Financial District, Chinatown, and the Leather District into a single “Downtown” neighborhood. To calculate the avoided losses for the portion of the neighborhood protected by the project, flood pathways and inundation areas were delineated against the proposed flood protection strategies to determine the benefiting area of the project.

The project’s benefiting area was then overlaid on a map of annualized losses\(^1\) identified in the 2016 Climate Ready Boston report to deduce the percentage of the total Downtown neighborhood the project would protect.

Avoided Losses used in this assessment were based on the anticipated annualized losses associated with direct physical damage (structures and building contents), stress factors, and displacement costs projected to be caused by the coastal flood events that would be prevented by the project during a 50-year period from 2030 to 2080.

Next Steps
This cost-effectiveness assessment is intended to provide a high-level understanding of the impact of the Wharf District Resilience Plan. This assessment is not intended to satisfy the requirements of a Benefit-Cost Analysis that would eventually be required for eligibility under many federal and state grant programs. The accuracy of the Avoided Losses used in this analysis are also dependent on the accuracy of the inventory gathered for the 2016 Climate Ready Boston analysis.

We recommend a more in-depth consequence and benefit cost analysis be performed. In particular, we recommend this analysis be developed to include a more robust approach to quantifying the project’s critical transportation, social, and ecological benefits.

Annular Costs and Benefits Summary

<table>
<thead>
<tr>
<th></th>
<th>2030 - 2049</th>
<th>2050 - 2069</th>
<th>2070 – 2080</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annualized Avoided</td>
<td>$28</td>
<td>$66</td>
<td>$182</td>
</tr>
<tr>
<td>Losses (Millions / Year)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One-Time Construction Costs (Millions)</td>
<td>$250</td>
<td>$593</td>
<td>$35</td>
</tr>
<tr>
<td>One-Time Design Costs (Millions)</td>
<td>$25</td>
<td>$59</td>
<td>$3</td>
</tr>
<tr>
<td>Annualized O&amp;M Costs (Millions / Year)</td>
<td>$3</td>
<td>$6</td>
<td>$9</td>
</tr>
</tbody>
</table>

\(^1\) Annualized losses are the sum the damages that would occur if the flood protection system is not built. In this case, annualized losses are weighted based on the probability for all four flood frequencies (10%, 2%, 1%, 0.1%) analyzed for each sea level rise scenario (9", 21", 36") used in the 2016 Climate Ready Boston Report, which are lower than the current sea level rise projections used for the Wharf District flood resiliency project. To find probability-weighted losses, losses for a single event are multiplied by the probability of that event occurring in a given year.
Funding Opportunities

The Wharf District Flood Resiliency Plan is expected to be eligible for multiple federal and state funding programs. A summary of potential funding opportunities is provided below. Each of these programs have unique eligibility requirements. Key eligibility requirements are generally categorized as ‘funding themes’ in the tables below. The applicable funding themes for each Sub-District Resiliency Project is also identified below to aid in identifying funding opportunities for each project.

To be eligible for many of these funding opportunities, it may be necessary for private property owners to partner with public and/or non-profit organizations (public-private partnerships) to be eligible for funding.

**Priority Federal Funding Opportunities:**
- FEMA - Building Resilient Infrastructure and Communities (BRIC)
- NOAA - National Coastal Resilience Fund (NCRF)
- USACE - Corps Water Infrastructure Financing Program (CWIFP)

**Other Potential Opportunities:**
- FEMA - Pre-Disaster Mitigation Grant Program
- FEMA - Safeguarding Tomorrow Through Ongoing Risk Mitigation (STORM)
- NOAA - Transformational Habitat Restoration and Coastal Resilience Grants

**Priority State Funding Opportunities:**
- Massachusetts Office of Coastal Zone Management - Coastal Resilience Grant Program
- MA - Municipal Vulnerability Preparedness (MVP) Grant Program
## Sub-District Resiliency Project Funding Themes

<table>
<thead>
<tr>
<th>Project Area</th>
<th>Project Elements</th>
<th>Funding Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Wharf</td>
<td>• Living shoreline</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Revetments for filter feeders</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Shade trees</td>
<td></td>
</tr>
<tr>
<td>Central Wharf</td>
<td>• Flood protection islands</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Floating wetlands</td>
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</tr>
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<td></td>
<td>• Revetments for filter feeders</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Shade trees</td>
<td></td>
</tr>
<tr>
<td>Harbor Towers</td>
<td>• New park space</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Revetments for filter feeders</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Shade trees</td>
<td></td>
</tr>
<tr>
<td>Rowes Wharf</td>
<td>• New vegetated open space</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Revetments for filter feeders</td>
<td></td>
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<tr>
<td>Northern Avenue</td>
<td>• New public open space</td>
<td></td>
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<tr>
<td></td>
<td>• New, accessible connections to the Harbor Walk</td>
<td></td>
</tr>
<tr>
<td>Fort Point Channel</td>
<td>• Flood resilience features</td>
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</tr>
</tbody>
</table>

- 🌊 Resilience
- 🏖️ Restoration
- 🌿 Canopy
- ✈️ Open space
### Funding Opportunities

<table>
<thead>
<tr>
<th>Grant Name</th>
<th>Agency</th>
<th>Amount (per project limit)</th>
<th>Eligible applicant</th>
<th>Summary</th>
<th>Funding Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rebuilding American Infrastructure with Sustainability and Equity (RAISE)</td>
<td>DOT</td>
<td>$25m</td>
<td>State and local governments</td>
<td>Funds critical freight and passenger transportation infrastructure projects. The project prioritizes projects that improve the resilience of road, rail, transit and port infrastructure to current and future weather and climate risks.</td>
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<tr>
<td>Building Resilient Infrastructure and Communities (BRIC)</td>
<td>FEMA</td>
<td>$50m</td>
<td>Local governments and partnerships apply through designated state agency.</td>
<td>Focuses on system-based mitigation risk reduction projects that protect critical infrastructure. Prioritizes nature-based solutions and serving disadvantaged communities.</td>
<td>⚛ ⚛</td>
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<tr>
<td>Pre-Disaster Mitigation Grant Program</td>
<td>FEMA</td>
<td>~$5m</td>
<td>Local governments apply through state. Project must be identified by congress.</td>
<td>Funds projects designed to reduce risk to individuals and property and reducing reliance on federal funding.</td>
<td>⚛ ⚛</td>
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<tr>
<td>Safeguarding Tomorrow Through Ongoing Risk Mitigation (STORM)</td>
<td>FEMA</td>
<td>$5m</td>
<td>States are eligible for capitalization grants and local communities apply to state for loans.</td>
<td>Low-interest loans that can be used as cost-share for another FEMA HMA grant. Focused on empowering local decision-making around hazard mitigation planning.</td>
<td>⚛ ⚛</td>
</tr>
<tr>
<td>Hazard Mitigation Grant Program (HMGP)</td>
<td>FEMA</td>
<td>No limit</td>
<td>Local governments apply through state after a presidentially declared disaster.</td>
<td>Funds hazard mitigation plan development and hazard mitigation projects designed to build long-term resilience after a disaster declaration.</td>
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<tr>
<td>Municipal Vulnerability Preparedness (MVP) Grant Program</td>
<td>MA EEA</td>
<td>$3 individual $5 regional</td>
<td>Municipalities</td>
<td>Prioritizes innovative resilience projects that incorporate nature-based solutions, present multiple co-benefits, and serve EJ communities.</td>
<td>⚛ ⚛</td>
</tr>
<tr>
<td>Program</td>
<td>Funding Source</td>
<td>Budget</td>
<td>Eligible Recipients</td>
<td>Description</td>
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<tr>
<td>National Coastal Resilience Fund</td>
<td>NOAA</td>
<td>$10m</td>
<td>Local governments, non-profits, regional council of governments, for-profits, and educational institutions</td>
<td>Funds conservation projects that restore or expand natural features that lessen the impacts of natural disasters. Prioritizes projects that are “restoration-ready”.</td>
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</tr>
<tr>
<td>Coastal Resilience Grant Program</td>
<td>NOAA/MA CZM</td>
<td>$10m</td>
<td>Municipalities and non-profits</td>
<td>MA CZM allocates NOAA funding locally for eligible project types including habitat restoration; sea wall /harbor infrastructure redesigns and retrofits, shoreline restoration.</td>
<td></td>
</tr>
<tr>
<td>Transformational Habitat Restoration and Coastal Resilience Grants</td>
<td>NOAA</td>
<td>$15m</td>
<td>Higher education, non-profits, commercial (for profit) organizations, state/local governments</td>
<td>Focused on habitat-based resilience approaches that strengthen both ecosystem and community resilience. Projects can include supporting water industries including tourism.</td>
<td></td>
</tr>
<tr>
<td>Corps Water Infrastructure Financing Program (CWIFP)</td>
<td>USACE</td>
<td>Must be greater than $20m</td>
<td>Local government entities, state infrastructure financing authorities, corporations, partnerships, joint ventures, trusts</td>
<td>Low-cost loans that accelerate investment in infrastructure projects focused on resilience, economic development, and improving environmental quality. Funds up to 49% of project costs for groups of projects over $20 million. However, requires dedicated source of repayment (taxes, user fees, etc.).</td>
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</tbody>
</table>
Definitions and Abbreviations:

Annualized losses – the sum of damages that would be expected to occur due to flood risks over a one-year period if the flood protection system were not built. In this report, annualized losses are weighted based on the probability of four flood frequencies (10%, 2%, 1%, 0.1%) analyzed for three sea level rise scenarios (9”, 21”, 36”) used in the City of Boston’s Climate Ready Boston report. To calculate the probability-weighted losses, the losses for a single event is multiplied by the probability of that event occurring in a given year.

Base Flood Elevation (BFE) – the height floodwaters are expected to reach during a design storm. Depending on the model and source, BFE values may include wave height.

Boston City Base (BCB) – a Boston city-wide datum that can be converted to NAVD88 by using a conversation factor of: NAVD88 = BCB – 6.46 feet.

Boston Harbor Flood Risk Model (BH-FRM) – A flood model developed by Woods Hole Group and academic partners with funding from MassDOT and Federal Highway Administration to evaluate coastal flooding risks from sea level rise and increased storm surge to the Central Artery Tunnel system caused by climate change. The BH-FRM flooding simulations were developed for three time horizons: Present, 2030, and 2070. The 2070 results include approximately 40 inches (3.3 ft) of relative sea level rise and a late 21st century climatology with more intense tropical cyclones.

Climate Resilience Task Force (CRTF) – A task force of volunteers within the Wharf District Council working to address issues of climate resiliency within the district.

Climate Resilience Task Force Management Team (CRTF MT) – A group of Climate Resilience Task Force members overseeing the management of the Project.

The Community – Commonwealth of Massachusetts residents, those who may visit the Wharf District, and those who may be impacted by or benefit from the Wharf District and the Project.

Design Flood Elevation (DFE) – the height to which flood protection systems should be designed in order to reduce flood risk. DFEs often account for considerations including freeboard, projections of sea level rise for a specific time horizon, and wave height.

EDI Partners – Social equity, diversity, & inclusion (EDI) organizations and/or champions participating in the Project, identified in close coordination with the City of Boston.

Freeboard – an additional amount of height above the BFE used as a factor of safety.

Highest Astronomical Tide (HAT) elevations – The elevation of the highest predicted astronomical tide expected to occur at a specific tide station over the time period of 40 years. The 40 years period will include 2 National Tidal Datum Epoch periods.
Inland Properties – All properties of the Wharf District exclusive of the Waterfront Properties.

Massachusetts Coast Flood Risk Model (MC-FRM) – The MC-FRM is an expanded version of the BH-FRM covering the entirety of coastal Massachusetts and including updated elevation and historical storm data, statistical methods, physical processes (wave run-up and overtopping), and sea level rise projections. The MC-FRM includes simulations and results for Present, 2030, 2050, and 2070 time horizons. The 2050 and 2070 results include approximately 3.1 and 4.29 feet of relative sea level rise, respectively, compared to 2000 baseline year, and a late 21st century climatology with more intense tropical cyclones.

Mean Higher High Water (MHHW) – The average of the higher high-water elevation of each tidal day observed over the National Tidal Datum Epoch.

National Tidal Datum Epoch – The specific 19-year period adopted by the National Ocean Service as the official time segment over which tide observations are taken and reduced to obtain mean values for tidal datums. It is necessary for standardization because of periodic and apparent secular trends in sea level.

North American Vertical Datum of 1988 (NAVD88) – The current vertical datum for the contiguous United States and Alaska used by the National Oceanic and Atmospheric Administration.

The Plan – The Wharf District Flood Resiliency Plan.

The Project – The Wharf District Council Conceptual District Protection & Resiliency Plan.

Sea Level Rise (SLR) – an increase in ocean levels due to effects of global warming.

SLR 2070 (MC-FRM) – Sea Level Rise projected through 2070 by MC-FRM (51.5 inches)

Stillwater Elevation is the water surface elevation that considers tides, Sea Level Rise (SLR), storm surge and wave set-up. Stillwater elevation does not include wave crest (or wave height) influence. See diagram below.

![Stillwater Elevation Diagram](image)

- Wave height – the vertical distance between the crest and the trough of a wave.
- Wave crest – the highest point on the wave above the stillwater line.
Sunny-day flooding (nuisance flooding) is referring to flooding associated with high tides during calm weather conditions, unlike storm surge or extreme weather events.

**Waterfront Properties** – The waterfront properties of the Wharf District, from Christopher Columbus Park to Congress Street at the Fort Point Channel, as indicated in the blue dashed line in image on the right.

**Wharf District Council (WDC)** – The Wharf District Council is a non-profit neighborhood organization recognized by the City of Boston as representing the Wharf District community – including residents, hotels, non-profit organizations, small businesses, and A Better City – on matters relating to planning, development, construction, programming events and transportation.

**WDC Stakeholders** – those who live, work, or own property in the Wharf District.

**Vertical Datum** – a surface elevation to which heights of various points are referenced.
Project Approach

Building on Prior Planning Initiatives

The City of Boston’s Climate Ready Boston and Coastal Resilience Solutions reports provide guidelines for district-scale flood resiliency projects, including Design Flood Elevations, Alignments, Evaluation Criteria, and Strategies. This section summarizes how these guidelines have been applied and/or updated for this project.

Design Flood Elevations (DFEs)

The City of Boston has identified the following Design Flood Elevations for the Wharf District:

- A “Target” DFE is established as the minimum elevation that district-wide flood protection systems are required to meet. The Target DFE is 15.0 feet NAVD88 in the north, and 14.0 feet NAVD88 in the south part of the district.
- A “Modular” DFE is also defined a higher elevation that flood protection systems may need to be raised to in the future as sea levels rise. The Modular DFE is 16.5 feet NAVD88 in the north, and 16.0 feet NAVD88 in the south.
The City of Boston’s DFEs are based on the Boston Harbor Flood Risk Model (BH-FRM) developed by Woods Hole Group for MassDOT in 2015. Since Boston’s Climate Ready Boston report was issued, Woods Hole Group has developed an updated flood model for MassDOT: the Massachusetts Coast Flood Risk Model (MC-FRM). Woods Hole Group has provided updated flood projections for this Wharf District Council project based on the updated MC-FRM.

In coordination with BPDA, we recommend the following Design Flood Elevations be used for this project:

<table>
<thead>
<tr>
<th>Conceptual District Protection &amp; Resiliency Plan – Design Flood Elevations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target DFE</strong> – Consistent with the City of Boston’s Target DFE, this is the minimum elevation that district-wide flood protection systems are recommended to meet.</td>
</tr>
<tr>
<td><strong>Strategic DFE</strong> – We recommend flood protection systems be designed to be incrementally raised over time from the Target DFE to the Strategic DFEs.</td>
</tr>
<tr>
<td>The Strategic DFEs vary based on location, with higher DFEs at the waterfront due to wave impacts near the water’s edge, and lower DFEs for inland areas, as indicated in the image below:</td>
</tr>
</tbody>
</table>

**Target DFE Assumptions:**

- BH-FRM Model*, 2070, 100-year storm event + 1-ft Freeboard

  - Coastal flood risk model used by the Climate Ready Boston reports
  - 50-year time-horizon
  - This indicates the potential flooding from a projected 1% storm with 40” sea level rise and storm surge caused by major coastal storms
  - Industry standard freeboard for non-essential and non-residential buildings

*Boston Harbor Flood Risk Model

**Strategic DFE Assumptions:**

- MC-FRM Model*, 2070, 100-year storm event + 2-ft Freeboard

  - Most up-to-date coastal flood risk model starting to inform statewide permit requirements
  - 50-year time-horizon
  - This indicates the potential flooding from a projected 1% storm with 51.5” sea level rise and storm surge + wave crests caused by major coastal storms
  - Aligned with Army Corps levee requirements; industry standard freeboard for critical infrastructure and residential buildings

*Massachusetts Coast Flood Risk Model
## Conceptual District Protection & Resiliency Plan – Design Flood Elevations

<table>
<thead>
<tr>
<th>Property ID</th>
<th>Known As</th>
<th>Target DFE</th>
<th>Strategic DFE</th>
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</thead>
<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td>Model Assumptions</td>
<td>2070 SLR, 1%</td>
<td></td>
<td>2070 SLR, 1% Annual Chance Stillwater + Wave</td>
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<tr>
<td></td>
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<td></td>
<td>Crest (BH-FRM)</td>
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<tr>
<td>Project Specific DFE Recommendation</td>
<td>Near-Term DFE</td>
<td>Long-Term Waterfront DFE</td>
<td>Long-Term Wharf DFE</td>
<td>Long-Term Inland DFE</td>
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<tr>
<td>P01</td>
<td>Christopher Columbus Park</td>
<td>16.0</td>
<td>16.2</td>
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<tr>
<td>P02</td>
<td>Long Wharf</td>
<td>15.0</td>
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<tr>
<td>P03</td>
<td>255 State Street</td>
<td>15.0</td>
<td>19.1</td>
<td>18.4</td>
</tr>
<tr>
<td>P04</td>
<td>Harbor Garage</td>
<td>15.0</td>
<td>19.1</td>
<td>18.4</td>
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<tr>
<td>P05</td>
<td>New England Aquarium</td>
<td>15.0</td>
<td>19.1</td>
<td>18.4</td>
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<tr>
<td>P06</td>
<td>Harbor Towers</td>
<td>15.0</td>
<td>19.1</td>
<td>18.4</td>
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<td>18.4</td>
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<tr>
<td>P08</td>
<td>Rowes Wharf</td>
<td>15.0</td>
<td>19.5</td>
<td>17.5</td>
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<tr>
<td>P09</td>
<td>400 Atlantic Building</td>
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<td>19.5</td>
<td>17.5</td>
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<td>Coast Guard Building</td>
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<td>17.5</td>
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<td>P14</td>
<td>Atlantic Wharf (Russia Building)</td>
<td>14.0</td>
<td>18.6</td>
<td>17.1</td>
</tr>
</tbody>
</table>

All elevations reference NAVD88

**Definitions:**

DFE: Project Design Flood Elevation Recommendations

Stillwater: water surface elevation considering tides, storm surge, & wave set-up

Wave Crest: wave height above the Stillwater elevation

SLR 2070 (MC-FRM): Sea Level Rise projected through 2070 by the Massachusetts Coast Flood Risk Model (51.5 inches)

Freeboard: 2-ft of freeboard applied across district to meet minimum requirements for FEMA Levee Certification Standards and Residential Building Use
### Design Flood Elevations | Ground Elevation at the Harborwalk

#### Elevation (NAVD88)

<table>
<thead>
<tr>
<th>Property ID</th>
<th>Christopher Columbus Park</th>
<th>Long Wharf</th>
<th>255 State St / Ping Plaza</th>
<th>Harbor Garage</th>
<th>New England Aquarium</th>
<th>Harbor Towers</th>
<th>Rowes Wharf</th>
<th>400 Atlantic</th>
<th>Williams Building</th>
<th>Hook Lobster &amp; Co.</th>
<th>Independence Wharf</th>
<th>Intercontinental Hotel</th>
<th>Atlantic Wharf</th>
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</tbody>
</table>

**Ground Elevation at the Harborwalk**

- Strategic DFE, Waterfront
- Target DFE
- Existing Ground Elevation at the Harborwalk
Building First Floor Elevations
Alignments: Several flood protection options are identified in the City of Boston's Coastal Resilience Solutions reports indicating the locations, or 'alignments' where a district flood protection system may be located. These include three 'Waterfront' options and one 'Spine' strategy at Atlantic Avenue:

- **Waterfront Option 1 – Inland Alignment:** A flood resiliency system consisting of a slightly elevated waterfront condition and higher inland line of defense.
- **Waterfront Option 2 – Water's Edge Alignment:** A resiliency system located entirely at the water's edge
- **Waterfront Option 3 – Outboard Alignment:** Resiliency system components such as living shorelines or filled land located outboard of the existing shoreline.
- **Spine Alignment:** Flood protection systems may be located along a roadway where a wharf or pier property is not able or willing to participate in the implementation of one of the waterfront options.

*Image Source: Coastal Resilience Solutions for Downtown Boston and North End*
**Waterfront Flood Protection Alignments – Christopher Columbus Park to Rowes Wharf**

*Image Source: Coastal Resilience Solutions for Downtown Boston and North End*

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**Waterfront Flood Protection Alignments – Fort Point Channel Option B – Protection at Northern Avenue Bridge**

*Image Source: Coastal Resilience Solutions for South Boston*
The resiliency system alignment locations indicated in the City of Boston’s Coastal Resilience Solutions reports were reviewed and updated for this Project based on the findings of the Due Diligence assessment, which considered: property boundaries, existing topography, existing and potential future land and water uses, emergency and non-emergency access routes, regulatory considerations, underground utilities and stormwater systems, Wharf District Stakeholder and EDI Partner feedback. **The alignment locations used in this Project are indicated on the Conceptual District Protection & Resiliency Plans and the image below.**

*Wharf District Project Resiliency System Alignments*
**Evaluation Criteria:**

This project uses a set of Evaluation Criteria to assess and rank potential flood resiliency strategies, and to inform the selection of a set of preferred strategies for the Wharf District. It is critical to the success of this project that these Evaluation Criteria represent the current priorities and preferences of community members and stakeholders. The project’s Evaluation Criteria are therefore based on community feedback from previous comprehensive public outreach and engagement initiatives, including Climate Ready Boston, Coastal Resilience Solutions for Downtown Boston and North End, and the Wharf District Public Realm Visioning Study. A summary of our understanding of the key relevant considerations from these prior public engagement initiatives is provided below:

<table>
<thead>
<tr>
<th>Considerations for assessment and identification of preferred strategies, applicable to this Project:</th>
<th>Considerations for development of implementation timelines, applicable to this Project:</th>
<th>Additional considerations for public and private land improvement planning and design, applicable to subsequent projects:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness</td>
<td>Timing of Flood Risk</td>
<td>Social Impact</td>
</tr>
<tr>
<td>Design Life + Adaptability / Flexibility</td>
<td>Consequences for People &amp; Economy</td>
<td>Value Creation</td>
</tr>
<tr>
<td>Environmental Impact</td>
<td>Leverage Building Cycles</td>
<td>Incorporate Local</td>
</tr>
<tr>
<td>Social Impact/Equity: Accessibility</td>
<td>Who and what are most at risk now</td>
<td>Involvement in Design</td>
</tr>
<tr>
<td>Social Impact: Impacts on Views</td>
<td>Existing efforts that can be built upon</td>
<td></td>
</tr>
<tr>
<td>Engineering Feasibility / Difficulty of implementation</td>
<td>Resources available to undertake work</td>
<td></td>
</tr>
<tr>
<td>Financial Feasibility</td>
<td>Precursor initiatives</td>
<td></td>
</tr>
<tr>
<td>Potential for Multiple Benefits</td>
<td>Risk or cost of delay</td>
<td></td>
</tr>
<tr>
<td>Residual Risk / Layers of Protection</td>
<td>Who has to take action</td>
<td></td>
</tr>
<tr>
<td>Induced Risk</td>
<td>Existing community support</td>
<td></td>
</tr>
</tbody>
</table>
The project team integrated those key considerations identified through prior public engagement initiatives with additional feedback received from the extensive Wharf District Stakeholder and EDI Partner engagement performed during this project to develop the following set of Evaluation Criteria:

### Conceptual District Protection & Resiliency Plan – Evaluation Criteria

<table>
<thead>
<tr>
<th>Effectiveness</th>
<th>Feasibility</th>
<th>Adaptability</th>
<th>Social Equity &amp; Access</th>
<th>Environmental &amp; Additional Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Meets Design Flood Elevations (DFEs)</td>
<td>• Minimizes ground settlement &amp; coastal erosion</td>
<td>• Compatible with existing property-specific plans and land use</td>
<td>• Preserves &amp; enhances the Harborwalk, including welcoming &amp; inclusive access and signage</td>
<td>• Preserves &amp; enhances environmental resources</td>
</tr>
<tr>
<td>• Facilitates continuous line of protection / resilience across the entire district</td>
<td>• Minimizes impacts to seawalls &amp; structural decks</td>
<td>• Compatible with district-wide and abutting-property resiliency strategies</td>
<td>• Preserves &amp; enhances outdoor public spaces, including welcoming &amp; inclusive access and signage</td>
<td>• Preserves &amp; enhances docks &amp; water transportation functionality and access</td>
</tr>
<tr>
<td>• Minimizes deployment complexity</td>
<td>• Minimizes permitting risks</td>
<td>• Provides opportunities for phased implementation</td>
<td>• Preserves &amp; enhances view of the Harbor</td>
<td>• Minimizes outdoor private land use impacts</td>
</tr>
<tr>
<td>• Protects critical infrastructure</td>
<td>• Minimizes construction cost</td>
<td></td>
<td>• Preserves &amp; enhances emergency access</td>
<td>• Compatible with the district’s architectural &amp; urban context, including the functionality &amp; visibility of wharves and historic resources</td>
</tr>
<tr>
<td>• Avoids increasing rainfall-based flooding at abutting properties</td>
<td>• Minimizes long term operations &amp; maintenance costs</td>
<td></td>
<td>• Preserves &amp; enhances non-emergency access to the waterfront, public transportation, &amp; buildings</td>
<td></td>
</tr>
</tbody>
</table>
Evaluation Criteria

The Wharf District Conceptual District Protection & Resiliency Plan will use a set of evaluation criteria to assess and rank potential flood resiliency strategies, and to inform the selection of a set of preferred strategies for the Wharf District.

These evaluation criteria are based on community feedback from previous comprehensive public outreach and engagement initiatives, including Climate Ready Boston, Coastal Resilience Solutions for Downtown Boston and North End, and the Wharf District Public Realm Visioning Study.

As this process continues, we are committed to continuing to provide opportunities for stakeholder input as well as providing timely updates on the process and decisions that are reached.

Effectiveness

Mitigating anticipated flood risks for people, homes, businesses, critical infrastructure, and community assets by using reliable flood adaptation strategies.

Considerations:
- Meets the Design Flood Elevations
- Facilitates continuous line of protection / resilience across the entire district
- Minimizes deployment complexity
- Protects critical infrastructure
- Avoids increasing rainfall-based flooding at abutting properties

Feasibility

Providing a practical strategy that can be implemented based on construction complexity, cost, and regulatory requirements.

Considerations:
- Minimizes ground settlement & coastal erosion
- Minimizes impacts to seawalls & structural decks
- Minimizes permitting risks
- Minimizes construction cost
- Minimizes long-term operations & maintenance costs

Adaptability

Supporting the phased implementation of district-scale and property-specific resilience strategies over time as sea levels rise.

Considerations:
- Compatible with existing property-specific plans and land use
- Compatible with district-wide and abutting-property resiliency strategies
- Provides opportunities for phased implementation
Social Equity & Access
Providing equitable access to the waterfront, safe transportation into, out of, and around the waterfront, & creating opportunities for new public recreational & cultural amenities.

Considerations:
✓ Preserves & enhances the Harborwalk, including welcoming & inclusive access & signage
✓ Preserves & enhances outdoor public spaces, including welcoming & inclusive access & signage
✓ Preserves & enhances Harbor views
✓ Preserves & enhances emergency access
✓ Preserves & enhances non-emergency access to the waterfront, public transportation & buildings

Hunters Point South
Image Source: Arup

Environmental & Additional Benefits
Providing multiple co-benefits in addition to flood adaptation, including preserving or enhancing the function of environmental resources, water dependent uses, private parcel programming, and the Wharf District’s architectural & urban context.

Considerations:
✓ Preserves & enhances environmental resources
✓ Preserves & enhances docks & water transportation functionality and access
✓ Minimizes outdoor private land use impacts
✓ Compatible with the district’s architectural & urban context, including the functionality & visibility of wharves and historic resources

Clippership Wharf, East Boston
Image Source: Ed Wonsek
**Strategies:** The Coastal Resilience Solutions report provides a Resilience Toolkit of possible design strategies that may be applied along the alignments is provided for guidance, as indicated in the image below.

The Multicriteria Assessment (MCA) indicated in the images on the following pages was used to qualitatively and quantitatively assess the feasibility of implementing each of the Strategies identified in the Resilience Toolkit at each of the Waterfront Alignment locations. This MCA was developed for the Project to provide a consistent and transparent decision making approach for using the Evaluation Criteria to rank and prioritize Alignments and Strategies for inclusion in the Preferred Flood Protection System for the project.
### Conceptual District Protection & Resiliency Plan – Multicriteria Assessment

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria (Assessment Criteria)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preserves &amp; enhances the Harborwalk, including welcoming &amp; inclusive access and signage</strong></td>
<td>Reduces width of Harborwalk, obstructs view of water from Harborwalk, precludes or adversely impacts contiguous harborwalk, or eliminates licensed facilities of public accommodation (FPAs)</td>
<td>reduces access points to the Harborwalk and increases harborwalk width or views of water, or includes new facilities of public accommodation (FPAs)</td>
</tr>
<tr>
<td><strong>Preserves &amp; enhances outdoor public spaces, including welcoming &amp; inclusive access and signage</strong></td>
<td>eliminates public access to existing open space</td>
<td>reduces the size of, access to, views/wayfinding to, or signage for open public space no reduction in size of, number of access points to, views/wayfinding to, or signage for open public space increases the size of open public spaces or creates new open public spaces</td>
</tr>
<tr>
<td><strong>Preserves &amp; enhances view of the Harbor</strong></td>
<td>-</td>
<td>fully or partially obstructed preserves current view quality</td>
</tr>
<tr>
<td><strong>Preserves &amp; enhances emergency access</strong></td>
<td>blocks any evacuation route, or blocks all existing emergency access routes to buildings or docks, or results in unacceptable loss of functionality of existing emergency access as determined by the Boston Fire Department</td>
<td>blocks existing emergency access routes to buildings or docks (including for fire boats), but alternative access routes remain and are not impacted no impact on existing emergency access routes to buildings or docks Improves function of existing emergency access, or preferred by Boston Fire Department</td>
</tr>
<tr>
<td><strong>Preserves &amp; enhances non-emergency access to the waterfront, public transportation, &amp; buildings</strong></td>
<td>eliminates access to Harborwalk Accessibility Points, Water Transportation Access Points, bus/subway facilities, parking garages, or loading areas; no practical alternatives to impacted access points exist</td>
<td>eliminates access to Harborwalk Accessibility Points, Water Transportation Access Points, bus/subway facilities, parking garages, or loading areas; alternative access routes are available or created no reduction in the number access routes to the waterfront, and no loss of functionality of existing access program to loading areas, garages, building entrances, or bus/subway facilities creates new public access points to the waterfront (including living shorelines)</td>
</tr>
</tbody>
</table>
### Conceptual District Protection & Resiliency Plan – Multicriteria Assessment

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Environmental and Additional Benefits</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preserves &amp; enhances environmental resources</td>
<td>infills Harbor for reasons not associated with flood resiliency</td>
<td>requires infill of the Harbor that isn’t a new living shoreline or wetland</td>
</tr>
<tr>
<td></td>
<td></td>
<td>does not infill Harbor</td>
</tr>
<tr>
<td>Preserves &amp; enhances docks &amp; water transportation functionality and access</td>
<td>irreconcilable differences with existing use (e.g. fully eliminates existing dock areas or all water transportation access points to any dock); in-kind replacements not identified(3)</td>
<td>requires reduction in function or access to docks (e.g. partially reduces existing dock area or the number of water transportation access points); in-kind replacements not identified(3) No impact on existing dock area or access to water transportation access points, or in-kind replacements(3) identified for any reduction of existing dock area or water transportation access points</td>
</tr>
<tr>
<td>Minimizes outdoor private land use impacts</td>
<td>eliminates private open space, or eliminates all access to existing private open space</td>
<td>reduces open private space size or access points</td>
</tr>
<tr>
<td>Compatable with the district’s architectural &amp; urban context, including the functionality &amp; visibility of wharves and historic resources</td>
<td>-</td>
<td>impacts the visibility or use of the district’s heritage and historic resources, including impacting the function of wharves, or impacting structures listed in the National Register of Historic Places(4)</td>
</tr>
<tr>
<td><strong>Effectiveness</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meets Design Flood Elevations (DFEs)</td>
<td>does not meet Target DFE</td>
<td>meets Target DFE; cannot be raised to Strategic DFE</td>
</tr>
<tr>
<td>Facilitates continuous line of protection / resilience across the entire district</td>
<td>precludes continuous flood protection system for the district</td>
<td>does not protect all buildings in the study area, or precludes protection of buildings or critical infrastructure(2) located immediately adjacent to the study area</td>
</tr>
<tr>
<td>Minimizes deployment complexity</td>
<td>fully deployable</td>
<td>partially deployable</td>
</tr>
<tr>
<td>Protects critical infrastructure</td>
<td>-</td>
<td>does not protect all critical infrastructure(2) from storm surge</td>
</tr>
<tr>
<td>Avoids increasing rainfall-based flooding at abuting properties</td>
<td>blocks major rainfall pathway to the Harbor; no practical mitigation strategies identified</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: Criteria are scored from Poor (-3) to Superior (3). Criteria with (3) indicate additional requirements or considerations.
## Conceptual District Protection & Resiliency Plan – Multicriteria Assessment

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria&lt;sup&gt;(1)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Feasibility</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimizes ground settlement &amp; coastal erosion</td>
<td>raises ground surface ? 2 feet within 30 feet of buildings, tunnels, or large diameter sewers; no practical mitigation strategies identified</td>
<td>Poor: raises ground surface ? 2 feet within 30 feet of buildings, tunnels, or large diameter sewers; practical mitigation strategies have been identified</td>
</tr>
<tr>
<td>Minimizes impacts to seawalls &amp; structural decks</td>
<td>raises ground surface ? 2 feet within 30 feet of Coastal Structure; no practical mitigation strategies have been identified</td>
<td>Poor: raises ground surface ? 2 feet within 30 feet of Coastal Structure; practical mitigation strategies have been identified</td>
</tr>
<tr>
<td>Minimizes permitting risks</td>
<td>strategy located outboard of existing seawall / shoreline; no potential permitting strategy identified</td>
<td>Poor: strategy located outboard of existing seawall / shoreline, or impacts access or views of a structure on the National Register of Historic Places(4); potential permitting strategy identified</td>
</tr>
<tr>
<td>Minimizes construction cost</td>
<td>strategy located outboard of seawall / shoreline</td>
<td>Poor: strategy located outboard of seawall / shoreline, with the exception of dock piling</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adaptability</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimizes long term operations &amp; maintenance costs</td>
<td>includes movable or deployable components, pump systems, or other electric components</td>
<td>Poor: requires significant reduction in function of planned land use, or not preferred by property owner</td>
</tr>
</tbody>
</table>

Other

<table>
<thead>
<tr>
<th>Conceptual District Protection &amp; Resiliency Plan</th>
<th>Multicriteria Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feasibility</td>
<td></td>
</tr>
<tr>
<td>Minimizes ground settlement &amp; coastal erosion</td>
<td>Poor: raises ground surface ? 2 feet within 30 feet of buildings, tunnels, or large diameter sewers; practical mitigation strategies have been identified</td>
</tr>
<tr>
<td>Minimizes impacts to seawalls &amp; structural decks</td>
<td>Poor: raises ground surface ? 2 feet within 30 feet of Coastal Structure; practical mitigation strategies have been identified</td>
</tr>
<tr>
<td>Minimizes permitting risks</td>
<td>Poor: strategy located outboard of existing seawall / shoreline, or impacts access or views of a structure on the National Register of Historic Places(4); potential permitting strategy identified</td>
</tr>
<tr>
<td>Minimizes construction cost</td>
<td>Poor: strategy located outboard of seawall / shoreline, with the exception of dock piling</td>
</tr>
</tbody>
</table>

Other

<table>
<thead>
<tr>
<th>Compatible with existing property-specific plans and land use</th>
<th>Poor: irreconcilable differences with planned land use</th>
<th>Good: requires significant reduction in function of planned land use, or not preferred by property owner</th>
<th>Superior: no impact on planned land use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compatible with district-wide and abutting-property resiliency strategies</td>
<td>Poor: precludes continuous flood protection system for the district</td>
<td>Good: precludes protection of buildings or critical infrastructure(2) located immediately adjacent to the study area</td>
<td>Superior: facilitates protection of buildings and critical infrastructure(2) located immediately adjacent to the study area</td>
</tr>
<tr>
<td>Provides opportunities for phased implementation</td>
<td>Poor: no potential for phased implementation</td>
<td>Superior: strategy can be implemented progressively with sea level rise</td>
<td></td>
</tr>
</tbody>
</table>

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<sup>(1)</sup> Scoring: Poor -3, Good 0, Superior 3.
The quantitative scores in the MCA are reported using a set of qualitative descriptions based on the numerical thresholds indicated below:

<table>
<thead>
<tr>
<th>Assessment Score Thresholds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Superior</td>
</tr>
<tr>
<td>Good</td>
</tr>
<tr>
<td>Poor</td>
</tr>
</tbody>
</table>

This MCA approach provides each Strategy with a relative score to compare it with alternative strategies, and also identifies potential opportunities and negative impacts associated with each strategy that can be flagged for optimization or mitigation, respectively, during design.

Findings from the Multicriteria Assessment is summarized on scorecards, as illustrated by the example scorecard in the image below.
To identify preferred resiliency Alignments and Strategies for inclusion in the district-wide flood protection system, we applied a screening approach to the findings of Multicriteria Assessment, by defining the two Evaluation Criteria of Social Equity & Access, and Environmental & Additional Benefits as ‘Prerequisite Criteria’. Any strategy that received a ‘Poor’ score in either of these Prerequisite Criteria was generally not recommended to be included in the proposed Plan. Such strategies are screened out as they are unlikely to gain the support of key stakeholders, the City, or regulatory agencies, and are therefore unlikely to be fully funded or built.

Any Strategies that receive a ‘Good’ or ‘Superior’ score in the Prerequisite Criteria were then ranked based on the MCA scores for the remaining Evaluation Criteria of Effectiveness, Feasibility, and Adaptability, which are collectively defined as the ‘Constructability Criteria’. The engineering feasibility of those Strategies that rank the highest in the Constructability Criteria were then assessed by our multi-disciplinary engineering team based on the site-specific key considerations identified during the Due Diligence assessment and feedback received from Wharf District Stakeholders and EDI Partners.

The findings of this MCA process and engineering feasibility assessment were then used to inform the design of the flood protection systems included on the Conceptual District Protection & Resiliency Plan.

Reasons that a Strategy might receive a ‘Poor’ score in the Prerequisite Criteria include:

- Negative impact on emergency access
- Negative impact on the functionality of the wharves or water transportation
- Fully eliminates access to public or private open space
- Fully eliminates views of or access to the water, the Harborwalk, the wharves, historic buildings, or water transportation
- Infills the Harbor without providing commensurate flood resiliency benefits

Example Elevated / Constructed Land Strategy at the Inland Alignment
Stakeholder and EDI Partner Engagement

The Conceptual District Protection & Resiliency Plan aims to define a preferred flood resiliency system along the Wharf District’s waterfront that has broad support from the Wharf District community. To accomplish this goal, the Project approach centers the direct involvement of Wharf District Stakeholders as well as Equity, Diversity, and Inclusion Partners (EDI Partners) in the planning and design process. This section summarizes the Project team’s engagement and coordination with Wharf District Stakeholders and EDI Partners.

Engagement Approach

The Project Team identified the following outreach and engagement approaches as being critical to the Project’s ultimate success:

- **Assess Potential Impacts of the Project on Waterfront Access and Issues of Equity, Diversity, and Inclusion.** In close collaboration with the City of Boston, the Project team identified EDI organizations and champions (EDI Partners) to include in the development of the Evaluation Criteria used for assessing and identifying preferred resiliency Alignments and Strategies. EDI Partner and City of Boston representatives were then invited to and participated in multiple opportunities to review and inform the project approach, and the development of project deliverables.

- **Building Broad Support for the Plan Among Wharf District Stakeholders.** For this Project, Wharf District Stakeholders are identified as those who live, work, or own property in the Wharf District. Wharf District Stakeholders provided input to the project approach and deliverables through the following engagement activities:
  - **Wharf District Council monthly public meetings:** Wharf District Stakeholders were provided periodic updates on the Project, and contributed feedback live during the meetings.
  - **Project Website:** The Wharf District Council hosted a public webpage for the Project on the Wharf District Council’s website at [https://www.wharfdistrictcouncil.org/](https://www.wharfdistrictcouncil.org/). Throughout the Project, this Project website page was updated with the latest project deliverables, and highlighted opportunities for the general public to provide written feedback to the Project team.
• **Building Support for the Plan Among Waterfront Property Owners.** Waterfront property owners who will have decision making authority over the construction of flood resiliency improvements on private property were engaged in a series of workshops during the Project.

The general outcomes of these workshops are summarized below.

  o **Visioning Workshops:**
    ▪ Shared knowledge of flood risks, prior resiliency initiatives, key considerations, land use, and planned improvements
    ▪ Waterfront Property Owners provided feedback on the Evaluation Criteria, and identified challenges, opportunities, preferences, and goals for resiliency for their properties

  o **Preliminary Plan Review Workshops:**
    ▪ Identified potential impacts of various options for flood resiliency system Alignments and Strategies at the waterfront properties
    ▪ Identified performance requirements and objectives to address in the preferred resiliency systems at each waterfront properties
    ▪ Identified additional information and next steps required to build support for the Plan

*Image Source: Top: Wharf District Council’s ‘A Vision for the Future’ video by NeoScape; Bottom: Halvorson*
Stakeholders and EDI Partners

The following representatives from the City of Boston and Commonwealth of Massachusetts were engaged during the Project:

**State Officials:**
- State Representative Aaron Michlewitz
- State Senator Lydia Edwards
- Congressman Stephen Lynch

**Boston City Councilors:**
- District 1: Gabriela Coletta
- District 2: Ed Flynn
- At-Large Councilors: Michael Flaherty, Ruthzee Louijeune, Julia Mejia, Erin Murphy

**Boston City Chiefs, Liaisons, and Advisors:**
- James Arthur Jemison, Chief of Planning
- Rev. White-Hammond, Chief of Environment, Energy, and Open Space
- Oliver Sellers-Garcia, Boston Green New Deal Director
- Ciara D’Amico, Boston Neighborhood Services Wharf District Liaison
- Chris Osgood, Senior Advisor for Infrastructure

**Boston Planning and Development Authority (BPDA):**
- Rich McGuinness, Deputy Director for Climate and Environmental Planning
- Chris Busch, Assistant Deputy Director for Climate and Environmental Planning

**Boston Parks & Recreation Department:**
- Cathy Baker-Eclipse, Director of the Capital Plan

EDI Partners from the following organizations were engaged during the Project:
- Boston Harbor Now
- Alternatives for Community & Environment
- Conservation Law Foundation
- The America City Coalition
- Greenroots
- Harborkeepers
- Neighborhood of Affordable Housing

Waterfront Property Owners for the following properties were engaged during the Project:
- Rose Kennedy Greenway
- Christopher Columbus Park (Parks & Recreation)
- Long Wharf: BPDA, Marriott Long Wharf, Boston Harbor City Cruises
- Roadways: Public Works, Public Improvement Commission, Transportation Department
- 255 State Street and Frog Pond Park
- New England Aquarium
- Boston Harbor Garage
- Harbor Towers
- Rowes Wharf
- 400 Atlantic Avenue
- Williams Building – United States Coast Guard
- James Hook & Company
- Independence Wharf
- Intercontinental Hotel Condos
- Atlantic Wharf
Engagement Approach Overview

**EDI Partners**
Solicit input on understanding of Evaluation Criteria from prior planning initiatives:
Letter summarizing opportunities to comment on Evaluation Criteria

**Update Evaluation Criteria** based on feedback
Use Evaluation criteria to identify resiliency Alignments & Strategies to assess in the Preliminary Plan

**Waterfront Property Owners**
Solicit input on summary of prior priorities & preferences, alignments, and strategies during first Visioning Workshops

**Develop Preliminary Resiliency Plans**
Solicit input from Waterfront Property Owners during Preliminary Plan Review Workshops, CRTF MT, and City Agencies/Departments

**Develop Inland Property Resiliency Guidelines**
Solicit input from all Wharf District Stakeholders & EDI Partners

**Develop Final District Resiliency Plan**
Solicit input from all Wharf District Stakeholders & EDI Partners
Resiliency System Design Process

Throughout this Project, we have strived to incorporate community priorities and preferences in design of a viable district-wide flood resiliency system. The Evaluation Criteria were therefore referenced by the Project team during the multi-disciplinary engineering feasibility assessments that underpinned the development of the Conceptual District Protection & Resiliency Plan. Examples of how key considerations associated with each Evaluation Criteria were incorporated into the design are summarized below.

It is our hope that the resulting Plan will facilitate meaningful conversations about each of these Evaluation Criteria in subsequent resiliency and land improvement planning and design efforts.

Redundant Flood Protection Systems

Design for Effectiveness

The Plan incorporates approaches to maximize effectiveness and minimize the risks remaining after implementation of the flood protection system by:

- Incorporating best practices for addressing all potential flood pathways, including coastal storm surge, tidally-influenced groundwater elevations, and inland rainfall on the dry-side of the flood protection systems.
- Providing multiple layers of protection, including:
  - Compartmentalizing groups of properties within the district with Redundant Flood Protection Systems that create a continuous line of protection from the resiliency systems at the water’s edge to inland high points – creating three self-contained Resilience Zones within the district to reduce risks of wide-spread flooding associated with single points of failure.
  - Multiple lines of protection in areas where the water’s edge solution may incorporate higher-risk strategies such as deployable barriers, or where the water’s edge solution is not anticipated to be implemented in the near-term.
  - Facilitating the implementation of independent flood protection systems at each building.
Wharf District Resilience Zones
Design for Feasibility

The Plan utilizes best practices for minimizing impacts of ground settlement and additional structural loading on existing infrastructure and buildings, such as by specifying relieving platforms and lightweight fill to minimize ground settlement and increased loads on existing structures. Where such strategies were identified during the feasibility analysis to be impractical, replacement and/or rehabilitation of existing infrastructure and structures is called out in the Plan.

Additionally, regulatory approval assessments were performed by the Project team for the proposed strategies. Only strategies identified to have a probable permitting path are included in the Plan. However, as the regulatory approvals process for work at the water’s edge and within the water can be complex, we have identified redundant alternative resiliency systems at several inland locations where such inland strategies have been identified as being viable.

The Project Team also considered potential construction and long-term operations and maintenance costs in the design of the flood resiliency system and developed the Plan to incorporate public benefits that are generally balanced with these costs to maximize opportunities to leverage city, state, and federal funding.
Design for Adaptability

The project has divided the Wharf District’s resiliency Plan into six distinct Sub-District Resiliency Projects, each comprised of one to five properties. These Sub-District Resiliency Projects are intended to maximize flexibility for funding and phased implementation of the resiliency Plan, while identifying property owners that are recommended to coordinate together, along with public partners, to implement the resiliency solutions within their project area. These project areas are delineated at locations where multiple options for transitioning between project areas have been identified to be viable.

The Plan also identifies phased implementation of the proposed resiliency strategies, identifying strategies as near-, mid-, and long-term implementation.
Design for Social Equity & Access

The design aims to provide equitable access to the waterfront, safe transportation into, out of, and around the waterfront, and create opportunities for new public recreational and cultural amenities. To achieve these goals, the Plan:

- Maintains emergency access routes to all buildings and Harborwalk locations
- Maintains or increases the width of the existing Harborwalk at all locations
- Results in an overall increase in existing Harborwalk and public open space areas, including identifying opportunities for new public open space areas to compensate for potential impacts to existing open space programming by the proposed resiliency strategies
- Identifies opportunities to widen the Harborwalk,
- Identifies opportunities for new accessible routes to the Harborwalk
- Minimizes impacts on views of the Harbor, and identifies new opportunities for public viewing of the water
- Identifies new opportunities for direct access for the public to ‘touch’ the water

EDI Partners and Wharf District Stakeholders were also provided opportunities to inform the Plan through review and comment periods on the Project deliverables.
Design for Environmental & Additional Benefits

While the primary intent of the Project is to identify engineering strategies for reducing the Wharf District’s flood risks, the Plan identifies opportunities to provide multiple co-benefits including:

- Enhancing the function of environmental resources with Nature Based Solutions such as living shorelines, floating wetlands, flood protection islands, and revetments that may host filter feeders to improve water quality;
- Improving water access with wave attenuation devices such as floating breakwaters that include decking systems for public access to the water and opportunities to increase water transportation and recreational activities;
- Identifying stormwater storage and treatment systems that can collect stormwater from the City’s stormwater and combined sewers, reduce rainfall-based flooding on the dry-side of the flood barriers, and provide treatment to improve the water quality of sewer overflows to the Harbor;
- Including strategies that support the functionality and visibility of the wharves and historic buildings;
- Identifying opportunities for shade trees and shade structures to improve heat resilience along the waterfront.
APPENDIX C

Building-Level Flood Resiliency Guidelines
Wharf District Council
Conceptual District Protection
& Resiliency Plan

Building-Level Flood Resiliency Guidelines

May 2023
Overview

Introduction
These Building-Level Flood Resiliency Guidelines provide flood resiliency recommendations to improve the flood resiliency of individual buildings within the Wharf District. These guidelines should be implemented in addition to the construction of a contiguous district-wide flood protection system located along the waterfront – creating a second layer of resiliency for the Wharf District community at each building to protect people and property in the near-term while district-scale flood protection measures are being implemented over the coming decades, and to further reduce the risks to the community associated with single points of failure in the district-scale resiliency system.

These guidelines are intended to serve as a supplemental resource providing targeted flood resiliency recommendations for the Wharf District, complementing existing comprehensive flood resiliency guidelines provided by the City, including:

- BPDA Coastal Flood Resilience Design Guidelines
- BPWD Climate Resilient Design Standards & Guidelines for Protection of Public Rights-of-Way

Inland Flood Hazards
While the Wharf District Council has identified a district-wide contiguous flood protection system located along the waterfront, this is only one piece of the multi-layered resiliency system required to minimize flood risks to the Wharf District community. As described in more detail in the City’s Climate Ready Boston report, one of these additional layers is adapting buildings located within flood-prone areas for flood risk.

“"No matter how well designed an HPS (Hurricane Protection System) may be, some level of residual risk always remains: risk is never reduced to zero.”

-National Academy of Engineering, Committee on New Orleans Regional Hurricane Protection Projects

Climate Ready Boston Layers of Resilience
With sea levels projected to rise up to 51.5-inches by 2070, storms such as 2018’s Winter Storm Grayson – a ‘100-year flood’ – are likely to cause more widespread flooding throughout the Wharf District in the coming years. The flood maps below indicate the extent and depth of flooding projected to impact the Wharf District’s buildings and critical infrastructure during 100-year floods in 2030, 2050, and 2070.

**Why Protect Against a 100-Year Flood?**

A 100-Year Flood is an event that has a 1-in-100 chance of occurring in any single year. The likelihood of one of these floods occurring over the period of a decade or more is significantly greater.

There is a 10% chance the Wharf District will experience a 100-Year Flood in the next 10 years, and a 40% chance such a flood event will occur over the next 50 years.

*Image Source: Arup Massachusetts Flood Viewer*

*Flood Layer Data Source: Massachusetts Coast Flood Risk Model (MC-FRM)*
Resiliency Guidelines

Resiliency Checklist

The following checklist is provided to assist property owners and residents of individual buildings within the Wharf District identify flood resiliency strategies for their properties.

- **Confirm if the property is located within a flood prone area.** Flood prone areas can be identified on the maps on the previous page, BPDA’s Zoning Viewer (http://maps.bostonredevelopmentauthority.org/zoningviewer/?climate=true) for coastal storm surge flood hazards, and BWSC’s Inundation Model Viewer (https://www.bwscstormviewer.com/stormapp/) for flood hazards associated with both coastal storm surge and rainfall flood events.

- **Identify the property’s Sea Level Rise - Design Flood Elevation (SLR-DFE).**
  - Identify the SLR-BFE for the property by opening the BPDA’s Zoning Viewer and clicking on the parcel. The parcel information box will list the SLR-BFE number in feet (Boston City Base datum).

  **BPDA Zoning Viewer: SLR-DFE**

  ![BPDA Zoning Viewer Image](image)

  - Calculate the Sea Level Rise - Design Flood Elevation (SLR-DFE) for the property by adding either 1- or 2-feet to the SLR-BFE, based on the requirements of the City’s Article 25 A Coastal Flood Resilience Overlay District. Current Article 25 regulations are summarized below. Higher Design Flood Elevations may be chosen if desired by the property owner to further reduce flood risks to the building. **Note: the SLR-DFE for individual buildings may vary from the DFE’s used for the district-wide flood protection system located along the waterfront.**
<table>
<thead>
<tr>
<th>Building Type</th>
<th>DFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>Buildings with a residential or critical use for the ground floor must be 2’ above SLR-BFE. 1’ above SLR-BFE if the residential use starts above the ground floor</td>
</tr>
<tr>
<td>Non-residential</td>
<td>Buildings with a critical use on the ground floor must be 2’ above SLR-BFE. 1’ above SLR-BFE for all other uses</td>
</tr>
<tr>
<td>Both</td>
<td>Buildings in a FEMA Coastal A, V, or VE zone must be 2’ above SLR-BFE</td>
</tr>
</tbody>
</table>

The USACE National Flood Proofing Committee has investigated the effect of various depths of water on masonry walls, discussed in their report titled *Floodproofing Test* (*USACE, 1988*). The results of their work show that, as a general rule, a maximum of 3 feet of water should be allowed on a non-reinforced concrete block wall that has not previously been designed and constructed to withstand flood loads.


### Identify flood risks to people and physical assets at the property.
Review locations and elevations of infrastructure, emergency egress routes, and shelter-in-place facilities relative to flood elevations and pathways. Include potential above- and below-ground flood pathways in the review. Consider impacts of uplift and lateral forces of floodwaters on the structure.

### Identify and implement a flood adaptation strategy.
Identify and assess potential flood adaptation strategies to mitigate the identified flood risks, and implement the preferred adaptation strategy for the property. Note that flood adaptation strategies for individual buildings shall not preclude the construction of the district-wide flood protection system. Resources for identifying and assessing adaptation strategies for retrofitting existing buildings typical to the Wharf District include:

- **BPDA’s Coastal Flood Resilience Design Guidelines**
- **BPWD’s Climate Resilient Design Standards & Guidelines for Protection of Public Rights-of-Way**
- **Wharf District Flood Adaptation Toolkit**, included on the following pages of these guidelines

### Considerations for assessing and selecting adaptation strategies may include:
- Maintaining emergency access including to emergency egresses and hydrants
- Operational capacity to store and deploy the flood protection system
- Permitting requirements
- Suitability for use based on site-specific building construction, site features, and Design Flood Elevation
- Effectiveness in addressing all above- and below-ground flood pathways
- Opportunities to reduce risk through redundant layers of protection
- Ability for incremental implementation
- Winter weather deployment considerations
- Capital costs, social impacts, and environmental impacts
- Operations & maintenance requirements and design life
Identify applicable regulations. Consult City, State, and Federal regulations and any other local jurisdictions, such as Historic Districts and Boston’s Article 25A Coastal Flood Resilience Zoning Overlay District, to identify all applicable regulatory and approval requirements for any proposed work.

Develop a Flood Preparedness, Response, and Recovery Plan. This plan should define how to prepare for and respond to a flood event. Key information to consider includes, but is not limited to:

- Staff and key vendor roles and responsibilities (e.g. removing or securing movable furniture, deploying any deployable barriers, etc.)
- Flood forecast monitoring and communications
- Operational procedures (e.g. setting elevator controls to lock out elevator cabs at the 2nd floor during a flood event)
- Evacuation and/or shelter-in-place procedures, equipment and supplies, and site access restrictions
- Clear guidance on flood recovery priorities to facilitate rapid recovery
- Cleaning and maintenance procedures following an event, including damage inspections of equipment and building systems

Train, Deploy, and Improve. Provide regular training for staff responsible for enacting the Flood Preparedness, Response, and Recovery Plan. Following deployments of flood adaptations strategies, review and incorporate lessons learned for future flood events.

BPDA Coastal Flood Resilience Design Guidelines – Resilient Design Principles

Resilient Design Principles
The strategies presented in this report draw on the four principles below that should guide the construction or retrofit of projects in the Overlay.

Resilience Standards
Proposed designs / renovations should incorporate best practices and standards to reduce or eliminate coastal flood risk or damage resulting from future climate conditions.

Urban Design and the Public Realm
Resilient measures should be seamlessly integrated into the public realm and building design. Resilient design should support pedestrian connections and accessibility and enhance the character of the streetscape, and they should not diminish the public realm to the greatest extent possible.

Sustainability Co-benefits
Wherever feasible, implementation of flood resilience measures should also enhance a building’s energy efficiency, carbon footprint, and passive survivability.

Relationship to District Solutions
Enhancements at a parcel level should not worsen risk at adjacent parcels or restrict future implementation of district coastal resilience plans, and, to the extent feasible, should support the resilience goals and implementation of district coastal resilience plans.
## Wharf District Flood Adaptation Toolkit

### Dry Floodproofing Strategies – Passive Systems

<table>
<thead>
<tr>
<th>Rough Order Magnitude Capital Costs</th>
<th>Maintenance Effort</th>
<th>Deployment Effort</th>
<th>Storage Requirements</th>
<th>Design Life</th>
<th>Types of Products/Solutions</th>
<th>Manufacturers/Proprietary Product Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varies</td>
<td>None</td>
<td>None</td>
<td>None - Low</td>
<td>50+ Yrs</td>
<td>External or external circulation to Design Flood Elevation</td>
<td>N/A  FloodControl International, Oldcastle FloodControl International, Presray, FloodPanel Watts, Neenah, TideFlex, Flood-Guard FST 250, Roxtec, Fiber Reinforced Plastic (FRP) Wrap ADS StormTech, StormTrap, Brentwood StormTank, Contech</td>
</tr>
</tbody>
</table>

### Dry Floodproofing

<table>
<thead>
<tr>
<th>Repurpose or Relocate or Elevate Ground Floor Use</th>
<th>Floodwalls &amp; Levees</th>
<th>Automatically Deployed Flood Barriers</th>
<th>Backflow Valves &amp; Pressure Covers</th>
<th>Sealants and Membranes</th>
<th>Stormwater Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varies</td>
<td>$</td>
<td>$$$</td>
<td>$</td>
<td>$</td>
<td>$$</td>
</tr>
</tbody>
</table>
Wharf District Flood Adaptation Toolkit

Dry Floodproofing Strategies – Deployable Systems

<table>
<thead>
<tr>
<th>Rough Order Magnitude Capital Costs</th>
<th>Deployable Systems</th>
<th>Flood Barriers</th>
<th>Flood Shields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance Effort:</td>
<td>$5</td>
<td>$5</td>
<td></td>
</tr>
<tr>
<td>Deployment Effort:</td>
<td>Moderate</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>Storage Requirements:</td>
<td>High</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Design Life:</td>
<td>Moderate</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>Types of Products/Solutions:</td>
<td>10 - 50+ Yrs</td>
<td>50+ Yrs</td>
<td></td>
</tr>
<tr>
<td>Manufacturers/Proprietary Product Names:</td>
<td>Inflatable Flood Barriers, Modular Flood Barriers, Membrane Barriers, Sandbags</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Door Barriers, Window Panels, Log Barriers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tigerdam, Eco-Dam, Aquafence, ILC Dover Flex-Wall, SmartVent Flex-Wall, FloodBlock</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Presray Door Barrier, FloodShield, Presray Window Panels, FloodPanel Flood Log, FloodControl International Removable Stop Logs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Wet Floodproofing and Supporting Strategies

<table>
<thead>
<tr>
<th></th>
<th>Wet Floodproofing</th>
<th>Supporting Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Building Modifications</td>
<td>Pumps and Drain Systems</td>
</tr>
<tr>
<td>Rough Order Magnitude Capital Costs:</td>
<td>Varies; must be completed in accordance with building code</td>
<td>Varies</td>
</tr>
<tr>
<td>Maintenance Effort:</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Deployment Effort:</td>
<td>None</td>
<td>None - Low</td>
</tr>
<tr>
<td>Storage Requirements:</td>
<td>None</td>
<td>None - Low</td>
</tr>
<tr>
<td>Design Life:</td>
<td>20 - 50+ Yrs</td>
<td>Pumps: 5-10 Yrs Drainage: 50+ Yrs</td>
</tr>
<tr>
<td>Types of Products/Solutions:</td>
<td>Open Crawlspace, Anchoring/Raising/Relocating Mechanical &amp; Utility Equipment, Flood Resistant Building Materials</td>
<td>Sump Pumps, Floor Drains, Back Flow Preventer</td>
</tr>
</tbody>
</table>

Manufacturers/Proprietary Product Names:  
- N/A  
- N/A  
- N/A  
- N/A
APPENDIX D

Due Diligence and Multi-Criteria Assessment Findings
Due Diligence and Multi-Criteria Assessment Findings: Long Wharf (1 of 2)

**PLAN INTENT**
This plan summarizes key considerations associated with the selection and design of potential flood resiliency strategies.

**EXISTING CONDITIONS AND ACCESS CONSIDERATIONS PLAN**
Resiliency system alignment locations indicated on this Existing Conditions and Access Considerations Plan are based on the City of Boston's Climate Ready Boston reports, and may vary from the proposed Preliminary Resiliency System alignments indicated on subsequent plan sheets, which have been informed by site-specific analyses undertaken during this project.

**KEY PLAN**

**LEGEND**
- LIMIT OF STUDY AREA
- INLAND PRELIMINARY ALIGNMENT
- WATERS EDGE PRELIMINARY ALIGNMENT
- OUTBOARD PRELIMINARY ALIGNMENT
- MAJOR FLOW LINES (CRS)
- MAJOR RAINFALL PATHS
- SLURRY WALL
- 1' CONTOUR LINES (LIDAR)
- MBTA SILVERLINE EASEMENT
- SPOT GRADE (ARTICLE 37)
- SPOT GRADE (LIDAR)
- SPOT GRADE (DATA REPOSITORY)
- EMERGENCY ACCESS POINT
- ACCESSIBILITY POINT
- BUS STOPS
- WATER TRANSPORTATION ACCESS POINT
- VEHICULAR ACCESS POINT
- VENTILATION GRATE

**KEY CONSIDERATIONS**

**Geotechnical:** Existing buildings such as the Chart House and Customs building are likely supported on timber piles and granite block pile cap; although the Chart House’s foundations were recently upgraded with micro-piles bearing in the bedrock. The Marriott Long Wharf building is supported on concrete piles which were likely driven to till or bedrock.

**Coastal Structures:** Seawalls have experienced historic deterioration, and sections of seawalls along the north and south sides of the wharf have recently been rebuilt or stabilized. Engineering inspection is recommended during detailed design. MBTA Blue Line tunnel is located below State Street / Long Wharf driveway. Portions of the Harborwalk and Long Wharf flood during present-day high tide events.

**Utilities:** Multiple storm sewer outfalls are located at Christopher Columbus Park (the Park), including 15*” and 18*” pipes, an 84” RCP culvert, and a 5x8’ wood sewer.

**Hailfall Flow Path:** Two major flow paths direct rainfall to the Harbor, one along State Street / Long Wharf, and one along Mercantile Street north of Christopher Columbus Park.

**Water Transportation:** Access to docks for water transportation is critical. The existing Harborwalk is at capacity during peak tourism season. Present-day high tides occasionally result in docks floating higher than the adjacent Harborwalk, causing operational issues for gangways. Water transportation operations are constrained due to narrow water passages.

**Access:** Maintenance and emergency vehicle access is required along the Harborwalk, to the MBTA Emergency Egress at the east end of Long Wharf, and to the C&G Egress adjacent the Aquarium Station headhouse.

**Historic Properties:** The Chart House and Customs House are listed in the National Register of Historic Places. Modifications within these buildings is not subject to historic building regulations, but Section 106 review is required for work outside of buildings for federal funded projects.
Due Diligence and Multi-Criteria Assessment Findings: Long Wharf (2 of 2)

**PLAN INTENT**
This plan summarizes findings of a multi-criteria assessment used to identify strengths and weaknesses of potential flood resiliency strategies.

**MULTI-CRITERIA ASSESSMENT SUMMARY**

<table>
<thead>
<tr>
<th>Assessment Key:</th>
<th>INLAND</th>
<th>WATER'S EDGE</th>
<th>OUTBOARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td><img src="image" alt="FLOOD WALL (NORTH AND SOUTH FACADES OF THE MARITTO) ELEVATED OR CONSTRUCTED LAND (THE PARK)" /></td>
<td><img src="image" alt="ELEVATED DOCK (THE PARK)" /></td>
<td><img src="image" alt="ELEVATED/CONSTRUCTED LAND (THE PARK &amp; LONG WHARF)" /></td>
</tr>
<tr>
<td>Good</td>
<td><img src="image" alt="ELEVATED RAMP/HARBOR WALL (OF MARITTO) RAISED STEPPED (ALL PROPERTIES)" /></td>
<td><img src="image" alt="ELEVATED DOCK (ALL PROPERTIES)" /></td>
<td><img src="image" alt="ELEVATED/CONSTRUCTED RAMP/HARBOR WALK (THE PARK &amp; LONG WHARF)" /></td>
</tr>
<tr>
<td>Poor</td>
<td><img src="image" alt="OVER WATER (ALL PROPERTIES)" /></td>
<td><img src="image" alt="ELEVATED DOCK (ALL PROPERTIES)" /></td>
<td><img src="image" alt="ELEVATED/CONSTRUCTED LAND (THE PARK &amp; LONG WHARF)" /></td>
</tr>
</tbody>
</table>

**RATING**

**Prerequisite Criteria**

| SOCIAL EQUITY & ACCESS | ![High](image) | ![Medium](image) | ![Low](image) |
| ENVIRONMENTAL & ADDITIONAL BENEFITS | ![High](image) | ![Medium](image) | ![Low](image) |

**Constructability Criteria**

| EFFECTIVENESS | ![High](image) | ![Medium](image) | ![Low](image) |
| FEASIBILITY | ![High](image) | ![Medium](image) | ![Low](image) |
| ADAPTABILITY | ![High](image) | ![Medium](image) | ![Low](image) |

**FINDINGS & RECOMMENDATIONS**

**Prerequisite Criteria:** None of the strategies receive a Poor score in the prerequisite criteria at the specific locations noted in the Multi-Criteria Assessment Summary. The Water's Edge alignment Elevated/Constructed Land strategy has the highest prerequisite criteria scores.

**Constructability Criteria:** The Water's Edge alignment Over Water and Elevated Dock strategies, and the Inland Alignment Flood Wall strategy (along the existing Marriott east and north facade walls) are the most constructable strategies studied.

**Recommendations:** The Water's Edge alignment Elevated Dock strategy should be considered in most areas for the Preferred Flood Protection System, and should be designed to minimize impacts on views of the Harbor and the historic Chart House and Customs House, and minimize loading on existing coastal structures and the MRTA tunnel. The Inland alignment Elevated/Constructed Land strategy should be considered for the Preferred Flood protection system at the Park to minimize impacts on views of the Harbor and access to the water. The Outboard Elevated/Constructed Land should be considered for the Preferred Flood Protection System at the Customs House to minimize impacts on views of the Harbor and access to the historic building. An Alternative Flood Protection System at the Inland alignment consisting of a Flood Wall along the Marriott east and north facade walls and a Deployable Barrier or Elevated Roadway/Harborwalk at the Long Wharf roadway should also be considered.
### Long Wharf

<table>
<thead>
<tr>
<th>INDEX</th>
<th>GROUP 7</th>
<th>Solutions List</th>
<th>P1 - Christopher Columbus Park</th>
<th>P2 - Long Wharf</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Building</td>
<td>New bulkhead - Raised/Stepped</td>
<td>Inland</td>
<td>Inland</td>
</tr>
<tr>
<td>2i</td>
<td></td>
<td>Floodwall</td>
<td>Waters Edge</td>
<td>Waters Edge</td>
</tr>
<tr>
<td>3w, 4w</td>
<td>Harbor Walk</td>
<td>Raised/Stepped/Social</td>
<td>Over Water</td>
<td>Outboard</td>
</tr>
<tr>
<td>5w, 6w</td>
<td></td>
<td>Elevated/Constructed Land</td>
<td>Elevated/Accessible</td>
<td>Elevated</td>
</tr>
<tr>
<td>7w</td>
<td>Open Space</td>
<td>Elevated/Constructed Land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8i, 8w</td>
<td>Dock Access</td>
<td>Elevated/Accessible</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Roadway</td>
<td>Elevated</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes:
1. Actual benefits and trade-offs of flood resiliency strategies will be subject to numerous site-specific considerations and can be influenced by nuanced detailed design approaches. This process provides simplified Evaluation Criteria definitions for each score to provide a transparent and repeatable high level assessment of the relative potential benefits and trade-offs for comparing the major components of various flood resiliency strategies.
2. Critical Infrastructure is defined in Section 2.0 of Boston Public Works Department 2018 Climate Resilient Design Standard & Guidelines.
3. In-kind dock replacement includes relocation to an area on the same property with similar or greater footprint, water depth, and protection from wind and waves. In-kind water transportation access point replacement includes relocation to an area on the same property with similar accessibility, connectivity, and visibility. In-kind private open space replacement includes relocation to an area on the same property with similar or greater footprint and access points.
4. National Register of Historic Places structures in the study area include the Long Wharf and Custom House Block, and the seawall between 360-400 Atlantic Avenue and Congress Street.

### Definitions:
- Facilities of Public Accommodation ("FPAs") are qualified under the State's Waterways Regulations (Chapter 91) as "facilities at which goods or services are made available directly to the public on a regular basis, or at which the advantages of use are otherwise open on essentially equal terms to the public at large." FPA space is located in buildings along the City's waterfront and is required through Chapter 91 licensing for new or redevelopment projects. Examples of interior facilities of public accommodation referenced in the regulations include restaurants, performance areas, hotels, retail establishments, and educational and cultural institutions.
- A Wharf is a level concrete, stone, or metal platform lying alongside or projecting into water to which a ship may be moored to load and unload. Adequate water depth for ships must exist alongside the structure to be defined as a wharf. The structure must be of adequate size and configuration to allow ships to moore to be defined as a wharf.

### Critical Infrastructure(2)
- Hospitals and health care facilities
- Emergency Response (Police, Fire, Rescue, Ambulance) facilities and related items (garages, shelters, operations centers, communications, back-up generators, substations, etc.)
- Correctional facilities
- Wastewater treatment plants
- Water storage tanks
- Operations centers
- Public works yards
- Municipal buildings
- Schools and facilities that may be used as emergency shelters
- Power transmission facilities, substations, and power generation stations
- Critical transportation networks (emergency evacuation routes, public transportation, aviation facilities, tunnels, bridges, train and transit maintenance yards and shops, traffic signals)
- Facilities where residents have limited mobility or ability (such as nursing homes and care facilities)
- Buildings or structures that contain hazardous waste; waste transfer stations
- Pumping stations (stormwater and sanitary)
- Fuelling storage and fuel stations
- Ventilation buildings and fan plants
- Telecommunications
- Major food distribution centers
Summary:

**Location:** Island
**Asset:** Building
**Solution:** Flooded
**Group:** 7 along Marriott north and east facade

### Social Equity & Access

**Environmental and Additional Benefits**

- Effectiveness
- Feasibility
- Adaptability

### Scoring:

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Social Equity &amp; Access</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Evaluates &amp; enhances the waterfront, seawall, shoreline &amp; coastal access and signage</strong></td>
<td>Floodwall reduces access points to the waterfront</td>
<td>does not reduce access points, with all of the waterfront and recreation access in existing facilities of public accommodation</td>
<td>10.0</td>
</tr>
<tr>
<td><strong>Evaluation</strong></td>
<td>Floodwall reduces access points to the waterfront</td>
<td>increases floodwall width or reduces access points to the waterfront</td>
<td>5.0</td>
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<tr>
<td><strong>Meets Target DFE</strong></td>
<td>Floodwall reduces access points to the waterfront</td>
<td>increases floodwall width or reduces access points to the waterfront</td>
<td>15.0</td>
</tr>
<tr>
<td><strong>Meets Target DFE</strong></td>
<td>Floodwall reduces access points to the waterfront</td>
<td>increases floodwall width or reduces access points to the waterfront</td>
<td>-0.6</td>
</tr>
<tr>
<td><strong>Screening Criteria</strong></td>
<td>Floodwall reduces access points to the waterfront</td>
<td>increases floodwall width or reduces access points to the waterfront</td>
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<tr>
<td><strong>Effectiveness</strong></td>
<td>Floodwall reduces access points to the waterfront</td>
<td>increases floodwall width or reduces access points to the waterfront</td>
<td></td>
</tr>
<tr>
<td><strong>Feasibility</strong></td>
<td>Floodwall reduces access points to the waterfront</td>
<td>increases floodwall width or reduces access points to the waterfront</td>
<td></td>
</tr>
<tr>
<td><strong>Adaptability</strong></td>
<td>Floodwall reduces access points to the waterfront</td>
<td>increases floodwall width or reduces access points to the waterfront</td>
<td></td>
</tr>
</tbody>
</table>

**Long Wharf**
Summary:

Location: Island
Area: Open Space
Elevation/Construced Land: Group 7 - Christopher Columbus Park to east facade of Marriott

Social Equity & Access

Environmental & Additional Benefits

Effectiveness

Feasibility

Adaptability

Notes:
- Strategic DFE not met
- Minimum DFE
- Minimum impact
- Solution min and max

Scoring:

1. Progressive & innovative: Elevated/Constructed Land
   - Does not meet Target DFE
   - Increases hardwreck width or width of seawall, or includes new facilities of public accommodation (Long Wharf)
   - Increases hardwreck width or width of seawall, or includes new facilities of public accommodation (Long Wharf)
   - Increases hardwreck width or width of seawall, or includes new facilities of public accommodation (Long Wharf)
   - Increases hardwreck width or width of seawall, or includes new facilities of public accommodation (Long Wharf)

2. Environmental & Additional Benefits
   - No impact on existing emergency access routes to buildings or dock
   - No impact on existing emergency access routes to buildings or dock
   - No impact on existing emergency access routes to buildings or dock
   - No impact on existing emergency access routes to buildings or dock

3. Effectiveness
   - Does not meet Target DFE
   - Does not meet Target DFE
   - Does not meet Target DFE
   - Does not meet Target DFE

4. Feasibility
   - Area not fronted by seawall or shoreline; no practical mitigation strategies
   - Area not fronted by seawall or shoreline; no practical mitigation strategies
   - Area not fronted by seawall or shoreline; no practical mitigation strategies
   - Area not fronted by seawall or shoreline; no practical mitigation strategies

5. Appropriateness
   - Strategic DFE not met
   - Strategic DFE not met
   - Strategic DFE not met
   - Strategic DFE not met

6. Compatibility with existing property-specific, open space, and historic components
   - Strategic DFE not met
   - Strategic DFE not met
   - Strategic DFE not met
   - Strategic DFE not met

7. Compatibility with strategic district-specific plans and alignment
   - Strategic DFE not met
   - Strategic DFE not met
   - Strategic DFE not met
   - Strategic DFE not met

8. Provisions for phased implementation
   - Strategic DFE not met
   - Strategic DFE not met
   - Strategic DFE not met
   - Strategic DFE not met
### Summary:

**Location:** Inland  
**Asset:** Elevated Roadway & Harborwalk  
**Solution:** Group 7, Long Wharf roadway end of Maritime garage entrance

<table>
<thead>
<tr>
<th>Social Equity &amp; Access</th>
<th>Environmental and Additional Benefits</th>
<th>Effectiveness</th>
<th>Feasibility</th>
<th>Adaptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feasibility</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Adaptability</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Scoring:

#### 1. Social Equity & Access

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Scoring Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missioned or an open space (no impervious surfaces)</td>
<td>-</td>
<td>Provides additional access to the roadway system</td>
<td>0</td>
</tr>
<tr>
<td>Inland or waters edge alignments</td>
<td>-</td>
<td>Enriches the visibility of the district's heritage</td>
<td>0</td>
</tr>
<tr>
<td>Missioned or an open space (no impervious surfaces)</td>
<td>-</td>
<td>Provides additional access to the roadway system</td>
<td>0</td>
</tr>
<tr>
<td>Inland or waters edge alignments</td>
<td>-</td>
<td>Provides additional access to the roadway system</td>
<td>0</td>
</tr>
<tr>
<td>Missioned or an open space (no impervious surfaces)</td>
<td>-</td>
<td>Provides additional access to the roadway system</td>
<td>0</td>
</tr>
<tr>
<td>Inland or waters edge alignments</td>
<td>-</td>
<td>Provides additional access to the roadway system</td>
<td>0</td>
</tr>
</tbody>
</table>

#### 2. Environmental and Additional Benefits

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Scoring Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missioned or an open space (no impervious surfaces)</td>
<td>-</td>
<td>Provides additional access to the roadway system</td>
<td>0</td>
</tr>
<tr>
<td>Inland or waters edge alignments</td>
<td>-</td>
<td>Expands the visibility of the district's heritage</td>
<td>0</td>
</tr>
<tr>
<td>Missioned or an open space (no impervious surfaces)</td>
<td>-</td>
<td>Provides additional access to the roadway system</td>
<td>0</td>
</tr>
<tr>
<td>Inland or waters edge alignments</td>
<td>-</td>
<td>Expands the visibility of the district's heritage</td>
<td>0</td>
</tr>
<tr>
<td>Missioned or an open space (no impervious surfaces)</td>
<td>-</td>
<td>Provides additional access to the roadway system</td>
<td>0</td>
</tr>
<tr>
<td>Inland or waters edge alignments</td>
<td>-</td>
<td>Expands the visibility of the district's heritage</td>
<td>0</td>
</tr>
</tbody>
</table>

### Notes:

- **Strategic CFE Stand:** 17.4  
- **Minimum CFE:** 15.04  
- **Graded Deviation at Alignment:** 9.0  
- **Solution Min and Max:** 9.0 to 9.6

---

**Long Wharf**

---
### Summary:

**Location:** Harbor Walk  
**Asset:** Long Wharf  
**Siting:** Group 7, all properties, except west side of Custom House

#### Social Equity & Access

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness</td>
<td>No changes to ground surface or shoreline below high tide</td>
<td>Meets Target DFE; can be raised to strategic DFE.</td>
<td>3.00</td>
</tr>
<tr>
<td>Feasibility</td>
<td>No impact on existing dock area or the number of access points, or facilitates access to water transportation services.</td>
<td>Meets Target DFE.</td>
<td>0.00</td>
</tr>
<tr>
<td>Adaptability</td>
<td>No impact on access points, or facilitates access to water transportation services.</td>
<td>Meets Target DFE.</td>
<td>0.00</td>
</tr>
</tbody>
</table>

#### Environmental and Additional Benefits

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness</td>
<td>No changes to ground surface or shoreline below high tide</td>
<td>Meets Target DFE; can be raised to strategic DFE.</td>
<td>3.00</td>
</tr>
<tr>
<td>Feasibility</td>
<td>No impact on existing dock area or the number of access points, or facilitates access to water transportation services.</td>
<td>Meets Target DFE.</td>
<td>0.00</td>
</tr>
<tr>
<td>Adaptability</td>
<td>No impact on access points, or facilitates access to water transportation services.</td>
<td>Meets Target DFE.</td>
<td>0.00</td>
</tr>
</tbody>
</table>

### Scoring:

#### Social Equity & Access

- **Effectiveness:** 3.00
- **Feasibility:** 0.00
- **Adaptability:** 0.00

#### Environmental and Additional Benefits

- **Effectiveness:** 3.00
- **Feasibility:** 0.00
- **Adaptability:** 0.00

### Long Wharf
### Summary:

**Location:** Historic Edge

**Asset:** Harbor Walk

**Solution:** ELEVATED OR CONTRUCTED LAND

**Group:** City of New Haven

**Elevation:** 10.1' to 0'

**Social Equity & Access**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feasibility</td>
<td>Reduces access points to the waterfront</td>
<td>Meets Target DFE; can be raised to higher</td>
<td>Involves new road for public access to waterfront, or involves new road facilities for public access to waterfront</td>
</tr>
<tr>
<td>Feasibility</td>
<td>Reduces access points to the waterfront</td>
<td>Meets Target DFE; can be raised to higher</td>
<td>Involves new road for public access to waterfront, or involves new road facilities for public access to waterfront</td>
</tr>
</tbody>
</table>

**Environment and Additional Benefits**

- **Adaptability**
  - Reduces access points to the waterfront
  - Reduces number of critical infrastructure(2) located immediately adjacent to the study area, and facilitates protection of buildings or critical infrastructure(2) from storm surge

**Scoring:**

1. **Social Equity & Access**

2. **Environmental and Additional Benefits**

3. **Solution:**

   - ELEVATED OR CONSTRUCTED LAND

4. **Notes:**

   - Strategic CFE stand: 18.1
   - Minimum CFE: 13
   - Ground/Decks at Alignment Solution: 11.1' to 10.1'
## Long Wharf

### Summary:

- **Location:** Boston<br>- **Asset:** Docks<br>- **Solution:** Elevated Dock Access Group 7

### Scoring:

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Social Equity &amp; Access</strong></td>
<td>Improve access for rowers, marinas, or other public users, including facilities public accommodation (FPAs)</td>
<td>Increase access points to the waterfront</td>
<td>2</td>
</tr>
<tr>
<td><strong>Feasibility</strong></td>
<td>Elevate or raise dock to meet flood protection. No benefit to end users if dock raised, and cannot be raised</td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td><strong>Effectiveness</strong></td>
<td>Minimizes impacts to seawalls &amp; coastal erosion</td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td><strong>Adaptability</strong></td>
<td>Facilitates protection of buildings or reduces existing flood area.</td>
<td>None</td>
<td>0</td>
</tr>
</tbody>
</table>

### Notes:

- **Strategic CFE level:** B<br>- **Minimum CFE:** 15<br>- **Group CFE:** 9.0<br>- **Group CFE Rank:** 9.1<br>- **Assessment Score:** 17.1

Elevated docks to 17' with a 2' setback to 17.7' elevators will reduce score to 17.1 for compatibility with elevator height.
## Summary:

<table>
<thead>
<tr>
<th>Location: Asset: Group:</th>
<th>Social Equity &amp; Access</th>
<th>Environmental and Additional Benefits</th>
<th>Effectiveness</th>
<th>Feasibility</th>
<th>Adaptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wharf District Resiliency Plan</td>
<td>ELEVATED: CONSTRUCTED</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Scoring:

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Equity &amp; Access</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harbors &amp; enhances the waterfront, accessibility &amp; inclusive access and signage</td>
<td>Reserve width of Harborwalk districts: area of water front, buildings, infrastructure, or amenities to provide for public access and enjoyment</td>
<td>Reduce access points to the waterfront</td>
<td></td>
</tr>
<tr>
<td>Harbors &amp; enhances public access points; enhancing public access to waterfront and adjacent neighborhoods</td>
<td>Reserve宽度의 할로의 해안과 주변 지역으로 이동할 수 있는 철도와 도로, 정비 인근 통행시설을 증가시킨다</td>
<td>을 설정할 수 있는 해안 전용 도로와 인근 지역으로 이동할 수 있는 철도와 도로를 증가시킨다</td>
<td></td>
</tr>
<tr>
<td>Harbors &amp; enhances view of the waterfront</td>
<td>fully or partially obstruted</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Harbors &amp; enhances emergency access</td>
<td>Any existing seawall or flood protection structures &amp;/or cliffs, or results in the inability to close</td>
<td>Infringe on existing seawall or flood protection structures &amp;/or cliffs, or results in the inability to close</td>
<td></td>
</tr>
<tr>
<td>Harbors &amp; enhances emergency access</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harborwalk Accessibility Plan, Water Transportation Access Points, pedestrian paths, parking garages, or other infrastructure on existing land</td>
<td>Number of water transportation access points</td>
<td>Number of existing water transportation access points</td>
<td>0</td>
</tr>
<tr>
<td>Project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harborwalk, including welcoming signage</td>
<td>Infringe on existing seawall or flood protection structures &amp;/or cliffs, or results in the inability to close</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heritage, history, including wharfs or historic structures</td>
<td>Possible flooding of critical infrastructure(2) located within 30 feet of buildings, or impacting infrastructure, such as sewer lines; identifies specific opportunties to improved access points and public spaces</td>
<td>Infringe on existing seawall or flood protection structures &amp;/or cliffs, or results in the inability to close</td>
<td></td>
</tr>
</tbody>
</table>

### Notes:

- Strategic CEI stand: 1.0
- Minimum CEI: 0.0
- 1.0 to 3.0: Not acceptable
- 4.0: No change
- CECI: 11.1

Long Wharf

Date Revised: 12/12/2022
Checked By: DA
Created By: KS
Summary:

Long Wharf

Social Equity & Access
- Facilitates protection of buildings or critical infrastructure (2) located immediately adjacent to the study area.
- Facilitates protection of buildings, tunnels, or large diameter sewers; practical mitigation strategies have been identified.

Environmental and Additional Benefits
- Meets Design Flood Elevations
- protects all buildings in the study area.
- Precludes or eliminates access to docks (e.g., partially obstructed preserves current view quality)
- Provides opportunities for phased implementation

Feasibility
- Meets Target DFE
- can be raised to Strategic DFE
- meets Target DFE; cannot be raised to Strategic DFE
- Meets Target DFE; can be raised to Strategic DFE

Adaptability
- includes in-kind replacements for licensed FPA(s) (Facility of Public Accommodation)
- Includes strategic consideration of new living shoreline or wetland infills Harbor for reasons not identified.
- Includes strategic consideration of new living shoreline or wetland infills Harbor for reasons not identified.

Scores:

1. Social Equity & Access
   - Facilitates protection of buildings or critical infrastructure (2) located immediately adjacent to the study area.
   - Meets Design Flood Elevations
   - Meets Target DFE
   - cannot be raised to Strategic DFE

2. Environmental and Additional Benefits
   - Meets Design Flood Elevations
   - includes in-kind replacements for licensed FPA(s) (Facility of Public Accommodation)
   - Includes strategic consideration of new living shoreline or wetland infills Harbor for reasons not identified.
   - Includes strategic consideration of new living shoreline or wetland infills Harbor for reasons not identified.

3. Feasibility
   - Meets Target DFE
   - cannot be raised to Strategic DFE
   - Meets Target DFE; cannot be raised to Strategic DFE
   - Meets Target DFE; can be raised to Strategic DFE

4. Adaptability
   - includes in-kind replacements for licensed FPA(s) (Facility of Public Accommodation)
   - Includes strategic consideration of new living shoreline or wetland infills Harbor for reasons not identified.
   - Includes strategic consideration of new living shoreline or wetland infills Harbor for reasons not identified.
   - Includes strategic consideration of new living shoreline or wetland infills Harbor for reasons not identified.

Scores:

- 0.79
- 0.79
- 0.79
- 0.79
Due Diligence and Multi-Criteria Assessment Findings: Central Warf (1 of 2)

**PLAN INTENT**
This plan summarizes key considerations associated with the selection and design of potential flood resiliency strategies.

**EXISTING CONDITIONS AND ACCESS CONSIDERATIONS PLAN**

Resiliency system alignment locations indicated on this Existing Conditions and Access Considerations Plan are based on the City of Boston's Climate Ready Boston reports, and may vary from the proposed Preliminary Resiliency System alignments indicated on subsequent plan sheets, which have been informed by site-specific analyses undertaken during this project.

**KEY CONSIDERATIONS**
- **Geotechnical:** Proposed solutions at water's edge will require groundwater cut-off.
- **Coastal Structures:** Structures in this group are pile supported and bear in glacial till or bedrock. The existing seawall is in deteriorating condition and requires a mitigation strategy. Engineering assessment recommended during detailed design. Portions of the Harborwalk flood during present-day high tide events.
- **Utilities:** A 60"x64" culvert in Central Street conveys combined sewer flows to a 72"x72" box culvert under the Harborwalk along the north side of Central Wharf to an outfall at the Northern tip of the wharf. An 84" storm pipe runs under the northern sidewalk of Milk Street at Frog Pond Park. A steam pipe is located below the the south side of Central Wharf below normal high tide elevation. An 8-ft wide condenser water piping easement extends from Harbor Garage to Harbor Towers through East India ROW.
- **Rainfall Flow Path:** During major rainfall events, stormwater from significant portions of the Wharf District are conveyed overland via State Street and Central Street to Old Atlantic Avenue before over flowing to the Harbor.
- **Emergency Access:** Emergency vehicles can access all buildings and the Harborwalk via roadways and the plaza located west and south side of the Aquarium. Emergency access must be maintained around Harbor Garage and may require future coordination during detailed design.

**KEY PLAN**

The diagram illustrates key plan elements and alignment details for the Central Warf area.
Due Diligence and Multi-Criteria Assessment Findings: Central Warf (2 of 2)

PLAN INTENT
This plan summarizes findings of a multi-criteria assessment used to identify strengths and weaknesses of potential flood resiliency strategies.

MULTI-CRITERIA ASSESSMENT SUMMARY

<table>
<thead>
<tr>
<th>Assessment Key:</th>
<th>INLAND</th>
<th>WATER'S EDGE</th>
<th>OUTBOARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td><img src="image" alt="Flood Wall" /></td>
<td><img src="image" alt="Elevated or Constructed Land (South of Old Atlantic Ave)" /></td>
<td><img src="image" alt="Elevated / Constructed Land" /></td>
</tr>
<tr>
<td>Good</td>
<td><img src="image" alt="Elevated or Constructed Land (South of Old Atlantic Ave)" /></td>
<td><img src="image" alt="Elevated Roadway/ Harborwalk (Old Atlantic Ave)" /></td>
<td><img src="image" alt="Elevated / Constructed Land" /></td>
</tr>
<tr>
<td>Poor</td>
<td><img src="image" alt="Raised/ Stepped" /></td>
<td><img src="image" alt="Elevated Dock" /></td>
<td><img src="image" alt="Elevated / Constructed Land" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rating</th>
<th>Social Equity &amp; Access</th>
<th>Environmental &amp; Additional Benefits</th>
<th>Effectiveness</th>
<th>Feasibility</th>
<th>Adaptability</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Circle" /></td>
<td><img src="image" alt="Circle" /></td>
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<td><img src="image" alt="Circle" /></td>
</tr>
</tbody>
</table>

FINDINGS & RECOMMENDATIONS

Prerequisite Criteria: The Inland alignment Flood Wall strategy is not preferred due to receiving a Poor score for Social Equity & Access due to obstructing views and access to public spaces, the Harbor, the Long Wharf bus stop on Old Atlantic Avenue, and the Aquarium. The Inland alignment Elevated Roadway / Harborwalk strategy is also not preferred due to receiving a Poor score for Environmental & Additional Benefits due to impacting the visibility of the district's wharves and historic buildings at Long Wharf and reducing access points to the sidewalk cafe at 255 State Street.

Constructability Criteria: The Water's Edge alignment strategies and the Inland alignment Elevated / Constructed Land strategy are the most constructable strategies in this assessment.

Recommendations:

The Water's Edge alignment strategies and the Elevated/Constructed land strategy at the Inland and Outboard alignment should be considered for the Preferred Flood Protection System. The strategies should incorporate approaches to minimize the impacts on views of the Harbor and wharves, to maximize programmable community space, and to minimize impacts of new fill causing ground settlement at existing buildings and sea walls. A stormwater storage and pump system will also be required to manage groundwater levels and accommodate the Major Rainfall Paths that would be impeded by the flood protection system in the vicinity of Old Atlantic Ave.
## Central Wharf

### Definitions:
- Facilities of Public Accommodation ("FPA") are qualified under the State's Waterways Regulations (Chapter 91) as “facilities at which goods or services are made available directly to the public on a regular basis, or at which the advantages of use are otherwise open on essentially equal terms to the public at large." FPA space is located in buildings along the City’s waterfront and is required through Chapter 91 licensing for new or redevelopment projects. Examples of interior facilities of public accommodation referenced in the regulations include restaurants, performance areas, hotels, retail establishments, and educational and cultural institutions.
- A Wharf is a level concrete, stone, or metal platform lying alongside or projecting into water to which a ship may be moored to load and unload. Adequate water depth for ships must exist alongside the structure to be defined as a wharf.

### Critical Infrastructure:
- Critical transportation networks for emergency evacuation routes, public transportation, aviation facilities, tunnels, bridges, train and transit maintenance yards and shops, traffic signals
- Facilities where residents have limited mobility or ability (such as nursing homes and care facilities)
- Buildings or structures that contain hazardous waste, waste transfer stations
- Pumping stations (stormwater and sanitary)
- Fueling storage and fuel stations
- Ventilation buildings and fan plants
- Telecommunications
- Major food distribution centers

### Solutions List

<table>
<thead>
<tr>
<th>INDEX</th>
<th>GROUP 6</th>
<th>Solutions List</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Building</td>
<td>New bulkhead - Raised/Stepped</td>
</tr>
<tr>
<td>2</td>
<td>Floodwall</td>
<td>Floodwall</td>
</tr>
<tr>
<td>3w</td>
<td>Harbor Walk</td>
<td>Raised/Stepped/Social</td>
</tr>
<tr>
<td>4w</td>
<td>Over Water</td>
<td>Over Water</td>
</tr>
<tr>
<td>5w, 5o</td>
<td>Elevated/Constructed Land</td>
<td>Elevated/Constructed Land</td>
</tr>
<tr>
<td>6i, 6o</td>
<td>Open Space</td>
<td>Elevated/Constructed Land</td>
</tr>
<tr>
<td>7w</td>
<td>Dock Access</td>
<td>Elevated/Accessible</td>
</tr>
<tr>
<td>8i</td>
<td>Roadway</td>
<td>Elevated</td>
</tr>
</tbody>
</table>

### Notes:
1. Actual benefits and trade-offs of flood resiliency strategies will be subject to numerous site-specific considerations and can be influenced by nuanced detailed design approaches. This process provides simplified Evaluation Criteria definitions for each score to provide a transparent and repeatable high level assessment of the relative potential benefits and trade-offs for comparing the major components of various flood resiliency strategies.
2. Critical Infrastructure is defined in Section 2.0 of Boston Public Works Department 2018 Climate Resilient Design Standard & Guidelines.
3. In-kind dock replacement includes relocation to an area on the same property with similar or greater footprint, water depth, and protection from wind and waves. In-kind water transportation access point replacement includes relocation to an area on the same property with similar accessibility, connectivity, and visibility. In-kind private open space replacement includes relocation to an area on the same property with similar or greater footprint and access points.
4. National Register of Historic Places structures in the study area include the Long Wharf and Custom House Block, and the seawall between 360-400 Atlantic Avenue and Congress Street.
### Summary:

**Location:** Boston

**Assessment:** Floodwall

**Social Equity & Access**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
<th>Screening</th>
<th>Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence &amp; accessibility of water access points to the harbor</td>
<td>Minimizes outdoor private land use impacts. Includes open private space size or access points.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Presence &amp; accessibility of emergency access routes</td>
<td>No impact on existing dock area or access to water transportation access points, or preferred by dock management.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Presence &amp; accessibility of transportation facilities</td>
<td>Provides new opportunities for trees, living shorelines, or wetlands (e.g. elevated constructed land at inland or marsh edge). Includes new public access points to the waterfront (including living shorelines).</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pedestrian infrastructure</td>
<td>Does not affect pedestrian circulation paths.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Flood barrier(s)</td>
<td>Does not impact the functional or visual characteristics of flood barriers.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Mitigation of existing impacts</td>
<td>Blockage or obstruction of existing emergency access routes to buildings or docks (including for fire boats), but alternative access routes remain and are not impacted.</td>
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<th>Criteria/Classification</th>
<th>Screening Criteria</th>
<th>Scoring Criteria</th>
<th>Assessment Score</th>
</tr>
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<tbody>
<tr>
<td>Presence &amp; accessibility of water access points to the harbor</td>
<td>Minimizes outdoor private land use impacts. Includes open private space size or access points.</td>
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<td>Presence &amp; accessibility of emergency access routes</td>
<td>No impact on existing dock area or access to water transportation access points, or preferred by dock management.</td>
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<tr>
<td>Presence &amp; accessibility of transportation facilities</td>
<td>Provides new opportunities for trees, living shorelines, or wetlands (e.g. elevated constructed land at inland or marsh edge). Includes new public access points to the waterfront (including living shorelines).</td>
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### Solutions:

- **Inland FLOODWALL:**
  - **Location:** Boston
  - **Assessment:** Floodwall
  - **Social Equity & Access:**
    - Presence & accessibility of water access points to the harbor
    - Presence & accessibility of emergency access routes
    - Presence & accessibility of transportation facilities
    - Pedestrian infrastructure
    - Flood barrier(s)
  - **Mitigation:**
    - No impact on existing dock area or access to water transportation access points, or preferred by dock management.
  - **Mitigation of new construction impacts:**
    - No impact on existing dock area or access to water transportation access points, or preferred by dock management.
  - **Mitigation of new environmental impacts:**
    - No impact on existing dock area or access to water transportation access points, or preferred by dock management.
  - **Mitigation of new construction impacts:**
    - No impact on existing dock area or access to water transportation access points, or preferred by dock management.

### Created By:

- **Central Wharf**

- **Date:** 11/18/2022

- **KS**

- **Created By:** KS
### Central Wharf

**Summary:**

<table>
<thead>
<tr>
<th>Location:</th>
<th>Asset Group:</th>
<th>Elevating or Constructed Years</th>
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<tbody>
<tr>
<td>Ocean</td>
<td>Elevated/Contactor Level</td>
<td>Group &amp; All Property</td>
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<tr>
<th>Environmental and Additional Benefits</th>
<th>Feasibility</th>
<th>Adaptable</th>
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<tbody>
<tr>
<td>Strategic DFE</td>
<td>Minimum DFE</td>
<td>Number of Critical Alignments</td>
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<td>Direction of review</td>
<td>Route/Seafront</td>
<td>Mile or Kilometer</td>
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**Notes:**

- Provides opportunities for phased implementation of local flood-resilient design strategies.
- Protection of buildings or critical infrastructure located immediately adjacent to the study area.
- Facilitates protection of buildings or critical infrastructure located on existing land more than 30 feet away from seawall / shoreline.
- Minimizes outdoor private land use impacts.
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### Summary:

**Central Wharf**

**Location:**
- Asset: Rowes Wharf
- Group: Elevated Roadway & Harbour

**Social Equity & Access**

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<tr>
<th>Criteria Description</th>
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**Evaluative and Additional Benefits**

- **Feasibility**
- **Effectiveness**
- **Adaptability**

**Notes:**
- Strategic DFE-based
- Minimum DFE: 17.4
- State/Local Align: 10.24
- Solution risk and ease: 5.0 to 6.4

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**Scoring:**

1. **Feasibility**
   - Meets criteria for public access, including waterfront recreational uses
   - Protects all critical infrastructure from storm surge
   - Raises ground surface ≥ 2 feet within 30 feet of buildings, tunnels, or large diameter sewers; practical mitigation strategies have been identified
   - Protects all critical infrastructure from storm surge
   - Partial protection from storm surge
   - Inadequate protection from storm surge

2. **Effectiveness**
   - Provides new opportunities for trees, living shorelines, or wetlands
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   - Minimizes permitting risks
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**Additional Benefits**

- **Preserves & enhances environmental resources**
- **Preserves & enhances outdoor public spaces**
- **Preserves & enhances emergency access**
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- **Preserves & enhances green infrastructure**
- **Preserves & enhances water transportation functions and access**
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**Adaptability**

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**Summary:**

**Wharf District Resiliency Plan**

**Central Wharf**

**Location:**
- Asset: Rowes Wharf
- Group: Elevated Roadway & Harbour

**Social Equity & Access**

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**Summary:**

**Wharf District Resiliency Plan**

**Central Wharf**

**Location:**
- Asset: Rowes Wharf
- Group: Elevated Roadway & Harbour

**Social Equity & Access**

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### Summary:

**Central Wharf**

**Location:**
- Asset: Waterfront
- Building: Central Wharf
- Project: Phase I - Major

**Social Equity & Access**

**Environmental and Additive Benefits**

**Effectiveness**

**Feasibility**

**Adaptability**

**Notes:**
- Strategy: DFE inland
- Minimum DFE: 15.0
- Ground Elevation at Aligned: 3.0
- Solution min and max: 3.0

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**Notes:**
- Strategy: DFE inland
- Minimum DFE: 15.0
- Ground Elevation at Aligned: 3.0
- Solution min and max: 3.0

### Additional Benefits:
- Waters Edge
- Location:
- PJN: 286982-00
- Central Wharf
- Wharf District Resiliency Plan

**Scoring:**
- Summary:
- Date Revised:
- Date: 11/18/2022
- Created By: KS

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### Additional Information:

- Central Wharf
- Wharf District Resiliency Plan
- Summary:
- Date Revised:
- Date: 11/18/2022
- Created By: KS
Central Wharf

Summary:

Location: Central Wharf

Overview:

- Central Wharf
- Objectives: Resilience, Sustainability, and Community Engagement
- Strategies: Flood Mitigation, Green Infrastructure, and Public Access Improvements

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Notes:

- Strategic DFE identified
- Minimum DFE: 19.1
- PJN: 286982-00
- Checked By: DA
- Created By: KS
- Date: 11/18/2022
Central Wharf

Summary:

- **Location:** Honan Edge
- **Area:** Dock
- **Ground Elevation at Allignmen:** Dock 6 ft above mean high tide
- **ELEVATED DOCK ACCESS**

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**Notes:**
- Strategy DCE listed
- Minimum GDE: 10.0
- Solution min and max: 10.0
- PJN: 286982-00
- Project: Central Wharf

**Scoring:**

1. **Efficiency & Access**
   - **Prerequisites:**
     - Facilitates protection of buildings
     - Minimizes deployment complexity
     - Preserves & enhances docks & water transportation functionality and access
     - Compatible with existing property-specific access and land use
     - Minimizes impact on seawalls & structural deck

   - **Solution:**
     - Increases dock area, or increases or improves water transportation access points, or facilitates development of a new water transportation center at Long Wharf

   - **Assessment:**
     - **Score:** 4.0
     - **Recommended Issue:**
       - Provides opportunities for phased implementation

2. **Effectiveness**
   - **Prerequisites:**
     - Minimizes impact on seawalls & structural deck
     - Minimizes ground settling & coastal erosion

   - **Solution:**
     - Facilitates reduction in the number of access routes to the waterfront, and no loss of functionality of existing access program to loading areas, building entrances, or parking garages

   - **Assessment:**
     - **Score:** 3.0
     - **Recommended Issue:**
       - Provides opportunities for phased implementation

3. **Feasibility**
   - **Prerequisites:**
     - Minimizes deployment complexity
     - Mitigates existing known coastal erosion and/or settlement

   - **Solution:**
     - Preserves & enhances non-emergency access to the waterfront, public transportation, & buildings

   - **Assessment:**
     - **Score:** 3.0
     - **Recommended Issue:**
       - Provides opportunities for phased implementation

4. **Adaptable**
   - **Prerequisites:**
     - Compatible with existing property-specific access and land use
     - Minimizes impact on seawalls & structural deck

   - **Solution:**
     - Preserves & enhances docks & water transportation functionality and access

   - **Assessment:**
     - **Score:** 4.0
     - **Recommended Issue:**
       - Provides opportunities for phased implementation

**Notes:**
- Strategic DCE listed
- Minimum GDE: 10.0
- Solution min and max: 10.0
- PJN: 286982-00
- Project: Central Wharf

**Effectiveness:**

- **Summary:**
  - **Score:** 3.0
  - **Recommended Issue:**
    - Provides opportunities for phased implementation
### Central Wharf

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<td>Minimizes ground settlement &amp; flooding at abutting properties</td>
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<tbody>
<tr>
<td>1. <strong>Social Equity &amp; Access</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1. Accessibility and Inclusive Access</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2. Social Equity &amp; Access</td>
<td>Inclusive within walking distance of public transportation, public facilities, pedestrian and bicycle pathways</td>
<td>0.6</td>
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<td>1.3. Social Equity &amp; Access</td>
<td>Use of area for recreation, public transportation, and public spaces</td>
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<td>Accessibility for all, including transportation, pedestrian, bicycle, and emergency access</td>
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<tr>
<td>2. <strong>Elevated or Constructed Land</strong></td>
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<tr>
<td>2.1. Elevated or Constructed Land</td>
<td>Elevation of property above flood elevation</td>
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<tr>
<td>2.2. Elevated or Constructed Land</td>
<td>Inclusion of an elevated or constructed land area</td>
<td>0.5</td>
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</table>

### Notes:

- Strategic DFE listed
- Minimum DFE
- Solution min and max
- Solution score
- PJN: 286982-00

### Summary:

- **Central Wharf**

- **Location:** Outdoor
- **Asset:** Open space
- **Group:** Developed or Constructed Land

- **Social Equity & Access**
  - **Accessibility and Inclusive Access**
  - **Social Equity & Access**
  - **Social Equity & Access**

- **Elevated or Constructed Land**
  - **Elevated or Constructed Land**
  - **Elevated or Constructed Land**

- **Notes:**
  - Strategic DFE listed
  - Minimum DFE
  - Solution min and max
  - Solution score
  - PJN: 286982-00
Due Diligence and Multi-Criteria Assessment Findings: Harbor Towers

This plan summarizes key considerations associated with the selection and design of potential flood resiliency strategies, and the findings of a multi-criteria assessment used to identify strengths and weaknesses of potential flood resiliency strategies.

**KEY PLAN AND LEGEND**

- **LIMIT OF STUDY AREA**
- **INLAND PRELIMINARY ALIGNMENT**
- **WATERS EDGE PRELIMINARY ALIGNMENT**
- **OUTBOARD PRELIMINARY ALIGNMENT**
- **MAJOR FLOW LINES (CRS)**
- **MAJOR RAINFALL PATHS**
- **SEAWALL**
- **SLURRY WALL**
- **1" CONTOUR LINES (LOAR)**
- **MBA SILVERLINE EASEMENT**
- **SPOT GRADE (ARTICLE 37)**
- **SPOT GRADE (DATA REPOSITORY)**
- **EMERGENCY ACCESS POINT**
- **ACCESSIBILITY POINT**
- **BUS STOPS**
- **WATER TRANSPORTATION ACCESS POINT**
- **VEHICULAR ACCESS POINT**
- **VNX & SWN CRABF**

**EXISTING CONDITIONS AND ACCESS CONSIDERATIONS PLAN**

Resiliency system alignment locations indicated on this Existing Conditions and Access Considerations Plan are based on the City of Boston's Climate Ready Boston reports and may vary from the proposed Preliminary Resiliency System alignments indicated on subsequent plan sheets, which have been informed by site-specific analyses undertaken during this project.

**EXPLANATION & RECOMMENDATIONS**

**Geotechnical:** The buildings are supported by piles bearing in the underlying glacial till and bedrock at depths exceeding 95-ft below ground.

**Coastal Structures:** The existing seawalls have experienced settlement, bowing, cracking, and movement. Existing timber piles supporting the sea walls are deteriorated due to marine borers.

**Utilities:** Condenser and condensate pipe easements between Harbor Garage and Harbor Tower 2 site. Storm sewer easement between Harbor Tower 1 & 2 for 10" storm pipe. No major sewer outfalls were identified, but storm, sewer and water pipes run east-west along East India Row.

**Flood Flow Path:** No major rainfall flow path on site.

**Access:** Emergency access to the buildings and waterfront is via East India Row for EMS vehicles & via water access for fire boats.

**Additional Considerations:** The Harborwalk currently experiences flooding during some high tide events. Outdoor public art installation may need to remain on site. The City's Climate Ready Boston reports indicate resiliency systems south of Harbor Towers may not be constructed until the 2050s.

**FINDINGS & RECOMMENDATIONS**

**Prerequisite Criteria:** The Inland Alignment strategies are not preferred as they receive Poor scores for Social Equity & Access due to obstructing water views, and reducing emergency and non-emergency access to the Harborwalk and Harbor Towers buildings.

**Constructability Criteria:** The Outboard Alignment Elevated or Constructed Land strategy is the most constructable strategy in this context, and also scores the highest for the Prerequisite Criteria. No significant relative differences were identified between the Water's Edge Alignment strategies.

**Recommendations:** The Elevated or Constructed Land strategy at the Outboard Alignment should be considered for the Preferred Flood Protection System, and should incorporate strategies to minimize the following impacts associated within inflit of the Harbor: permitting risks, construction costs, environmental impacts, and boat access. In particular, Elevated Dock Access should be considered at the existing marina.

An Alternative Flood Protection System at the Water's Edge Alignment should be considered and may incorporate any of the Water's Edge strategies.
### Solutions List

<table>
<thead>
<tr>
<th>INDEX</th>
<th>GROUP 5</th>
<th>Solutions List</th>
<th>Inland</th>
<th>Waters Edge</th>
<th>Outboard</th>
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<tr>
<td>1</td>
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<tr>
<td>2i</td>
<td></td>
<td>Floodwall</td>
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<tr>
<td>3w</td>
<td>Harbor Walk</td>
<td>Raised/Stepped/Social</td>
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<td></td>
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<tr>
<td>4w</td>
<td></td>
<td>Over Water</td>
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<td></td>
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<td>5w,5o</td>
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<td>Elevated/Constructed Land</td>
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<tr>
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<td>Open Space</td>
<td>Elevated/Constructed Land</td>
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<tr>
<td>7w</td>
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<tr>
<td>8</td>
<td>Roadway</td>
<td>Elevated</td>
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### Notes:

1. Actual benefits and trade-offs of flood resiliency strategies will be subject to numerous site-specific considerations and can be influenced by a variety of factors.
2. Critical Infrastructure is defined in Section 2.0 of Boston Public Works Department 2018 Climate Resilient Design Standard & Guidelines.
3. In-kind dock replacement includes relocation to an area on the same property with similar or greater footprint, water depth, and design.
4. National Register of Historic Places structures in the study area include the Long Wharf and Custom House Block, and the seawall between the wharves.

### Definitions:

Facilities of Public Accommodation ("FPAs") are qualified under the State's Waterways Regulations (Chapter 91) as "facilities at which goods are transferred or handled from water to land, or vice versa."

A Wharf is a level concrete, stone, or metal platform lying alongside or projecting into water to which a ship may be moored to load and unload. Adequate water depth for ships must exist alongside the structure to be defined as a wharf. The structure must be of adequate size and configuration to allow ships to moore to be defined as a wharf.

### Critical Infrastructure(2)

- Hospitals and health care facilities
- Emergency Response (Police, Fire, Rescue, Ambulance) facilities and related items (garages, shelters, operations centers, communications, back-up generators, substations, etc.)
- Correctional facilities
- Wastewater treatment plants
- Water storage tanks
- Operations centers
- Public works yards
- Municipal buildings
- Schools and facilities that may be used as emergency shelters
- Power transmission facilities, substations, and power generation stations
- Critical transportation networks (emergency evacuation routes, public transportation, aviation facilities, tunnels, bridges, train and transit maintenance yards and shops, traffic signals)
- Facilities where residents have limited mobility or ability (such as nursing homes and care facilities)
- Buildings or structures that contain hazardous waste; waste transfer stations
- Pumping stations (stormwater and sanitary)
- Fueling storage and fuel stations
- Ventilation buildings and fan plants
- Telecommunications
- Major food distribution centers
## Harbor Towers

### Summary:

<table>
<thead>
<tr>
<th>Group</th>
<th>Property</th>
<th>Location</th>
<th>Asset</th>
<th>Solution</th>
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<tbody>
<tr>
<td>Group 5</td>
<td>P06-Harbor Towers</td>
<td>17.2</td>
<td>Building</td>
<td>Floodwall</td>
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### Scoring:

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<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Score</th>
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<tbody>
<tr>
<td><strong>Floodwall</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Floodwall</strong></td>
<td>No flood wall</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Floodwall</strong></td>
<td>Flood wall not meet Target DFE</td>
<td>-3</td>
<td></td>
</tr>
<tr>
<td><strong>Assessment Criteria</strong></td>
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<tr>
<td><strong>Social Equity &amp; Access</strong></td>
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<tr>
<td>Social Equity &amp; Access</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental and Additional Benefits</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Adaptability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feasibility</td>
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<td></td>
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</tbody>
</table>

### Notes:

- Strategic DFE inland: 17.2
- Minimum DFE: 15
- Ground Elevation at Alignment: 10-13.4
- Solution center and rise example: S.S Floodwall

### Environmental and Additional Benefits

| Access | Preserves & enhances emergency harbor spaces, including welcoming & of wharves and historic resources including the functionality & visibility impacts of water transportation access points, or in-kind replacements.
|---|---|
| Accessibility | Strategy located on existing land (30 feet of coastal structure, project the flood protection system for the district). No reduction in size of, number of access points, or in-kind replacements.
| Benefits | Strategy located on existing land (30 feet of coastal structure, project the flood protection system for the district). No reduction in size of, number of access points, or in-kind replacements.

### Feasibility

- Transportation Access Points, Water Transportation Access Points, waterfront facilities, parking, existing emergency access routes to buildings or public space, and non-pedestrian areas.
- Preserves or creates land for rainfall storage & pumping system at the flood protection system.
- Minimizes deployment complexity.
- Minimizes long term operations & maintenance costs.
- Minimizes impacts to existing structures or coastal features.
- Minimizes impacts to waterways or adjacent public accommodations.

### Effectiveness

- Inland Building:
- Floodwall

### Group 5 / P06 - Harbor Towers

- Strategic DFE inland: 17.2
- Minimum DFE: 15
- Ground Elevation at Alignment: 10-13.4
- Solution center and rise example: S.S Floodwall

---

**Assessment Score**

- **Social Equity & Access:** 4
- **Environmental and Additional Benefits:** 2
- **Feasibility:** 0
- **Adaptability:** 3

---

**Preserves & enhances emergency harbor spaces, including welcoming & of wharves and historic resources including the functionality & visibility impacts of water transportation access points, or in-kind replacements.**

- Strategy located on existing land (30 feet of coastal structure, project the flood protection system for the district). No reduction in size of, number of access points, or in-kind replacements.

---

**Assessment Score**

- **Social Equity & Access:** 4
- **Environmental and Additional Benefits:** 2
- **Feasibility:** 0
- **Adaptability:** 3

---

**Preserves & enhances emergency harbor spaces, including welcoming & of wharves and historic resources including the functionality & visibility impacts of water transportation access points, or in-kind replacements.**

- Strategy located on existing land (30 feet of coastal structure, project the flood protection system for the district). No reduction in size of, number of access points, or in-kind replacements.

---

**Assessment Score**

- **Social Equity & Access:** 4
- **Environmental and Additional Benefits:** 2
- **Feasibility:** 0
- **Adaptability:** 3

---

**Preserves & enhances emergency harbor spaces, including welcoming & of wharves and historic resources including the functionality & visibility impacts of water transportation access points, or in-kind replacements.**

- Strategy located on existing land (30 feet of coastal structure, project the flood protection system for the district). No reduction in size of, number of access points, or in-kind replacements.
<table>
<thead>
<tr>
<th>Scoring:</th>
<th>Criteria Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Score</th>
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<tbody>
<tr>
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<td>Group / Property</td>
<td>Group / P06 - Harbor Towers</td>
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<tr>
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<td></td>
<td>Location</td>
<td>Solution</td>
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<td>Group</td>
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<tr>
<td></td>
<td>Location</td>
<td>Location</td>
<td>Location</td>
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</table>

### Harbor Towers

#### Summary:

- **Group / Property:** Group / P06 - Harbor Towers
- **Location:** Intact
- **Asset:** Intact
- **Solution:** Elevated or Constructed Land

#### Effectiveness

- Criteria: Location, Location, Location
- Assessment: Group
- Score: 4 to 7.2

#### Feasibility

- Criteria: Location, Location, Location
- Assessment: Group
- Score: 0 to 0.6

#### Adaptability

- Criteria: Location, Location, Location
- Assessment: Group
- Score: 0.75

#### Social Equity & Access

- Criteria: Location, Location, Location
- Assessment: Group
- Score: 15

---

#### Scoring Key:

- **Location:** Group / Property, Location
- **Assessment:** Group, Property
- **Score:** 4 to 7.2, 0 to 0.6, 0.75, 15

---

#### Notes:

- **Location:** Group / Property
- **Solution:** Elevated or Constructed Land
- **Score:** 4 to 7.2
- **Condition Rating:** Intact

---

#### Harbor Towers

- **Location:** Group / Property
- **Asset:** Intact
- **Solution:** Elevated or Constructed Land

---

#### Harbor Towers

- **Location:** Group / Property
- **Asset:** Intact
- **Solution:** Elevated or Constructed Land

---

#### Harbor Towers

- **Location:** Group / Property
- **Asset:** Intact
- **Solution:** Elevated or Constructed Land

---

#### Harbor Towers

- **Location:** Group / Property
- **Asset:** Intact
- **Solution:** Elevated or Constructed Land
# Harbor Towers

## Summary:

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<tbody>
<tr>
<td>Location</td>
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<tr>
<td>Asset</td>
<td>Harborwalk</td>
</tr>
<tr>
<td>Solution</td>
<td>Raised/Stepped</td>
</tr>
</tbody>
</table>

## Group 5:  

### Feasibility

- **Notes:**
  - Strategic DFE: water edge
  - Minimum DFE: 15
  - Ground Elevation at Alignment: 7.2 ± 1.1 ft
  - Solution min and max example: raise seawall to 12.2’ (3.7 m, south side of property; 5.1’ (1.5 m, north side of property); install 3 solid wall + 4 glass wall on top of harborwalk, vertical wall from water side edge of seawall to top

### Environmental and Social Benefits

- **Social Equity & Access**
  - Minimizes outdoor private land use
  - Preserves & enhances docks & waterfront
  - Minimizes structural decks
  - Minimizes permitting risks
  - Minimizes impacts to seawalls & structural decks

### Effectiveness

- **Compatibility with existing property relationships**
- **Compatibility with existing property relationships**
- **Compatibility with existing property relationships**
- **Compatibility with existing property relationships**

### Adaptable

- **Environmental and Additional Criteria Description**

### Scoring:

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<tbody>
<tr>
<td></td>
<td>Raised/Stepped</td>
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<td></td>
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### Notes:

- **Environmental and Additional Criteria Description**

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### Notes:

- **Environmental and Additional Criteria Description**

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### Notes:

- **Environm...
## Harbor Towers

**Summary:**

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<th>Group / Property</th>
<th>Location</th>
<th>Asset</th>
<th>Solution</th>
<th>Group 0.6 - Harbor Towers</th>
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<tbody>
<tr>
<td></td>
<td>Harbor Walk</td>
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### Effectiveness

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<th>Assessment Criteria</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes. Target DFE can be raised to TF-3.</td>
<td>1</td>
</tr>
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</table>

### Adaptable

<table>
<thead>
<tr>
<th>Policy Area</th>
<th>Description</th>
<th>Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>No practical mitigation strategies have been identified.</td>
<td>3</td>
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</table>

### Environmental and Additional Benefits

<table>
<thead>
<tr>
<th>Policy Area</th>
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<tbody>
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<td></td>
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<td>No practical mitigation strategies have been identified.</td>
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</tbody>
</table>

### Social Equity & Access

<table>
<thead>
<tr>
<th>Policy Area</th>
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<th>Criteria</th>
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<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>No practical mitigation strategies have been identified.</td>
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</tr>
</tbody>
</table>

### Notes

- Strategic DFE: waters edge
- Maximum DFE: 10
- Ground Elevation at Alignment: 7 to 11 ft
- Solution min and max: 5 ft to 12 ft
- Example cases: high-rise to 12.2 ft (south side of property); 5.1 ft (north side of property); install 0.5 ft solid wall + 0.5 ft glass wall on top of seawall, vertical wall from land-side edge of seawall to seaward

### Scoring

<table>
<thead>
<tr>
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<tbody>
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<td></td>
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<td>No practical mitigation strategies have been identified.</td>
<td>3</td>
</tr>
</tbody>
</table>

### Assessment Criteria

<table>
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<tr>
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<th>Description</th>
<th>Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Score</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>No practical mitigation strategies have been identified.</td>
<td>3</td>
</tr>
</tbody>
</table>

### Analysis

- Strategic DFE: waters edge
- Maximum DFE: 10
- Ground Elevation at Alignment: 7 to 11 ft
- Solution min and max: 5 ft to 12 ft
- Example cases: high-rise to 12.2 ft (south side of property); 5.1 ft (north side of property); install 0.5 ft solid wall + 0.5 ft glass wall on top of seawall, vertical wall from land-side edge of seawall to seaward

### Conclusion

Harbor Towers meets the Target DFE of TF-3-1. The project can be raised to TF-3.1 by incorporating the following strategies:

- **Improve tidal flows and water circulation**
  - installing high-flow seepage measures
  - promoting high-flow seepage measures

- **Reduce coastal erosion**
  - installing coastal dune systems
  - promoting coastal dune systems

- **Increase water access**
  - installing water access systems
  - promoting water access systems

- **Increase public access**
  - installing public access systems
  - promoting public access systems

- **Preserve and enhance environmental resources**
  - installing wetland preservation measures
  - promoting wetland preservation measures

- **Preserve and enhance social equity and access**
  - installing social equity measures
  - promoting social equity measures

- **Preserve and enhance cultural resources**
  - installing cultural resource preservation measures
  - promoting cultural resource preservation measures

- **Preserve and enhance coastal and ocean resources**
  - installing coastal and ocean resource preservation measures
  - promoting coastal and ocean resource preservation measures

- **Preserve and enhance transportation and land use**
  - installing transportation and land use preservation measures
  - promoting transportation and land use preservation measures

These strategies will ensure that Harbor Towers meets the Target DFE of TF-3-1 and can be raised to TF-3.1.
Harbor Towers

Summary:

<table>
<thead>
<tr>
<th>Group / Property</th>
<th>Group / Property</th>
<th>Location</th>
<th>Asset</th>
<th>Solution</th>
<th>Adaptability</th>
<th>Environment and Additional Benefits</th>
<th>Social Equity &amp; Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 5 / 100 - Harbor Towers</td>
<td>Group 5 / 100 - Harbor Towers</td>
<td>Waters Edge</td>
<td>Harbor Walk</td>
<td>Elevated or Constructed Land</td>
<td>3</td>
<td>1</td>
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**Assessment Score**

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Possible Equations</th>
<th>Ass. Criteria (D)</th>
<th>Target</th>
<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Feasibility</strong></td>
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<tr>
<td><strong>Popularity</strong></td>
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<tr>
<td><strong>Effectiveness</strong></td>
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<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

**Notes:**

- Strategic DFE waters edge
- Minimum DFE
- Ground Elevation at Alignment
- Solution min and max
- Example: raise harborwalk to 12.3’ (2.3’ tall @ south side of property; 5.1’ @ north side of property); install 3’ solid wall + 4’ glass wall on top of seawall / shoreline, or impacts the visibility or use of the harborwalk, and maintains access to docks (e.g. partially obstructed views, or is preferred by property owner)

**Scoring:**

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</thead>
<tbody>
<tr>
<td>- Minimizes ground settlement &amp; structural subsidence</td>
<td>None</td>
<td>- does not block major rainfall path to the harbor; no structural mitigation strategies identified</td>
<td>3</td>
</tr>
<tr>
<td>- Minimizes impacts to research &amp; structural data</td>
<td>None</td>
<td>- does not block major rainfall path to the harbor; no structural mitigation strategies identified</td>
<td>3</td>
</tr>
<tr>
<td>- Minimizes permitting risks</td>
<td>None</td>
<td>- does not block major rainfall path to the harbor; no structural mitigation strategies identified</td>
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</tr>
<tr>
<td>- Minimizes construction cost</td>
<td>None</td>
<td>- does not block major rainfall path to the harbor; no structural mitigation strategies identified</td>
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<tr>
<td>- Minimizes long-term operations &amp; maintenance costs</td>
<td>None</td>
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**Effective Risk:**

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<td>- Minimizes permitting risks</td>
<td>None</td>
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<tr>
<td>- Minimizes construction cost</td>
<td>None</td>
<td>- does not block major rainfall path to the harbor; no structural mitigation strategies identified</td>
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<tr>
<td>- Minimizes long-term operations &amp; maintenance costs</td>
<td>None</td>
<td>- does not block major rainfall path to the harbor; no structural mitigation strategies identified</td>
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**Ineffective Risk:**

<table>
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<tr>
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<th>Ass. Criteria (D)</th>
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<tr>
<td>- Minimizes ground settlement &amp; structural subsidence</td>
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<td>None</td>
<td>- does not block major rainfall path to the harbor; no structural mitigation strategies identified</td>
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<tr>
<td>- Minimizes construction cost</td>
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<td>- does not block major rainfall path to the harbor; no structural mitigation strategies identified</td>
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<tr>
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<td>None</td>
<td>- does not block major rainfall path to the harbor; no structural mitigation strategies identified</td>
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<td></td>
</tr>
</tbody>
</table>
## Harbor Towers

### Summary:
- **Group / Property:** Group 5
- **Location:** P06 - Harbor Towers
- **Asset:** Water's Edge
- **Solution:** Elevated Dock Access

### Feasibility

#### Effectiveness
- Preserves & enhances outdoor public spaces or creates new open public spaces
- Improves function of existing public access points, or is preferred by public accommodation
- Improves the visibility or usability of the Historic Significance or Historic Structure
- Improves the function or historical significance of the Historic Significance or Historic Structure

#### Adaptability
- Preserves & enhances environmental resources
- Preserves & enhances historic dockside & water transportation functionality and access

#### Environmental & Additional Benefits
- Minimizes long term operations & maintenance costs
- Minimizes construction cost
- Minimizes flooding at abutting properties
- Preserves & enhances structural decks
- Minimizes structural decks
- Minimizes Outdoor private land use issues

### Scoring:

#### Criteria Description

<table>
<thead>
<tr>
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</tbody>
</table>

#### Notes:
- Strategic DFE: South end of the district, north side of property
- Minimum DFE: Water's Edge
- Strategic Height: 12.3' (2.3' tall @ north side of property; 5.1' @ south side of property)
- Example: use height of 12.3' (2.3' tall @ north side; 5.1' @ south side) at Roediger Point; 12.3' tall @ north side; 5.1' @ south side)

#### Ground Elevation at Alignment

<table>
<thead>
<tr>
<th>Ground Elevation at Alignment</th>
<th>Minimum DFE</th>
<th>Strategic DFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solution max &amp; min</td>
<td>12.3'</td>
<td>12.3'</td>
</tr>
</tbody>
</table>

#### Social Equity & Access

- Minimizes flooding at abutting properties
- Preserves & enhances outdoor public spaces or creates new open public spaces
- Improves function of existing public access points, or is preferred by public accommodation
- Increases the visibility or usability of the Historic Significance or Historic Structure
- Improves the function or historical significance of the Historic Significance or Historic Structure

#### Preserves & enhances environmental resources

- Requires reduction of existing dock area or replacements(3) identified for any reduction of existing dock area or replacement
- Increases dock area, or increases water transportation access points, or is preferred by dock owner

#### Preserves & enhances historic dockside & water transportation functionality and access

- Requires reduction in function of submerged land use, or not preferred by property owner
- No impact on planned land use
- Incorporates elements of current infrastructure or equivalent placement

#### Preserves & enhances outdoor private land use issues

- Requires open private space size or access points
- Increases dock area, or increases water transportation access points, or is preferred by dock owner

#### Preserves & enhances structural decks

- Requires reduction in function of submerged land use, or not preferred by property owner
- No impact on planned land use
- Incorporates elements of current infrastructure or equivalent placement

#### Preserves & enhances outdoor public spaces, including waterfront & recreational spaces

- Increases the visibility or usability of the Historic Significance or Historic Structure
- Improves the function or historical significance of the Historic Significance or Historic Structure
- Increases the size of number of open public spaces
- Increases the size of number of open public spaces
- Increases the size of number of open public spaces

#### Preserves & enhances non-emergency access to the waterfront, public transportation, & buildings

- Increases the number of emergency access routes to the waterfront
- Improves function of existing emergency access routes to buildings or parking
- Improves function of existing emergency access routes to buildings or parking
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- Improves function of existing emergency access routes to buildings or parking

#### Preserves & enhances emergency access

- Increases the number of emergency access routes to the waterfront
- Improves function of existing emergency access routes to buildings or parking
- Improves function of existing emergency access routes to buildings or parking
- Improves function of existing emergency access routes to buildings or parking
- Improves function of existing emergency access routes to buildings or parking

#### Preserves & enhances non-emergency access to the waterfront, public transportation, & buildings

- Increases the number of non-emergency access points
- Increases the number of non-emergency access points
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- Increases the number of non-emergency access points

#### Preserves & enhances historic dockside

- Increases the number of non-emergency access points
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- Increases the number of non-emergency access points

#### Minimizes ground settlement & subsurface erosion

- Increases ground surface 2 feet within 20 feet of buildings, structures, or large diameter sewer, so as practical mitigation strategies have been identified
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#### Minimizes impacts to research & structural decks

- Increases ground surface 2 feet within 20 feet of buildings, structures, or large diameter sewer, so as practical mitigation strategies have been identified
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#### Minimizes parking issues

- Strategic located outboard of existing seawall/abutment, or replaces existing coastal structure with Condition Rating of "Poor" or lower
- Strategic located outboard of existing seawall/abutment, or replaces existing coastal structure with Condition Rating of "Poor" or lower
- Strategic located outboard of existing seawall/abutment, or replaces existing coastal structure with Condition Rating of "Poor" or lower
- Strategic located outboard of existing seawall/abutment, or replaces existing coastal structure with Condition Rating of "Poor" or lower
- Strategic located outboard of existing seawall/abutment, or replaces existing coastal structure with Condition Rating of "Poor" or lower

#### Preserves & enhances view of the waterfront (including living shorelines, or wetlands)

- Preserves & enhances view of the district’s heritage and history, including wharfs or trees, living shorelines, or wetlands
- Preserves & enhances view of the district’s heritage and history, including wharfs or trees, living shorelines, or wetlands
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<th>Assessment Score</th>
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</thead>
<tbody>
<tr>
<td>1. Feasibility</td>
<td>Good</td>
<td>Good</td>
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<tr>
<td>2. Adaptable</td>
<td>Superior</td>
<td>Superior</td>
<td>3.0</td>
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<tr>
<td>3. Environmental and Additional Benefits</td>
<td>Good</td>
<td>Good</td>
<td>5.0</td>
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<tr>
<td>4. Social Equity &amp; Access</td>
<td>Good</td>
<td>Good</td>
<td>5.0</td>
</tr>
</tbody>
</table>

## Notes:
- Strategic DFE: waters edge
- Minimum DFE: 19.3
- Strategic DFE: 30.2
- Minimum Distance to Adjacent Resource: 0
- Minimum Shoreline Alignment to Strategic DFE: 0
- Designated Public Accommodation: Public Accommodation

## Scoring:
- Harbor Towers

### Facilities
- 5

### Effectiveness
- 5

### Feasibility
- 5

### Adaptability
- 3

### Environmental and Additional Benefits
- 5

### Social Equity & Access
- 5

---

**Assessment Criteria:***
- Poor: requires significant reduction in function of planned land use, or not preferred by property owner
- Good: requires minimal reduction in function of planned land use, or not preferred by property owner
- Superior: requires no reduction in function of planned land use

---

**Screening Criteria:***
- $G_5$ (30.2 feet of buildings, tunnels, or large diameter sewer; no practical mitigation strategies identified): Determines if the building, tunnel, or large diameter sewer is within the 30.2 feet of buildings, tunnels, or large diameter sewer.
- $G_6$ (includes movable or deployable structures located on existing land, offshore, or in deep water): Determines if the movable or deployable structures are located on existing land, offshore, or in deep water.
- $G_7$ (reduces opportunity for planned implementation): Determines if the reduction in opportunity for planned implementation is significant.

---

**Assessment Score:**
- 5.0: Superior
- 3.0: Good
- 0.0: Poor

---

**Notes:**
- Strategic DFE: waters edge
- Minimum DFE: 5.0
- Ground Elevation at Alignment: 73.0 to 11.0
- Solution min and max: 5.0 to 12.0
- Example: new levee constructed to a min & max elevation and a max 90° wall on top of historic structures; vertical wall from water side edge of historic structures to seawall; sloping shoreline from water side edge of historic structures to seawall.
## Harbor Towers

### Summary:

**Group / Property:** Group 5 / 06 - Harbor Towers  
**Location:** Open Space  
**Asset:** Elevated or Constructed Land  
**Solution:** 5

**Efficiency:**  
No potential for phased implementation (is preferred by property owner)  
Meets Target DFE (performance criteria met)  
No impact on existing land use  
Preserves & enhances view of the harbor, or increases harborwalk width or facilities of public accommodation (meets Target DFE)  
Preserves & enhances view of the harbor (meets Target DFE)  
Improves function of emergency access routes to buildings or docks  
Maintains or increases open public space, or creates new open public space  
No reduction in the number of access points to, or signage for open public space  
Cost conforms to Strategic DFE

**Feasibility:**  
No changes to ground surface exceeding 2 feet within 30 feet of buildings, houses, or large diameter sewer; practice mitigation strategies have been identified  
No changes to ground surface exceeding 2 feet within 30 feet of buildings, houses, or large diameter sewer  
No changes to ground surface exceeding 2 feet within 30 feet of buildings, houses, or large diameter sewer  
No impacts on existing flood protection system or critical infrastructure  
No changes to ground surface exceeding 2 feet within 30 feet of buildings, houses, or large diameter sewer

**Adaptability:**  
No changes to ground surface exceeding 2 feet within 30 feet of buildings, houses, or large diameter sewer; practice mitigation strategies have been identified  
No changes to ground surface exceeding 2 feet within 30 feet of buildings, houses, or large diameter sewer  
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**Environmental and Additional Benefits:**  
Provides opportunities for phased implementation  
Preserves & enhances environmental resources (e.g. fully eliminates existing dock area or the reduction of existing dock area or water transportation access points)  
Preserves & enhances outdoor public space, in-kind replacements(3) identified for any reduction of existing dock area or water transportation access points  
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**Social Equity & Access:**  
Preserves & enhances outdoor public space, in-kind replacements(3) identified for any reduction of existing dock area or water transportation access points  
Preserves & enhances environmental resources (e.g. fully eliminates existing dock area or the reduction of existing dock area or water transportation access points)  
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<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong></td>
<td>Impact of proposed coastal system on adjacent buildings and critical infrastructure</td>
<td>Strategy located outboard of existing seawall/ shoreline; no protected parking strategy identified</td>
<td>strategy located outboard of existing seawall/ shoreline; no protected parking strategy identified</td>
<td>Poor</td>
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<tr>
<td></td>
<td>Minimizes coastal erosion &amp;(({footnote})</td>
<td>Strategies located outboard of existing seawall/ shoreline; no protected parking strategy identified</td>
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<td>Poor</td>
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<tr>
<td><strong>2</strong></td>
<td>Compatibility with existing property-specific plans and land use</td>
<td>Incomparable differences with planning land use; no significant reduction in function of planned land use, or not preferred by property owner</td>
<td>no significant reduction in function of planned land use, or not preferred by property owner</td>
<td>Poor</td>
</tr>
<tr>
<td></td>
<td>Compatibility with district-wide and neighborhood resiliency strategies</td>
<td>Preexisting coastal flood protection system for the district</td>
<td>Preexisting coastal flood protection system for the district</td>
<td>Poor</td>
</tr>
<tr>
<td></td>
<td>Provides opportunities for phased implementation</td>
<td>No potential for phased implementation</td>
<td>No potential for phased implementation</td>
<td>Poor</td>
</tr>
<tr>
<td></td>
<td>Environmental &amp; additional benefits</td>
<td>Preserves &amp; enhances environmental resources</td>
<td>No changes to ground surface exceeding 2 feet within 30 feet of buildings, houses, or large diameter sewer; practice mitigation strategies have been identified</td>
<td>Poor</td>
</tr>
<tr>
<td></td>
<td>Social equity &amp; access</td>
<td>Preserves &amp; enhances outdoor public space</td>
<td>No changes to ground surface exceeding 2 feet within 30 feet of buildings, houses, or large diameter sewer; practice mitigation strategies have been identified</td>
<td>Poor</td>
</tr>
</tbody>
</table>

### Notes:

- **Strategic DFE:** water edge
- **Maximum DFE:**
- **Ground Elevation at Alignment:** 73 to 11.4
- **Solution min and max:** 54 to 12
- **exit example:** new elevated seawall; 12.3 inches; 110 gallon wall on top of seawalls; vertical wall from water side edge of seawalls to eaved; slope being shoreline from water side edge of seawalls to -

### Table:

<table>
<thead>
<tr>
<th>Assessment Criteria</th>
<th>Screening Criteria</th>
<th>Assessed Criteria</th>
<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact of proposed coastal system on adjacent buildings and critical infrastructure</td>
<td>Strategy located outboard of existing seawall/ shoreline; no protected parking strategy identified</td>
<td>strategy located outboard of existing seawall/ shoreline; no protected parking strategy identified</td>
<td>Poor</td>
</tr>
<tr>
<td>Minimizes coastal erosion &amp;</td>
<td>Strategies located outboard of existing seawall/ shoreline; no protected parking strategy identified</td>
<td>strategies located outboard of existing seawall/ shoreline; no protected parking strategy identified</td>
<td>Poor</td>
</tr>
<tr>
<td>Minimizes impacts to research &amp;</td>
<td>Strategies located outboard of existing seawall/ shoreline; no protected parking strategy identified</td>
<td>strategies located outboard of existing seawall/ shoreline; no protected parking strategy identified</td>
<td>Poor</td>
</tr>
<tr>
<td>Minimizes permitting risks</td>
<td>Strategy located outboard of existing seawall/ shoreline; no protected parking strategy identified</td>
<td>strategy located outboard of existing seawall/ shoreline; no protected parking strategy identified</td>
<td>Poor</td>
</tr>
<tr>
<td>Minimizes construction cost</td>
<td>Strategy located outboard of existing seawall/ shoreline; no protected parking strategy identified</td>
<td>strategy located outboard of existing seawall/ shoreline; no protected parking strategy identified</td>
<td>Poor</td>
</tr>
<tr>
<td>Minimizes long term operations &amp; maintenance costs</td>
<td>Strategy located outboard of existing seawall/ shoreline; no protected parking strategy identified</td>
<td>strategy located outboard of existing seawall/ shoreline; no protected parking strategy identified</td>
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<td>No changes to ground surface exceeding 2 feet within 30 feet of buildings, houses, or large diameter sewer; practice mitigation strategies have been identified</td>
<td>Poor</td>
</tr>
</tbody>
</table>

---

*Footnotes:*  
(1) Preserves & enhances environmental resources include infill of the Harbor that isn’t a living shoreline or wetland; requires significant reduction in the number access points, or in-kind replacements (3) identified for any reduction of existing dock area or water transportation access points.  
(2) Preserves & enhances environmental resources include infill of the Harbor that isn’t a living shoreline or wetland; requires significant reduction in the number access points, or in-kind replacements (3) identified for any reduction of existing dock area or water transportation access points.  
(3) Preserves & enhances environmental resources include infill of the Harbor that isn’t a living shoreline or wetland; requires significant reduction in the number access points, or in-kind replacements (3) identified for any reduction of existing dock area or water transportation access points.
Due Diligence and Multi-Criteria Assessment Findings: Rowes Wharf

This plan summarizes findings of a multi-criteria assessment used to identify strengths and weaknesses of potential flood resiliency strategies.

**KEY PLAN AND LEGEND**

- LIMIT OF STUDY AREA
- INLAND PRELIMINARY ALIGNMENT
- WATERS EDGE PRELIMINARY ALIGNMENT
- OUTBOARD PRELIMINARY ALIGNMENT
- MAJOR FLOW LINES (CFR)
- MAJOR RAINFALL PATHS
- SEAWALL
- SLURRY WALL
- 1' CONTOUR LINES (LDAR)
- MBTA SILVERLINE EASEMENT
- SPOT GRADE (ARTICLE 37)
- SPOT GRADE (LDAR)
- SPOT GRADE (DATA REPOSITORY)
- EMERGENCY ACCESS POINT
- ACCESSIBILITY POINT
- BUS STOPS
- WATER TRANSPORTATION ACCESS POINT
- VEHICULAR ACCESS POINT
- VENTILATION GRATE

The preliminary plan includes alignments based off of Climate Ready Boston report. Alignments may vary in this report based on recommendations.

**MULTI-CRITERIA ASSESSMENT**

<table>
<thead>
<tr>
<th>Assessment Key:</th>
<th>WATER’S EDGE</th>
<th>OUTBOARD</th>
<th>INLAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td>RAISED/STEPED</td>
<td>ELEVATED:</td>
<td>ELEVATED:</td>
</tr>
<tr>
<td>Good</td>
<td>OVER WATER</td>
<td>CONSTRUCTED</td>
<td>CONSTRUCTED</td>
</tr>
<tr>
<td>Poor</td>
<td>ELEVATED DOCK</td>
<td>HARBORWALK</td>
<td>LAND</td>
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</table>

**STRATEGIES**

<table>
<thead>
<tr>
<th>SOCIAL EQUITY &amp; ACCESS</th>
<th>ENVIRONMENTAL &amp; ADDITIONAL BENEFITS</th>
<th>EFFECTIVENESS</th>
<th>FEASIBILITY</th>
<th>ADAPTABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td>Superior</td>
<td>Superior</td>
<td>Superior</td>
<td>Superior</td>
</tr>
<tr>
<td>Good</td>
<td>Superior</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Poor</td>
<td>Superior</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
</tr>
</tbody>
</table>

**PLAN VIEW**

**KEY CONSIDERATIONS**

- **Geotechnical:** The Wharf buildings are supported by concrete caissons bearing in underlying glacial till at depths exceeding 80-ft below ground. An underground garage built using concrete diaphragm walls extends from the Atlantic Avenue building to approximately 10 feet from the seawall.

- **Coastal Structures:** Wharf buildings are located on piers above the Harbor. Wharf building piers extend to till / bedrock. A reinforced concrete slurry wall exists approximately 10 feet or more inland of the seawall. The Wharf building floor elevations are lower than the Design Flood Elevations, and therefore may experience significant uplift from extreme storms.

- **Utilities:** 42” Storm drain outfall located on the south side of the property.

- **Rainfall Flow Path:** No major rainfall flow path on site.

- **Emergency Access:** to the buildings and waterfront is via the pedestrian walkways from Atlantic Avenue to the Wharf Buildings (center, south-side, north-side of the Atlantic Ave Building) for EMS vehicles & via water access for fire boats.

- **Pedestrian Access:** to the waterfront and retail store fronts occurs along the water’s edge where elevations are lowest.

**FINDINGS & RECOMMENDATIONS**

- **Prerequisite Criteria:** The Inland Alignment strategies receive Poor scores for Social Equity & Access due to obstructing water views, and reducing emergency and non-emergency access to the Harborwalk and Wharf buildings. The Outboard Alignment Elevated/Constructed Land strategy and the Water’s Edge strategies receive Poor scores for Environmental & Additional Benefits due to infill of the Harbor that does not incorporate living shorelines or wetlands. These strategies are therefore not preferred.

- **Constructability Criteria:** The Outboard Alignment Elevated/Constructed Harborwalk strategy is the most constructable strategy in this assessment, and also scores the highest for the Prerequisite Criteria.

**Recommendations:**

The Elevated/Constructed Harborwalk strategy at the Outboard Alignment should be considered for the Preferred Flood Protection System, and should incorporate strategies to minimize the following impacts associated withinfill of the Harbor: permitting risks, construction costs, long-term O&M costs, and fire boat access.

An Alternative Flood Protection System should be considered at the Inland Alignment and/or along the Rose Kennedy Greenway, and should combine elements of the elevated or constructed land and flood wall strategies to minimize the feasibility and effectiveness risks of the individual strategies.
Rowes Wharf

<table>
<thead>
<tr>
<th>INDEX</th>
<th>GROUP 4</th>
<th>Solutions List</th>
<th>P8 - Rowes Wharf</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Building</td>
<td>New bulkhead - Raised/Stepped</td>
<td>Inland</td>
</tr>
<tr>
<td>2i</td>
<td>Floodwall</td>
<td></td>
<td>Waters Edge</td>
</tr>
<tr>
<td>3w</td>
<td>Harbor Walk</td>
<td>Raised/Stepped/Social</td>
<td>Outboard</td>
</tr>
<tr>
<td>4w</td>
<td>Over Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5w, 5o</td>
<td>Open Space</td>
<td>Elevated/Constructed Land</td>
<td></td>
</tr>
<tr>
<td>6i, 6o</td>
<td>Elevated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7w</td>
<td>Dock Access</td>
<td>Elevated/Accessible</td>
<td></td>
</tr>
<tr>
<td>8w</td>
<td>Roadway</td>
<td>Elevated</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
1. Actual benefits and trade-offs of flood resiliency strategies will be subject to numerous site-specific considerations and can be
2. Critical Infrastructure is defined in Section 2.0 of Boston Public Works Department 2018 Climate Resilient Design Standard &
3. In-kind dock replacement includes relocation to an area on the same property with similar or greater footprint, water depth, and
4. National Register of Historic Places structures in the study area include the Long Wharf and Custom House Block, and the seawall

**Definitions:**
Facilities of Public Accommodation (“FPAs”) are qualified under the State’s Waterways Regulations (Chapter 91) as “facilities at
A Wharf is a level concrete, stone, or metal platform lying alongside or projecting into water to which a ship may be moored to load

**Critical Infrastructure(2)**
- Hospitals and health care facilities
- Emergency Response (Police, Fire, Rescue, Ambulance) facilities and related items (garages, shelters, operations centers, communications, back-up generators, substations, etc.)
- Correctional facilities
- Wastewater treatment plants
- Water storage tanks
- Operations centers
- Public works yards
- Municipal buildings
- Schools and facilities that may be used as emergency shelters
- Power transmission facilities, substations, and power generation stations
- Critical transportation networks (emergency evacuation routes, public transportation, aviation facilities, tunnels, bridges, train and transit maintenance yards and shops, traffic signals)
- Facilities where residents have limited mobility or ability (such as nursing homes and care facilities)
- Buildings or structures that contain hazardous waste; waste transfer stations
- Pumping stations (stormwater and sanitary)
- Fueling storage and fuel stations
- Ventilation buildings and fan plants
- Telecommunications
- Major food distribution centers
**Summary:**

**Group / Property:** Rowes Wharf

**Location:**
- **Address:** Group 4 / P08 - Rowes Wharf
- **Building:** Floodwall

**Effectiveness**

<table>
<thead>
<tr>
<th>Criteria/Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptability</td>
<td>-1.8</td>
<td>-3, 0, 3</td>
<td>Adaptability score based on the floodwall's ability to adapt to changing water levels.</td>
</tr>
<tr>
<td>Inland Effectiveness</td>
<td>does not meet Target DFE; cannot be raised</td>
<td>As the floodwall cannot be raised to meet the Target DFE, it does not meet the effectiveness criteria.</td>
<td></td>
</tr>
<tr>
<td>Potential for phased</td>
<td>no potential for phased deployment</td>
<td>The floodwall does not have potential for phased deployment.</td>
<td></td>
</tr>
<tr>
<td>Deployability</td>
<td>1.8</td>
<td>3, 2, 1</td>
<td>Deployability score based on the floodwall's ability to be deployed in different locations.</td>
</tr>
</tbody>
</table>

**Environmental and Additional Benefits**

- **Minimizes construction cost:** Structural decks and components reduce construction costs.
- **Minimizes impacts to seawalls:** By protecting against erosion and reinforcing existing structures.
- **Preserves & enhances view of the public spaces, including welcoming harborwalk, or eliminates access points to views/wayfinding to, or signage for open public space:** Enhances public access and promotes pedestrian-friendly spaces.
- **Preserves & enhances outdoor resources, including the functionality & history, including wharfs or licensed facilities of public accommodation:** Maintains historical and functional integrity of the area.
- **Compatible with district-wide and departmental and property owners' plans:** Aligns with broader district development goals.

**Scoring:**

**Adaptability:** 1.8

**Inland Effectiveness:** does not meet Target DFE; cannot be raised

**Potential for phased:** no potential for phased deployment

**Deployability:** 1.8

**Environmental and Additional Benefits:**
- Minimizes construction cost
- Minimizes impacts to seawalls
- Preserves & enhances view of the public spaces, including welcoming harborwalk, or eliminates access points to views/wayfinding to, or signage for open public space
- Preserves & enhances outdoor resources, including the functionality & history, including wharfs or licensed facilities of public accommodation
- Compatible with district-wide and departmental and property owners' plans

**Notes:**
- **Grading: ELF Island:** 1.5
- **Minimum ELF:** 1.5
- **Ground Elevation or Alignment:** 1.5
- **Solution in and near existing buildings:** 1.5
- **Exempt from Requirement:** General 0.5 with option to raise to 1.5 with glass wall. Services will be provided through a phased approach, with structures modified as needed to minimize environmental impact.
### Scoring:

<table>
<thead>
<tr>
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<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feasibility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adaptability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional Benefits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Equity &amp; Access</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes:
- Strategic DEE inland 13.5
- Midtown DEE 15
- Ground Elevation at Almanaers 15

### Example:
- In 2022, if a new walkway between buildings (plus 12 with option to raise to 2.2) with flood wall along seaward side of walkway would require additional barrier at interior building modifier.
### Scoring:

<table>
<thead>
<tr>
<th>Category Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Feasibility</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground Elevation at Alignment</td>
<td>Meets Target DFE; can be raised</td>
<td>Must meet Target DFE to be raised</td>
<td>Cost to Strategic DFE</td>
</tr>
<tr>
<td>Mitigation impacts on seawalls &amp; stormwater facilities</td>
<td>Mitigation strategies have been identified</td>
<td>Requires significant reduction in function of existing seawall, or no mitigation strategy identified</td>
<td>No impact on planned land use</td>
</tr>
<tr>
<td>Mitigation strategies</td>
<td>Strategy located within 30 feet of Coastal Structure for existing seawalls, or no mitigation strategy identified</td>
<td>Strategy located within 30 feet of Coastal Structure for existing seawalls, or no mitigation strategy identified</td>
<td>Mitigates existing coastal erosion and/or sediment</td>
</tr>
<tr>
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</tr>
<tr>
<td><strong>Effectiveness</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rent and taxes</td>
<td>-3</td>
<td>No impact on existing dock area or access to water transportation access points, or existing replacement not identified</td>
<td>Mitigates existing coastal erosion and/or sediment</td>
</tr>
<tr>
<td>Rent and taxes</td>
<td>-3</td>
<td>No impact on existing dock area or access to water transportation access points, or existing replacement not identified</td>
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<td></td>
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<tr>
<td>Rent and taxes</td>
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<td>No impact on existing dock area or access to water transportation access points, or existing replacement not identified</td>
<td>Mitigates existing coastal erosion and/or sediment</td>
</tr>
</tbody>
</table>

**Notes:**
- Strategic DFE existing
- Minimum DFE: 15
- Ground Elevation at Alignment: 0.5
- Rent and taxes: -3
- Effectiveness: -3
- Feasibility: -3
- Adaptability: -3
- Rent and taxes: -3
- Effectiveness: -3
- Feasibility: -3
- Adaptability: -3
Rowes Wharf

**Summary:**

<table>
<thead>
<tr>
<th>Group / Property</th>
<th>Location</th>
<th>Asset</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 4 / Pier 5 - Rowes Wharf</td>
<td>Waterfront</td>
<td>Harbor Walk</td>
<td>Over Water</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effectiveness</th>
<th>Feasibility</th>
<th>Adaptability</th>
<th>Environmental &amp; Additional Benefits</th>
<th>Social Equity &amp; Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>10</td>
<td>4</td>
<td>8.5</td>
<td>Superior</td>
</tr>
<tr>
<td>-1.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Markers:**
- Strategic DFE inland: 195
- Minimum DFE: 15
- Ground Elevation at Alignment: 0.5
- Solution min and max: 5 to 10

**Example:** Infill barcode building; raised to elevation to rise 15 with option for 2.5 flood wall at seawall edge, adjacent to lower walkway for access to buildings at elev 13 (27 for south wharf); alt raise floor of soul.

**Scoring:**

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scoring:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. **Impact on existing property specific plans and land use**
   - Irreversible differences with planned land use requires significant reduction in condition of planned land use, or not modified by property owner.
   - No impact on planned land use.

2. **Infill harmony**
   - No harmonious differences; incompatible with existing structures.
   - Includes compatible and complimentary materials.

3. **Effectiveness**

4. **Note:**
   - Infill harmony.
   - No compatibility with existing structures.

5. **Feasibility**

6. **Adaptability**

7. **Environmental & Additional Benefits**
   - Environmental & Additional Benefits.
   - Environmental & Additional Benefits.

8. **Social Equity & Access**
   - Social Equity & Access.
   - Social Equity & Access.
Summary:

**Group / Property:** Group 4 / P08 - Rowes Wharf
**Location:** Water's Edge
**Asset:** Docks
**Solution:** Elevated Dock Access

<table>
<thead>
<tr>
<th>Effectiveness</th>
<th>Feasibility</th>
<th>Adaptability</th>
<th>Environmental and Additional Benefits</th>
<th>Societal Equity &amp; Access</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- Strategic DFE strain: 19.5
- Minimum DFE: 15
- Ground Elevation at Aligned: 8.5
- Solution min and max: 5 to 1
- Example: It is below buildings; raised functional to exit 15 with option for 3.5 flood wall at waterfront, adjacent to lower walking for access to buildings at el 13 (F for south wharf fill, EL raised floor of south

**Scoring:**

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria*</th>
<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rowes Wharf

1. **Design of Flood Resilience (DFR):**
   - Does not meet Target DFE
   - Does not meet Target DFE, cannot be raised to Strategic DFE

2. **Structural and Shoreline Protection:**
   - Strategic DFR:
     -raise ground surface ≥ 2 feet within 30 feet of building, waterfront, or large diameter sewer, no practical mitigation strategies identified
     -raise ground surface ≥ 2 feet within 30 feet of building, waterfront, or large diameter sewer, practical mitigation strategies have been identified

3. **Benefits:**
   - Strategic DFR:
     - Minimizes flooding at abutting properties
     - Does not affect major rainfall patterns or flow through properties
     - Minimizes long-term operations and maintenance costs
     - Minimizes permitting risks
     - Minimizes ground foundation loss and coastal erosion
     - Minimizes permitting risks

4. **Compatibility:**
   - Strategic DFR:
     - Minimizes loss of functionality of existing emergency access routes to buildings or docks, or reduces or eliminates unaccommodate access from buildings, tunnels, or large diameter sewer
     - Minimizes loss of functionality of existing emergency access routes to buildings or docks, or eliminates unaccommodate access from buildings, tunnels, or large diameter sewer

5. **Social Equity & Access:**
   - Minimizes loss of functionality of existing emergency access routes to buildings or docks, or reduces or eliminates unaccommodate access from buildings, tunnels, or large diameter sewer
   - Minimizes loss of functionality of existing emergency access routes to buildings or docks, or eliminates unaccommodate access from buildings, tunnels, or large diameter sewer
Rowes Wharf

Summary:

Group / Property: Group 4 / P08 - Rowes Wharf
Location: Outboard
Asset: Harbor Wall
Solution: Elevated or Constructed Harborwalk
Group: 4

Scoring:

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protects critical infrastructure</td>
<td>-</td>
<td>does not protect critical infrastructure(s) from storm surge</td>
<td>0.0</td>
</tr>
<tr>
<td>Minimizes permitting risks</td>
<td>strategy located outside of existing flood zone or, if located within flood zone, incorporates Elements of current permitting strategy identified</td>
<td>strategy located outside of existing flood zone or, if located within flood zone, incorporates Elements of current permitting strategy identified</td>
<td>3.0</td>
</tr>
<tr>
<td>Minimizes structural damage or structural defects</td>
<td>-</td>
<td>does not eliminate all access to existing private land use (e.g. fully eliminates existing dock system for the district)</td>
<td>0.0</td>
</tr>
<tr>
<td>Minimizes transportation access points or structural defects</td>
<td>-</td>
<td>does not eliminate all access to existing private land use (e.g. fully eliminates existing dock system for the district)</td>
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</tr>
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</tr>
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</tr>
<tr>
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<td>-</td>
<td>does not eliminate all access to existing private land use (e.g. fully eliminates existing dock system for the district)</td>
<td>0.0</td>
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</table>
### Rowes Wharf

#### Summary:

<table>
<thead>
<tr>
<th>Group</th>
<th>Property</th>
<th>Location</th>
<th>Asset</th>
<th>Solution</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevator</td>
<td>4 / 106 - Rowes Wharf</td>
<td>Outside</td>
<td>Open Space</td>
<td>Elevated or Constructed Land</td>
<td>4</td>
</tr>
</tbody>
</table>

#### Feasibility

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic Elevation Difference (SED) (1)</td>
<td>Does not meet Target SED</td>
<td>Strategic Elevation Difference</td>
<td>5</td>
</tr>
<tr>
<td>Suitability of Contiguous Flood Protection Elevation (CPE)</td>
<td>Provides contiguous flood protection elevation for the district</td>
<td>Strategic Elevation Difference</td>
<td>5</td>
</tr>
<tr>
<td>Minimizes ground settlement</td>
<td>Viable and sustainable</td>
<td>Minimizes ground settlement</td>
<td>5</td>
</tr>
<tr>
<td>Protects critical infrastructure</td>
<td>Not affected by flooding</td>
<td>Protects critical infrastructure</td>
<td>5</td>
</tr>
</tbody>
</table>

#### Environmental and Additional Benefits

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimizes ground settlement &amp; coastal erosion</td>
<td>Minimizes ground surface &gt; 2 feet within 30 feet of buildings, slopes, or large diameter sewers</td>
<td>Strategic Elevation Difference</td>
<td>5</td>
</tr>
<tr>
<td>Minimizes impacts to walls &amp; structures</td>
<td>Minimizes ground surface &gt; 2 feet within 30 feet of Coastal Structure, and practical mitigation strategies have been identified</td>
<td>Strategic Elevation Difference</td>
<td>5</td>
</tr>
<tr>
<td>Minimizes permitting risks</td>
<td>Minimal located outside of existing seawall and shoreline, no potential permitting strategy identified</td>
<td>Strategic Elevation Difference</td>
<td>5</td>
</tr>
<tr>
<td>Minimizes construction cost</td>
<td>Strategic located outside of existing seawall and shoreline</td>
<td>Strategic Elevation Difference</td>
<td>5</td>
</tr>
<tr>
<td>Minimizes long-term operations &amp; maintenance costs</td>
<td>Strategic located outside of existing seawall and shoreline</td>
<td>Strategic Elevation Difference</td>
<td>5</td>
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</table>

#### Social Equity & Access

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compatible with existing property-specific plans and land use</td>
<td>Compatible with existing property-specific plans and land use</td>
<td>Strategic Elevation Difference</td>
<td>5</td>
</tr>
<tr>
<td>Compatible with existing parking, transportation, and roadway strategies for the district</td>
<td>Compatible with existing parking, transportation, and roadway strategies for the district</td>
<td>Strategic Elevation Difference</td>
<td>5</td>
</tr>
<tr>
<td>Minimizes resistance to strategic replacement</td>
<td>Strategic located outside of existing seawall and shoreline</td>
<td>Strategic Elevation Difference</td>
<td>5</td>
</tr>
</tbody>
</table>

#### Notes:

- Strategic SED waterfront edge
- Minimum SED: 15 feet
- Ground Elevation at Alignment: -6.5 feet
- Solution range: +3 to +11 feet
- Example: infill boxes and between buildings creating new open space or overland/underwater storage between buildings; raised outward terraces to elevate 15 with option for 3.5 flood wall at seaward edge; no change to

#### Scoring:

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</tr>
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<td>Minimizes impacts to walls &amp; structures</td>
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<td>Strategic Elevation Difference</td>
</tr>
<tr>
<td>Minimizes permitting risks</td>
<td>Minimal located outside of existing seawall and shoreline, no potential permitting strategy identified</td>
<td>Strategic Elevation Difference</td>
</tr>
<tr>
<td>Minimizes construction cost</td>
<td>Strategic located outside of existing seawall and shoreline</td>
<td>Strategic Elevation Difference</td>
</tr>
<tr>
<td>Minimizes long-term operations &amp; maintenance costs</td>
<td>Strategic located outside of existing seawall and shoreline</td>
<td>Strategic Elevation Difference</td>
</tr>
</tbody>
</table>

#### Compatibility with existing property-specific plans and land use

<table>
<thead>
<tr>
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<th>Assessment Criteria</th>
<th>Assessment Score</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Compatible with existing property-specific plans and land use</td>
<td>Strategic Elevation Difference</td>
</tr>
<tr>
<td>Compatible with existing parking, transportation, and roadway strategies for the district</td>
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<td>Strategic Elevation Difference</td>
</tr>
</tbody>
</table>

#### Note on Compatibility:

- Strategic Elevation Difference (SED) waterfront edge
- Minimum SED: 15 feet
- Ground Elevation at Alignment: -6.5 feet
- Solution range: +3 to +11 feet
- Example: infill boxes and between buildings creating new open space or overland/underwater storage between buildings; raised outward terraces to elevate 15 with option for 3.5 flood wall at seaward edge; no change to
Due Diligence and Multi-Criteria Assessment Findings: Northern Avenue

This plan summarizes findings of a multi-criteria assessment used to identify strengths and weaknesses of potential flood resiliency strategies.

KEY PLAN AND LEGEND

**PLAN VIEW**

The preliminary plan includes alignments based off of Climate Ready Boston report. Alignments may vary in this report based on recommendations.

**KEY CONSIDERATIONS**

Geotechnical: 400 Atlantic building piles are driven into deep till / bedrock. Williams Coast Guard building piles may rest in clay and be subject to settlement from new structural loads. There are numerous piles at the James Hook + Co docking system which may present obstruction from sheet pile walls.

Coastal Structures: Seawall conditions were not assessed due to access constraints with piers and deck systems located in front of sea walls. Detailed sea wall assessment recommended.

Utilities: Sewer outfalls are located under the Seaport Blvd bridge and at 400 Atlantic Avenue. A 10" sewer line is located under the centerline of Northern Avenue. Numerous underground utilities are located under Seaport Blvd / Atlantic Ave intersection. Independence Wharf & the Williams Coast Guard Building have below ground utility rooms. The Williams Coast Guard Building includes a cooling tower along the Harborwalk. J Hook Co site includes a pump house with intake pipes from the Harbor.

Access: I-93 Tunnel access is located at Seaport Blvd / Atlantic Ave intersection & is a local evacuation route. Northern Ave is utilized for emergency access. James Hook + Co parking lot provides access for deliveries.

Other Considerations: The seawall between Rows Wharf and Congress St is listed in the National Register of Historic Places.

**FINDINGS & RECOMMENDATIONS**

**Prerequisite Criteria:** The Inland alignment Flood Wall strategy is not preferred due to receiving a Poor Social Equity & Access score due to reducing access to the Harborwalk and waterfront buildings. The Water’s Edge alignment Raised/Stepped and Elevated Roadway/Harborwalk strategies are not preferred for receiving a Poor Environmental & Additional Benefits score due to infill of the Harbor and impacting views of the historic seawall. All strategies that allow vehicular traffic over the two bridges have a Poor score in one of the two Prerequisite Criteria.

**Constructibility Criteria:** The Water’s Edge alignment Over Water and Elevated Dock strategies and the Inland alignment Elevated / Constructed Land strategy are the most constructible strategies in this study. The Inland Alignment Elevated / Constructed Land strategy is only applicable as a transition between Outboard and Inland alignments at 400 Atlantic Avenue.

Recommendations: The Water’s Edge alignment Over Water and Elevated Dock strategies should be considered for the Preferred Flood Protection System, and should incorporate approaches to mitigate impacts on views of the historic sea walls. Deployable flood walls should be considered at Seaport Boulevard and Northern Avenue Bridge. Conversion of Northern Avenue bridge into a flood gate should be further investigated to protect all upstream properties along the Fort Point Channel.
### Northern Avenue

<table>
<thead>
<tr>
<th>INDEX</th>
<th>GROUP 2</th>
<th>Solutions List</th>
<th>P9 - 400 Atlantic</th>
<th>P10 - Williams Building</th>
<th>P11 - James Hook + Co.</th>
<th>RS - Northern Ave</th>
<th>R7 - Seaport Blvd</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Building</td>
<td>New bulkhead - Raised/Stepped</td>
<td>Inland Waters Edge Outboard</td>
<td>Inland Waters Edge Outboard</td>
<td>Inland Waters Edge Outboard</td>
<td>Inland Waters Edge Outboard</td>
<td>Inland Waters Edge Outboard</td>
</tr>
<tr>
<td>2</td>
<td>Floodwall</td>
<td>Raised/Stepped/Social</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3W</td>
<td>Harbor Walk</td>
<td>Elevated/constructed Land</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4W</td>
<td>Waterway</td>
<td>Elevated/constructed Land</td>
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<tr>
<td>5W, 5O</td>
<td>Open Space</td>
<td>Elevated/constructed Land</td>
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<td>7W</td>
<td>Dock Access</td>
<td>Elevated/accessible</td>
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<td>8W, 8K</td>
<td>Roadway</td>
<td>Elevated</td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Notes:**

1. Actual benefits and trade-offs of flood resiliency strategies will be subject to numerous site-specific considerations and can be influenced by nuanced detailed design approaches. This process provides simplified Evaluation Criteria definitions for each score to provide a transparent and repeatable high level assessment of the relative potential benefits and trade-offs for comparing the major components of various flood resiliency strategies.

2. Critical Infrastructure is defined in Section 2.0 of Boston Public Works Department 2018 Climate Resilient Design Standard & Guidelines.

3. In-kind dock replacement includes relocation to an area on the same property with similar or greater footprint, water depth, and protection from wind and waves. In-kind water transportation access point replacement includes relocation to an area on the same property with similar accessibility, connectivity, and visibility. In-kind private open space replacement includes relocation to an area on the same property with similar or greater footprint and access points.

4. National Register of Historic Places structures in the study area include the Long Wharf and Custom House Block, and the seawall between 360-400 Atlantic Avenue and Congress Street.

**Definitions:**

- Facilities of Public Accommodation ("FPAs") are qualified under the State's Waterways Regulations (Chapter 91) as "facilities at which goods or services are made available directly to the public on a regular basis, or at which the advantages of use are otherwise open on essentially equal terms to the public at large." FPA space is located in buildings along the City's waterfront and is required through Chapter 91 licensing for new or redevelopment projects. Examples of interior facilities of public accommodation referenced in the regulations include restaurants, performance areas, hotels, retail establishments, and educational and cultural institutions.

A Wharf is a level concrete, stone, or metal platform lying alongside or projecting into water to which a ship may be moored to load and unload. Adequate water depth for ships must exist alongside the structure to be defined as a wharf. The structure must be of adequate size and configuration to allow ships to moore to be defined as a wharf.

**Critical Infrastructure (2):**

- Hospitals and health care facilities
- Emergency Response (Police, Fire, Rescue, Ambulance) facilities and related items (garages, shelters, operations centers, communications, back-up generators, substations, etc.)
- Correctional facilities
- Wastewater treatment plants
- Water storage tanks
- Operations centers
- Public works yards
- Municipal buildings
- Schools and facilities that may be used as emergency shelters
- Power transmission facilities, substations, and power generation stations

- Critical transportation networks (emergency evacuation routes, public transportation, aviation facilities, tunnels, bridges, train and transit maintenance yards and shops, traffic signals)
- Facilities where residents have limited mobility or ability (such as nursing homes and care facilities)
- Buildings or structures that contain hazardous waste, waste transfer stations
- Pumping stations (stormwater and sanitary)
- Fueling storage and fuel stations
- Ventilation buildings and fan plants
- Telecommunications
- Major flood distribution centers
**Summary:**

<table>
<thead>
<tr>
<th>Social Equity &amp; Access</th>
<th>Environmental and Additional Benefits</th>
<th>Effectiveness</th>
<th>Adaptable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- Strategic: DFE rated
- Minimum CFE: 15.00
- Ground Elevation at Aligned Solution min and max: 0.50 to 10.00

**Scoring:**

<table>
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<tr>
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</tr>
</tbody>
</table>

**Compatibility:**
- Compatible with existing property-specific plans and legal use
- Incompatible with existing property-specific plans or legal use

**Additional Benefits:**
- Provides opportunities for reduced property insurance costs

---

**Northern Avenue**
### Feasibility

<table>
<thead>
<tr>
<th>Criteria Description</th>
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<th>Assessed Criteria</th>
<th>Scored Score</th>
<th>Referred Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimizes long term operations &amp; maintenance costs</td>
<td>Requires infill of the Harbor that isn't a new living shoreline or wetland</td>
<td>does not infill Harbor</td>
<td>0</td>
<td>-3</td>
</tr>
<tr>
<td>Minimizes short term operations &amp; maintenance costs</td>
<td>Involves creating new public access points to the waterfront (including living shorelines)</td>
<td>creates new public access points to the waterfront (including living shorelines)</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Minimizes ground level setback requirements</td>
<td>Does not meet Target DFE</td>
<td>does not meet Target DFE</td>
<td>17.4</td>
<td>17.4</td>
</tr>
<tr>
<td>Minimizes impact to sewers &amp;structural decks</td>
<td>Does not protect all buildings or the harbor, or prevents access to buildings or critical infrastructure(2) located on or adjacent to the study</td>
<td>does not protect all buildings or the harbor, or prevents access to buildings or critical infrastructure(2) located on or adjacent to the study</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Minimizes permitting risks</td>
<td>Does not block existing emergency access routes to buildings or docks (including for fire boats), but alternative access routes remain and are not impacted</td>
<td>does not block existing emergency access routes to buildings or docks (including for fire boats), but alternative access routes remain and are not impacted</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Minimizes coastal erosion attenuation</td>
<td>More protected or creates land for coastal structure; no potential permitting strategy identified</td>
<td>more protected or creates land for coastal structure; no potential permitting strategy identified</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Effectiveness

<table>
<thead>
<tr>
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<th>Screening Criteria</th>
<th>Assessed Criteria</th>
<th>Scored Score</th>
<th>Referred Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimizes parking demands</td>
<td>More inclusive of existing parking demands, or eliminates parking demands</td>
<td>more inclusive of existing parking demands, or eliminates parking demands</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Minimizes existing public space size or access</td>
<td>Increases open private space size or access</td>
<td>increases open private space size or access</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Mitigate existing sea level rise impacts</td>
<td>Does not meet Target DFE</td>
<td>does not meet Target DFE</td>
<td>17.4</td>
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</tr>
<tr>
<td>Mitigate existing coastal erosion risk</td>
<td>More protected or creates land for coastal structure; no potential permitting strategy identified</td>
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### Environmental and Additional Benefits

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### Analysis

#### Summary:

- **Location:** [400 Atlantic St, Boston, MA 02114](https://www.google.com/maps/place/400+Atlantic+St,+Boston,+MA+02114/@42.3674694,-71.0469839,15z/data=!4m5!3m4!1s0x0:0x0!8m2!3d42.3674694!4d-71.0469839)
- **Assessment Criteria:** Inland
- **Solution:** [Inland](https://www.google.com/maps/place/400+Atlantic+St,+Boston,+MA+02114/@42.3674694,-71.0469839,15z/data=!4m5!3m4!1s0x0:0x0!8m2!3d42.3674694!4d-71.0469839)

#### Scoring:

- **Group:** 2; [400 Atlantic @ Rowes Wharf](https://www.google.com/maps/place/400+Atlantic+St,+Boston,+MA+02114/@42.3674694,-71.0469839,15z/data=!4m5!3m4!1s0x0:0x0!8m2!3d42.3674694!4d-71.0469839)
- **Social Equity & Access:** [Inland](https://www.google.com/maps/place/400+Atlantic+St,+Boston,+MA+02114/@42.3674694,-71.0469839,15z/data=!4m5!3m4!1s0x0:0x0!8m2!3d42.3674694!4d-71.0469839)

#### Notes:

- Strategic DFE: [Inland](https://www.google.com/maps/place/400+Atlantic+St,+Boston,+MA+02114/@42.3674694,-71.0469839,15z/data=!4m5!3m4!1s0x0:0x0!8m2!3d42.3674694!4d-71.0469839)
- Minimum DFE: [Inland](https://www.google.com/maps/place/400+Atlantic+St,+Boston,+MA+02114/@42.3674694,-71.0469839,15z/data=!4m5!3m4!1s0x0:0x0!8m2!3d42.3674694!4d-71.0469839)
- Rise and run: [Inland](https://www.google.com/maps/place/400+Atlantic+St,+Boston,+MA+02114/@42.3674694,-71.0469839,15z/data=!4m5!3m4!1s0x0:0x0!8m2!3d42.3674694!4d-71.0469839)
### Northern Avenue

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#### Notes:

- Strategic DFE Island
- Minimum CPE: 10.0
- Project Alignment: 3
- Social walk: 10.0

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</table>
### Summary:

**Location:** Boston Harbor

**Assessment Area:** Northern Avenue

**Social Equity & Access**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Screening Criteria</th>
<th>Recommendation</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessibility</td>
<td>Meets Target DFE; can be raised</td>
<td>Poor</td>
<td>No impact on existing dock area or access to water transportation access points, or in-kind replacements identified for any reduction of existing dock area or water transportation access points; no practical alternatives to impacted access points exist</td>
</tr>
<tr>
<td>Accessibility</td>
<td>No impact on existing dock area or access to water transportation access points, or in-kind replacements identified for any reduction of existing dock area or water transportation access points; alternative access routes are available or created</td>
<td>Good</td>
<td>No impact on existing dock area or access to water transportation access points, or in-kind replacements identified for any reduction of existing dock area or water transportation access points; alternative access routes are available or created</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Blocks existing emergency access routes to buildings or docks (including for fire boats), but alternative access routes remain and are not impacted</td>
<td>Superior</td>
<td>Blocks existing emergency access routes to buildings or docks (including for fire boats), but alternative access routes remain and are not impacted</td>
</tr>
</tbody>
</table>

**Environmental and Additional Benefits**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Screening Criteria</th>
<th>Recommendation</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protects coastal infrastructure</td>
<td>Does not block existing known coastal erosion and/or settlement</td>
<td>Poor</td>
<td>Does not block existing known coastal erosion and/or settlement</td>
</tr>
<tr>
<td>Protects coastal infrastructure</td>
<td>Blocks existing emergency access routes to buildings or docks (including for fire boats), but alternative access routes remain and are not impacted</td>
<td>Good</td>
<td>Blocks existing emergency access routes to buildings or docks (including for fire boats), but alternative access routes remain and are not impacted</td>
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<tr>
<td>Protects coastal infrastructure</td>
<td>No impact on existing dock area or access to water transportation access points, or in-kind replacements identified for any reduction of existing dock area or water transportation access points; alternative access routes are available or created</td>
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<td>No impact on existing dock area or access to water transportation access points, or in-kind replacements identified for any reduction of existing dock area or water transportation access points; alternative access routes are available or created</td>
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**Scoring:**

<table>
<thead>
<tr>
<th>Screening Criteria</th>
<th>Poor</th>
<th>Good</th>
<th>Superior</th>
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</thead>
<tbody>
<tr>
<td>Accessibility</td>
<td></td>
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<tr>
<td>Environmental and Additional Benefits</td>
<td></td>
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</tr>
</tbody>
</table>

### Additional Information:

- **Northern Avenue**
- **Location:** Boston Harbor
- **Assessment Area:** Northern Avenue
- **Social Equity & Access**
- **Environmental and Additional Benefits**
- **Scoring:**
- **Notes:**
  - Strategic DFE rated: Poor
  - Minimum DFE: 15.04
  - Ground Elevation at Alignment: 8.0
  - Solution not to be used: 11.0
  - Solution not to be used: 11.1
### Scoring:

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Location &amp; Access</td>
<td>Provides opportunities for phased implementation</td>
<td>- No potential for phased implementation</td>
<td>1.25</td>
</tr>
<tr>
<td>2. Environmental &amp; Additional Benefits</td>
<td>Minimizes long term operations &amp; maintenance costs</td>
<td>- Requires significant reduction in function of planned land use, or not preferred by property owner</td>
<td>3.00</td>
</tr>
<tr>
<td>3. Social Equity &amp; Access</td>
<td>Minimizes ground settlement &amp; coastal erosion</td>
<td>- Blocks any evacuation route, or eliminates public access to any dock; or eliminates coastal access to the harbor</td>
<td>1.25</td>
</tr>
<tr>
<td>4. Effectiveness</td>
<td>Minimizes construction cost</td>
<td>- Does not protect all buildings in the study area, or precludes protection of buildings or critical infrastructure located immediately adjacent to the study area</td>
<td>1.25</td>
</tr>
<tr>
<td>5. Adaptable</td>
<td>Minimizes building with in areas of public or critical infrastructure adjacent to the study area</td>
<td>- Location of owners and/or managers or other site components</td>
<td>1.25</td>
</tr>
</tbody>
</table>

### Notes:
- Strategic DFE-based
- Minimum DFE: ≥ 2 feet
- Phase or alignment: 0.0
- Scored out of 2.0

### Summary:
- **Northern Avenue**
- **Location:** Harbor Park
- **Asset:** Over Water
- **Solution:** Group 2: North of Southport Blvd
- **Group:** OVER WATER
- **Notes:**
  - Strategic DFE-based
  - Minimum DFE: ≥ 2 feet
  - Phase or alignment: 0.0
  - Scored out of 2.0


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<th>Criteria Description</th>
<th>Screening Criteria</th>
<th>Assessment Criteria</th>
<th>Scoring</th>
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</thead>
<tbody>
<tr>
<td>Prevents &amp; enhances environmental resilience</td>
<td>Criteria not associated with flood resilience</td>
<td>なしの場合はNot Helpful</td>
<td>-3</td>
</tr>
<tr>
<td>Prevents &amp; enhances disaster risk (e.g., flood, fire)</td>
<td>Low priority (e.g., flood, fire)</td>
<td>なしの場合はNot Helpful</td>
<td>-3</td>
</tr>
<tr>
<td>Ensures outdoor private land impacts</td>
<td>Low priority (e.g., flood, fire)</td>
<td>なしの場合はNot Helpful</td>
<td>-3</td>
</tr>
<tr>
<td>Communicates with the district infrastructure and streetscape (including the functionality &amp; visibility of streets and facilities)</td>
<td>Low priority (e.g., flood, fire)</td>
<td>なしの場合はNot Helpful</td>
<td>-3</td>
</tr>
<tr>
<td>Ensures equipment compatibility</td>
<td>Low priority (e.g., flood, fire)</td>
<td>なしの場合はNot Helpful</td>
<td>-3</td>
</tr>
<tr>
<td>Prevents critical infrastructure</td>
<td>Low priority (e.g., flood, fire)</td>
<td>なしの場合はNot Helpful</td>
<td>-3</td>
</tr>
<tr>
<td>Lowers increasing medical-based finding at existing properties</td>
<td>Low priority (e.g., flood, fire)</td>
<td>なしの場合はNot Helpful</td>
<td>-3</td>
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<tr>
<td>Prevents ground water settlement &amp; associated erosion</td>
<td>Low priority (e.g., flood, fire)</td>
<td>なしの場合はNot Helpful</td>
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<tr>
<td>Ensures privacy and security</td>
<td>Low priority (e.g., flood, fire)</td>
<td>なしの場合はNot Helpful</td>
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<tr>
<td>Prevents property parcelization (e.g., loss of view)</td>
<td>Low priority (e.g., flood, fire)</td>
<td>なしの場合はNot Helpful</td>
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<tr>
<td>Prevents property parcelization (e.g., loss of water access)</td>
<td>Low priority (e.g., flood, fire)</td>
<td>なしの場合はNot Helpful</td>
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<td>Prevents property parcelization (e.g., loss of public access)</td>
<td>Low priority (e.g., flood, fire)</td>
<td>なしの場合はNot Helpful</td>
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**Northern Avenue**

**Location:** Northern Ave
**Asst. Sponsor:** Harbor Park
**Developer or Constructed Land:** Group 2 of Southport Site

### Feasibility

#### Summary:

- **Location:** Northern Ave
- **Asst. Sponsor:** Harbor Park
- **Developer or Constructed Land:** Group 2 of Southport Site

### Environmental and Additional Benefits

#### Feasibility

- **Adaptability**

### Objective

**Elevated or Constructed Land**

#### Notes:

- **Strategic DFE**
  - **Minimum DFE**
  - **Strategic DFE I**
  - **Strategic DFE II**

#### Scoring:

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<td>Prevents ground water settlement &amp; associated erosion</td>
<td>Low priority (e.g., flood, fire)</td>
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### Summary:

**Location:** Northern Avenue

**Asset:** Docks

**Group:** Elevated Dock Access

**ELEVATED DOCK ACCESS**

### Scoring:

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<tr>
<td><strong>Benefits</strong></td>
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<tr>
<td>Progressive &amp; enhances the environment, including waterfront</td>
<td>Includes benefits that are immediately adjacent or located immediately adjacent to the study area</td>
<td>Includes benefits that are immediately adjacent or located immediately adjacent to the study area</td>
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<td>Meets Design Flood Elevations</td>
<td>Meets Design Flood Elevations</td>
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<td>Minimizes construction cost</td>
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<td>Minimizes long term operations &amp; maintenance costs</td>
<td>Minimizes long term operations &amp; maintenance costs</td>
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<td>Minimizes impacts to seawalls &amp; structures</td>
<td>Minimizes impacts to seawalls &amp; structures</td>
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<td>Preserves &amp; enhances environmental resources</td>
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<td>Lowers flood at abutting properties</td>
<td>Lowers flood at abutting properties</td>
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<td>Preserves &amp; enhances emergent areas</td>
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<td>Preserves &amp; enhances visibility</td>
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<td>Preserves &amp; enhances access to or from the waterfront, public transportation &amp; public spaces</td>
<td>Preserves &amp; enhances access to or from the waterfront, public transportation &amp; public spaces</td>
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</table>

### Notes:
- Strategic DFE-based
- Minimum DFE
- Location or Alignment
- Scoring range and max

<table>
<thead>
<tr>
<th>Notes</th>
<th>Location or Alignment</th>
<th>Scoring range and max</th>
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<td>Minimum DFE</td>
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<td>Location or Alignment</td>
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**Elevated Dock Access**

- **Location:** Northern Avenue
- **Asset:** Docks
- **Group:** Elevated Dock Access
- **Elevated Dock Access**

---

**Northern Avenue**

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**Scoring:**

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<td>Meets Design Flood Elevations</td>
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<td>Preserves &amp; enhances access to or from the waterfront, public transportation &amp; public spaces</td>
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**Notes:**
- Strategic DFE-based
- Minimum DFE
- Location or Alignment
- Scoring range and max
### Summary:

**Location:** Waters Edge  
**Asset:** Roslany  
**Solution:** Elevated Roadway & Harborwalk  
**Group:** Stage 2: Upper Blvd & Northern Ave

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<tr>
<th>Social Equity &amp; Access</th>
<th>Environmental and Additional Benefits</th>
<th>Effectiveness</th>
<th>Feasibility</th>
<th>Adaptable</th>
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| *Progressively with sea level rise* | Provides opportunities for phased implementation  
- No potential for phased actions within the study area  
- No reduction in size of open access to, views/wayfinding to, or signage for open public space  
- No adverse impacts to the habitatwalk  
- No adverse impacts to public accommodations (FPAs) | *Minimizes long term operations & maintenance costs*  
- *Minimizes deployment complexity*  
- *Minimizes permitting risks* | *Provides new opportunities for trees, living shorelines, or wetlands (e.g. elevated constructed land at inland or waters edge alignments), and no other infill of the Harbor is required*  
*Reduces width of Harborwalk, obstructs view of water from Harborwalk, or eliminates licensed facilities of public accommodation (FPAs)*  
*Mitigates existing known coastal erosion and/or settlement*  
*Preserves & enhances view of the Harbor*  
*Preserves & enhances outdoor public spaces, including signage, living shorelines, or wetlands*  
*Preserves & enhances the Harborwalk, including welcoming & inclusive access and signage* | *No impact on planned land use*  
*No adverse impacts to the habitatwalk*  
*No adverse impacts to public accommodations (FPAs)* | *Minimizes ground settlement & coastal erosion*  
*Preserves & enhances environmental resources*  
*Minimizes construction cost*  
*Minimizes ground elevation at alignment*  
*Strategic DFE inland* | *Minimizes ground elevation at alignment*  
*Strategic DFE inland*  
*Minimizes construction cost*  
*Minimizes ground elevation at alignment*  
*Strategic DFE inland*  
| *Minimizes deployment complexity*  
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*Minimizes construction cost*  
*Minimizes ground elevation at alignment*  
*Strategic DFE inland* | *No impact on planned land use*  
*No adverse impacts to the habitatwalk*  
*No adverse impacts to public accommodations (FPAs)* | *Minimizes ground elevation at alignment*  
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*No adverse impacts to public accommodations (FPAs)* | *Minimizes ground elevation at alignment*  
*Strategic DFE inland*  
*Minimizes construction cost*  
*Minimizes ground elevation at alignment*  
*Strategic DFE inland*  

#### Scoring:

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<th>Recommendation Issues</th>
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| **Assessment Criteria**:  
Elevated Roadway & Harborwalk  
- Preserves & enhances the habitatwalk, including welcoming & inclusive access and signage  
- Provides new opportunities for trees, living shorelines, or wetlands (e.g. elevated constructed land at inland or waters edge alignments), and no other infill of the Harbor is required  
- Reduces width of Harborwalk, obstructs view of water from Harborwalk, or eliminates licensed facilities of public accommodation (FPAs)  
- Mitigates existing known coastal erosion and/or settlement  
- Preserves & enhances view of the Harbor  
- Preserves & enhances outdoor public spaces, including signage, living shorelines, or wetlands  
- Preserves & enhances the Harborwalk, including welcoming & inclusive access and signage  
- Preserves & enhances environmental resources  
- Minimizes construction cost  
- Minimizes ground elevation at alignment  
- Strategic DFE inland  | *Preserves & enhances the habitatwalk, including welcoming & inclusive access and signage*  
*Provides new opportunities for trees, living shorelines, or wetlands (e.g. elevated constructed land at inland or waters edge alignments), and no other infill of the Harbor is required*  
*Reduces width of Harborwalk, obstructs view of water from Harborwalk, or eliminates licensed facilities of public accommodation (FPAs)*  
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*Strategic DFE inland* | *Minimizes deployment complexity*  
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*Strategic DFE inland*  
*Minimizes construction cost*  
*Minimizes ground elevation at alignment*  
*Strategic DFE inland*  

### Notes:

- Strategic DFE: 13.0  
- Minimum CFE: 19.0  
- Ground Elevation at Alignment: 3.0  
- Solution min and max: 10.0  
- PJN: 286982-00  
- Wharf District Resilience Plan

**Northern Avenue**
Northern Avenue

Summary:

Location: Outfall

Assess: Open Space

Solutions: Evaluated or Constructed Land

Group of 40 Acres to James Hotel + Co.

Social Equity & Access

Additional Benefits

Feasibility

Adaptability

Notes:

Minimum Life: 15.36

Minimum WAC: 5.9

Solution run & new: 19.1

Scoring:

<table>
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<th>Scoring Criteria</th>
<th>Assessment Criteria</th>
<th>Achievement Score</th>
<th>Remarks Score</th>
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**2.0 Additional Benefits**

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**4.0 Adaptability**

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Due Diligence and Multi-Criteria Assessment Findings: Fort Point Channel

This plan summarizes findings of a multi-criteria assessment used to identify strengths and weaknesses of potential flood resiliency strategies.

**KEY PLAN AND LEGEND**

- **Limit of Study Area**
- **Inland Preliminary Alignment**
- **Waters Edge Preliminary Alignment**
- **Outboard Preliminary Alignment**
- **Major Flow Lines (CRS)**
- **Major Rainfall Paths**
- **Seawall**
- **Slurry Wall**
- **1st Contour Lines (LSAR)**
- **MBTA Silverline Easement**
- **SE 150' Spot Grade (Article 37)**
- **SE 100' Spot Grade (Data Repository)**
- **Emergency Access Point**
- **Accessibility Point**
- **Bus Stops**
- **Water Transportation Access Point**
- **Vehicular Access Point**
- **Ventilation Grate**

**MULTI-CRITERIA ASSESSMENT**

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<th>ELEVATED / CONSTRUCTED LAND (ATLANTIC WHARF &amp; INTERCONTINENTAL)</th>
<th>ELEVATED ROADWAY / CONSTRUCTED ROADWAY (CONGRESS ST)</th>
<th>DEPLOYABLE BARRIER / SLURRY WALL (CONGRESS ST)</th>
<th>RAISED/STEPPED (ATLANTIC WHARF &amp; INTERCONTINENTAL)</th>
<th>OVER WATER (ALL PROPERTIES)</th>
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**PLAN VIEW**

The preliminary plan includes alignments based off of Climate Ready Boston report. Alignments may vary in this report based on recommendations.

**KEY CONSIDERATIONS**

**Geotechnical:** The building at Independence Wharf is supported on Bell Caisson piles driven into clay. The Fort Point Channel mudline along the waterfront properties is estimated to be approximately elevation -10' NAVD88.

**Coastal Structures:** Indications of building settlement observed at Independence Wharf, and the associated sea wall is in critical condition. The MBTA Silver Line tunnel is located below the Harborwalk at Intercontinental Hotel, with estimated top of tunnel elevation of -14.9' to -18.7' NAVD88.

**Utilities:** Outfall pipes observed at Intercontinental Hotel and Atlantic Wharf. CA/T vent observed at Intercontinental Hotel.

**Rainfall Flow Path:** A major flow path at Congress Street directs rainfall to the Fort Point Channel. Storm drains around the buildings and in the Harborwalk deck direct rainwater into the building drainage systems.

**Access:** The alley between Intercontinental Hotel and Atlantic Wharf is used for generator fuel deliveries, access to a MassDOT facility located in Intercontinental Hotel, and for emergency vehicle access to the Harborwalk.

**Regulatory:** Structures outboard of the State Harbor Line (roughly at the face of InterContinental Hotel deck) generally require Massachusetts legislative authorization. Seawalls in this area are listed in the National Register of Historic Places. Access to the Harborwalk via the alley between Atlantic Wharf and Intercontinental Hotel, and public programming of the Harborwalk deck are Chapter 91 requirements.

**FINDINGS & RECOMMENDATIONS**

**Prerequisite Criteria:** The Inland alignment Flood Wall, Elevated / Constructed Land, and Deployable Barrier strategies are preferred over Poor Social Equity & Access scores resulting from reducing harbor access. The Water's Edge Flood Wall, Raised/Stepped, and Over Water strategies are not preferred due to Poor Environmental & Additional Benefits scores resulting from impacting the visibility of historic seawalls and infilling the channel.

**Constructability Criteria:** The Water's Edge alignment Elevated Dock and Elevated/Constructed Land strategies are the most constructable strategies in this study, however the Elevated/Constructed Land strategy is not recommended due to potentially impacting navigable waters in Fort Point Channel and adding loading to the MBTA tunnel.

**Recommendations:** The Water's Edge alignment Elevated Dock strategy should be considered for the Preferred Flood Protection System, and should be designed to avoid increasing loads at the MBTA tunnel and Independence Wharf, and mitigate impacted views of historic sea walls. Coordination is required with City of Boston to continue the flood protection system south along the Channel. Conversion of Northern Avenue bridge into a flood gate should also be further investigated to protect all properties along the Channel.
Fort Point Channel

Notes:
1. Actual benefits and trade-offs of flood resiliency strategies will be subject to numerous site-specific considerations and can be influenced by nuanced detailed design approaches. This process provides simplified Evaluation Criteria definitions for each score to provide a transparent and repeatable high level assessment of the relative potential benefits and trade-offs for comparing the major components of various flood resiliency strategies.

2. Critical Infrastructure is defined in Section 2.0 of Boston Public Works Department 2018 Climate Resilient Design Standard & Guidelines

3. In-kind dock replacement includes relocation to an area on the same property with similar or greater footprint, water depth, and protection from wind and waves. In-kind water transportation access point replacement includes relocation to an area on the same property with similar accessibility, connectivity, and visibility. In-kind private open space replacement includes relocation to an area on the same property with similar or greater footprint and access points.

4. National Register of Historic Places structures in the study area include the Long Wharf and Custom House Block, and the seawall between 360-400 Atlantic Avenue and Congress Street.

Definitions:
Facilities of Public Accommodation ("FPAs") are qualified under the State’s Waterways Regulations (Chapter 91) as "facilities at which goods or services are made available directly to the public on a regular basis, or at which the advantages of use are otherwise open on essentially equal terms to the public at large." FPA space is located in buildings along the City’s waterfront and is required through Chapter 91 licensing for new or redevelopment projects. Examples of interior facilities of public accommodation referenced in the regulations include restaurants, performance areas, hotels, retail establishments, and educational and cultural institutions.

A Wharf is a level concrete, stone, or metal platform lying alongside or projecting into water to which a ship may be moored to load and unload. Adequate water depth for ships must exist alongside the structure to be defined as a wharf. The structure must be of adequate size and configuration to allow ships to moore to be defined as a wharf.

Critical Infrastructure(2)
- Hospitals and health care facilities
- Emergency Response (Police, Fire, Rescue, Ambulance) facilities and related items (garages, shelters, operations centers, communications, back-up generators, substations, etc.)
- Correctional facilities
- Wastewater treatment plants
- Water storage tanks
- Operations centers
- Public works yards
- Municipal buildings
- Schools and facilities that may be used as emergency shelters
- Power transmission facilities, substations, and power generation stations
- Critical transportation networks (emergency evacuation routes, public transportation, aviation facilities, tunnels, bridges, train and transit maintenance yards and shops, traffic signals)
- Facilities where residents have limited mobility or ability (such as nursing homes and care facilities)
- Buildings or structures that contain hazardous waste, transfer stations
- Pumping stations (stormwater and sanitary)
- Fueling storage and fuel stations
- Ventilation buildings and fan plants
- Telecommunications
- Major food distribution centers
<table>
<thead>
<tr>
<th>Social Equity &amp; Access</th>
<th>Assessment Score</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessibility</td>
<td>-3</td>
<td>Irreconcilable differences with planned land use, or not required by the Public Accommodations Act (FPA)</td>
</tr>
<tr>
<td>Environmental &amp; Additional Benefits</td>
<td>-3</td>
<td>Sites major traffic pathway to the harbor, or planned mitigation strategies identified</td>
</tr>
<tr>
<td>Feasibility</td>
<td>-3</td>
<td>Irreconcilable differences with planned land use, or not required by the Public Accommodations Act (FPA)</td>
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<tr>
<td>Sustainability</td>
<td>-3</td>
<td>Irreconcilable differences with planned land use, or not required by the Public Accommodations Act (FPA)</td>
</tr>
</tbody>
</table>

### Fort Point Channel

- **Social Equity & Access**
  - Accessibility: 
    - Site major traffic pathway to the harbor, or planned mitigation strategies identified
  - Environmental & Additional Benefits: 
    - Sites major traffic pathway to the harbor, or planned mitigation strategies identified
  - Feasibility: 
    - Irreconcilable differences with planned land use, or not required by the Public Accommodations Act (FPA)
  - Sustainability: 
    - Irreconcilable differences with planned land use, or not required by the Public Accommodations Act (FPA)

- **Project Description**
  - Provides new opportunities for phased implementation

- **Scoring**
  - Philips & implements others: 
    - No significant credit or reduction in flood protection
  - Provides new opportunities for phased implementation

- **Conclusion**
  - Fort Point Channel provides new opportunities for phased implementation.
## Fort Point Channel

### Technical Description

<table>
<thead>
<tr>
<th>Location</th>
<th>Asset</th>
<th>Solution</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boston</td>
<td>Harbor</td>
<td>District</td>
<td>Schedule</td>
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</table>

### Social Equity & Access

<table>
<thead>
<tr>
<th>Environmental and Additional Benefits</th>
<th>Feasibility</th>
<th>Adaptable</th>
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<tbody>
<tr>
<td>Notes:</td>
<td></td>
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<tr>
<td>Strategic DFE</td>
<td>16.6</td>
<td>15</td>
</tr>
<tr>
<td>Mitigation DFE</td>
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<tr>
<td>Solution size and max</td>
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### ELEVATED SPACE

### Scoring:

<table>
<thead>
<tr>
<th>Subject/Description</th>
<th>Non-Combatant</th>
<th>Combatant</th>
<th>Mitigation</th>
<th>Strategic DFE</th>
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</tr>
<tr>
<td>Effectiveness</td>
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</tbody>
</table>

### Notes:

- Strategic DFE 16.6
- Mitigation DFE 15
- Solution size and max 35.5

### Observation:

- Strategic DFE:
  - Technology:
  - Accessibility:
  - Preservation:
  - Adaptability:
  - Effectiveness:

### Mitigation:

- Technology:
- Accessibility:
- Preservation:
- Adaptability:
- Effectiveness:

### Strategic DFE:

- Technology:
- Accessibility:
- Preservation:
- Adaptability:
- Effectiveness:

### Observation:

- Strategic DFE:
  - Technology:
  - Accessibility:
  - Preservation:
  - Adaptability:
  - Effectiveness:

### Mitigation:

- Technology:
- Accessibility:
- Preservation:
- Adaptability:
- Effectiveness:

### Strategic DFE:

- Technology:
- Accessibility:
- Preservation:
- Adaptability:
- Effectiveness:

### Observation:

- Strategic DFE:
  - Technology:
  - Accessibility:
  - Preservation:
  - Adaptability:
  - Effectiveness:

### Mitigation:

- Technology:
- Accessibility:
- Preservation:
- Adaptability:
- Effectiveness:

### Strategic DFE:

- Technology:
- Accessibility:
- Preservation:
- Adaptability:
- Effectiveness:

### Observation:

- Strategic DFE:
  - Technology:
  - Accessibility:
  - Preservation:
  - Adaptability:
  - Effectiveness:

### Mitigation:

- Technology:
- Accessibility:
- Preservation:
- Adaptability:
- Effectiveness:

### Strategic DFE:

- Technology:
- Accessibility:
- Preservation:
- Adaptability:
- Effectiveness:

### Observation:

- Strategic DFE:
  - Technology:
  - Accessibility:
  - Preservation:
  - Adaptability:
  - Effectiveness:

### Mitigation:

- Technology:
- Accessibility:
- Preservation:
- Adaptability:
- Effectiveness:

### Strategic DFE:

- Technology:
- Accessibility:
- Preservation:
- Adaptability:
- Effectiveness:

### Observation:

- Strategic DFE:
  - Technology:
  - Accessibility:
  - Preservation:
  - Adaptability:
  - Effectiveness:

### Mitigation:

- Technology:
- Accessibility:
- Preservation:
- Adaptability:
- Effectiveness:

### Strategic DFE:

- Technology:
- Accessibility:
- Preservation:
- Adaptability:
- Effectiveness:
### Fort Point Channel

**Location:** Boston, Massachusetts

**Iland:** Boston

**Roadway:** 1 Congress St. – North Cove Bridge

<table>
<thead>
<tr>
<th>Social Equity &amp; Access</th>
<th>Environmental &amp; Additional Benefits</th>
<th>Feasibility</th>
<th>Adaptability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

**Notes:**
- Strategic Plan: TID 16
- Minimum DFE: 15
- Maximum DFE: 18
- Solution min and max: 3 to 7

### ELEVATED ROADWAY & HARBOR WALL

### Scoring:

<table>
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<tr>
<th>Assessment Score</th>
<th>Model</th>
<th>Rating</th>
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<td>4</td>
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<th>3</th>
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<th>Notes</th>
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<tbody>
<tr>
<td>Social Equity &amp; Access</td>
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<td>Environmental &amp; Additional Benefits</td>
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<tr>
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<tr>
<td>Adaptability</td>
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</tbody>
</table>

**Assessment Score:**
- 4: Does not block major rainfall storage & pumping system to the waterfront (including living shorelines)
- 3: Maintains or increases open public spaces or critical infrastructure
- 2: Does not block major rainfall storage & pumping system to the waterfront (including living shorelines)
- 1: Does not block major rainfall storage & pumping system to the waterfront (including living shorelines)

**Notes:**
- Strategic Plan: TID 16
- Minimum DFE: 15
- Maximum DFE: 18
- Solution min and max: 3 to 7
## Fort Point Channel

### Environmental and Additional Benefits

<table>
<thead>
<tr>
<th>Social Equity &amp; Access</th>
<th>DEPLOYABLE</th>
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<tr>
<td>Effectiveness</td>
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<tr>
<td>Feasibility</td>
<td>Neutral</td>
</tr>
<tr>
<td>Adaptability</td>
<td>Neutral</td>
</tr>
</tbody>
</table>

### Notes:

- Strategy CFE: Inland
- Minimum DFE: 15
- Ground Elevation Aligned: 12
- Solution min and max: 3

### Scoring:

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Non-impact</th>
<th>Negative</th>
<th>Neutral</th>
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<th>Assessed Score</th>
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<td>Protects critical infrastructure</td>
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<td>Protects cultural resources</td>
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<tr>
<td>Reduces environmental impact</td>
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<tr>
<td>Reduces flood risk</td>
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<tr>
<td>Reduces runoff</td>
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<tr>
<td>3</td>
<td></td>
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<tr>
<td>Mitigation of erosion</td>
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<td>Mitigation of subsidence</td>
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<td>Mitigation of coastal erosion</td>
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<tr>
<td>4</td>
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<tr>
<td>Feasibility</td>
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</tr>
<tr>
<td>Meets design flood discharge (DFD)</td>
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<tr>
<td>Precludes flood damage to public land (e.g. shoreline)</td>
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<tr>
<td>5</td>
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<td>Mitigation of erosion</td>
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<tr>
<td>Mitigation of coastal erosion</td>
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</tbody>
</table>

### Key Points:

- **DEPLOYABLE**
  - Meets Target DFE; can be raised
  - Minimizes impacts to seawalls & coastal erosion
  - Minimizes ground settlement & flooding at abutting properties
  - Protects critical infrastructure including the functionality & visibility of the district’s heritage and history, which includes wharves, facilities, or buildings that are listed in the National Register of Historic Places.

- **Non-impact**
  - Meets Target DFE; cannot be raised
  - Does not block all existing emergency access to the waterfront, public transportation, or buildings
  - Does not block major rainfall storage & pumping system or channel
  - Does not block any new public space access points
  - Does not block any emergency access routes to buildings or docks
  - Does not block any phased development

- **Neutral**
  - Meets Target DFE; can be raised
  - Does not meet Target DFE; cannot be raised
  - Does not fully deployable
  - Does not meet Strategic DFE
  - Does not create new public access points to the waterfront (including new boat berths)

- **Negative**
  - Meets Target DFE; cannot be raised
  - Does not meet Target DFE; cannot be raised
  - Does not meet Target DFE; cannot be raised

- **Positive**
  - Meets Target DFE; can be raised
  - Minimizes impacts to seawalls & coastal erosion
  - Minimizes ground settlement & flooding at abutting properties
  - Protects critical infrastructure including the functionality & visibility of the district’s heritage and history, which includes wharves, facilities, or buildings that are listed in the National Register of Historic Places.

- **Assessment Score**
  - 5: Positive
  - 3: Neutral
  - 1: Negative
### Fort Point Channel

#### Location:
- Address: 1 Independence Wharf

#### Environmental and Additional Benefits

<table>
<thead>
<tr>
<th>Effectiveness</th>
<th>Feasibility</th>
<th>Adaptability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

#### Notes:
- Strategy: Oyster Island
- Minimum DFE: 10
- Maximum DFE: 15
- Solution score: 10
- Solution max: 15

### Scoring:

#### Criteria Description

<table>
<thead>
<tr>
<th>Effectiveness</th>
<th>Feasibility</th>
<th>Adaptability</th>
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#### Assessment Score

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<tr>
<th>Location</th>
<th>Asset</th>
<th>Solution</th>
<th>Group</th>
<th>Assessment Score</th>
<th>Interpretation</th>
<th>Rating</th>
<th>Median</th>
<th>Range</th>
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</thead>
<tbody>
<tr>
<td>Inland</td>
<td>Building</td>
<td>Floodwall</td>
<td>Independence Wharf</td>
<td>FLOODWALL</td>
<td>Increases hardshell width or increases water of seawall, precludes or severely limits passable seawall, or limits economics of seawall to increased cost</td>
<td>Neutral</td>
<td>meets Target DFE; cannot be raised</td>
<td>3</td>
</tr>
</tbody>
</table>

- **Floodwall**
  - "Non-starter" customers, including commercial, industrial, and public utilities, achieve a fully passable seawall with no potential for phased deployment.
  - Fully or partially obstructs preserves current view quality
  - Does not protect all critical infrastructure
  - Does not block major emergency access routes to buildings or critical infrastructure
  - Minimizes long-term operations & infrastructure maintenance costs

- **Ground Elevation at Alignment**
  - Location: Fort Point Channel
  - Solution: Inland

- **Inland**
  - Achieves a hardshell width of seawall exceeding 2 feet.
  - Seawall is maintained and meets strategic DFE.
  - Infrastructure is preserved or creates land for public open space.
  - Protects critical infrastructure.
  - Does not reduce access to, width of, or views of water from the seawall.
  - Inland floodwall has minimal impact on coastal erosion and/or settlement.

- **Ground Elevation at Intersection**
  - Location: Fort Point Channel
  - Solution: Inland

- **Inland**
  - Achieves a hardshell width of seawall exceeding 2 feet.
  - Seawall is maintained and meets strategic DFE.
  - Infrastructure is preserved or creates land for public open space.
  - Protects critical infrastructure.
  - Does not reduce access to, width of, or views of water from the seawall.
  - Inland floodwall has minimal impact on coastal erosion and/or settlement.

- **Inland**
  - Achieves a hardshell width of seawall exceeding 2 feet.
  - Seawall is maintained and meets strategic DFE.
  - Infrastructure is preserved or creates land for public open space.
  - Protects critical infrastructure.
  - Does not reduce access to, width of, or views of water from the seawall.
  - Inland floodwall has minimal impact on coastal erosion and/or settlement.

- **Inland**
  - Achieves a hardshell width of seawall exceeding 2 feet.
  - Seawall is maintained and meets strategic DFE.
  - Infrastructure is preserved or creates land for public open space.
  - Protects critical infrastructure.
  - Does not reduce access to, width of, or views of water from the seawall.
  - Inland floodwall has minimal impact on coastal erosion and/or settlement.

- **Inland**
  - Achieves a hardshell width of seawall exceeding 2 feet.
  - Seawall is maintained and meets strategic DFE.
  - Infrastructure is preserved or creates land for public open space.
  - Protects critical infrastructure.
  - Does not reduce access to, width of, or views of water from the seawall.
  - Inland floodwall has minimal impact on coastal erosion and/or settlement.

- **Inland**
  - Achieves a hardshell width of seawall exceeding 2 feet.
  - Seawall is maintained and meets strategic DFE.
  - Infrastructure is preserved or creates land for public open space.
  - Protects critical infrastructure.
  - Does not reduce access to, width of, or views of water from the seawall.
  - Inland floodwall has minimal impact on coastal erosion and/or settlement.

- **Inland**
  - Achieves a hardshell width of seawall exceeding 2 feet.
  - Seawall is maintained and meets strategic DFE.
  - Infrastructure is preserved or creates land for public open space.
  - Protects critical infrastructure.
  - Does not reduce access to, width of, or views of water from the seawall.
  - Inland floodwall has minimal impact on coastal erosion and/or settlement.

- **Inland**
  - Achieves a hardshell width of seawall exceeding 2 feet.
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  - Infrastructure is preserved or creates land for public open space.
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- **Inland**
  - Achieves a hardshell width of seawall exceeding 2 feet.
  - Seawall is maintained and meets strategic DFE.
  - Infrastructure is preserved or creates land for public open space.
  - Protects critical infrastructure.
  - Does not reduce access to, width of, or views of water from the seawall.
  - Inland floodwall has minimal impact on coastal erosion and/or settlement.

- **Inland**
  - Achieves a hardshell width of seawall exceeding 2 feet.
  - Seawall is maintained and meets strategic DFE.
  - Infrastructure is preserved or creates land for public open space.
  - Protects critical infrastructure.
  - Does not reduce access to, width of, or views of water from the seawall.
  - Inland floodwall has minimal impact on coastal erosion and/or settlement.

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<tr>
<th>Criteria Description</th>
<th>Positive Score</th>
<th>Neutral Score</th>
<th>Negative Score</th>
<th>Assessment Score</th>
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<tr>
<td>1. Adaptable &amp; Accessible</td>
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<tr>
<td>- Feasibility</td>
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<td>- Accessibility</td>
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<td>- Public Accommodation</td>
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<td>- Parking</td>
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<td>2. Environmental &amp; Additional Benefits</td>
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<td>- Waters Edge</td>
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<td>- Harbor Walk</td>
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<tr>
<td>- RAISED / STEPPED</td>
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<td>3. Accessibility</td>
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<tr>
<td>- Provides new opportunities for phased implementation</td>
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<tr>
<td>- Preserves or creates land for future storage &amp; pumping system</td>
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<td>- Improves and facilitates protection of buildings or critical infrastructure(2) located immediately adjacent to the study area</td>
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<td>4. Resilience</td>
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<tr>
<td>- Resilient to Strategic DFE</td>
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<tr>
<td>- Anchors or improves access to Harborwalk</td>
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<tr>
<td>- In-kind replacements for any existing dock area</td>
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<tr>
<td>- Water transportation access points</td>
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<tr>
<td>- Mitigation of coastal impacts</td>
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<td>6. Infrastructure</td>
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<td>- Existing facilities of public accommodation</td>
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<td>- New facilities to existing facilities of public accommodation</td>
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<tr>
<td>- Minimizes long-term operations &amp; maintenance costs</td>
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<td>- Presents superficial breaches that would impact implementation</td>
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<td>7. Sustainability</td>
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<tr>
<td>- Integrates with existing property plans and uses</td>
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<tr>
<td>- Facilitates climate resilient development</td>
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<tr>
<td>- Electronic Components</td>
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<td>8. Accessibility &amp; Efficiency</td>
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<tr>
<td>- Local public access points</td>
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<tr>
<td>- Excellent function of existing transportation &amp; access</td>
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<tr>
<td>- Access to existing dock area</td>
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<tr>
<td>- Provides access to Harborwalk</td>
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Notes:
- Strategic DFE: 3
- Minimum DFE: 2
- Ground Elevation at Alignment: 12
- Solution mix: 3

Fort Point Channel

Location: Waters Edge
Asset: Harbor Walk
Solution: RAISED / STEPPED Harbor Walk
1. Atlantic Wharf and Intercontinental Hotel
## Fort Point Channel

### Scoring:

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Notional Score</th>
<th>Imparted Score</th>
<th>Position</th>
<th>Assessed Score</th>
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<td>Environmental &amp; Additional Benefits</td>
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<td>Over Water</td>
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<tr>
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### Notes:

- Strategic Goals:
  - D1C: Island
  - D1C: Waterfront

### Criteria:

1. **Social Equity & Access**
   - Waterfront: Neutral
   - Over Water: Positive

2. **Environmental & Additional Benefits**
   - Waterfront: Neutral
   - Over Water: Negative

3. **Feasibility**
   - Waterfront: Neutral
   - Over Water: Neutral

4. **Adaptable**
   - Waterfront: Neutral
   - Over Water: Neutral

5. **Adaptive**
   - Waterfront: Neutral
   - Over Water: Neutral

### Criteria Scoring Table:

<table>
<thead>
<tr>
<th>Criteria Description</th>
<th>Notional Score</th>
<th>Imparted Score</th>
<th>Position</th>
<th>Assessed Score</th>
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<tr>
<td>Over Water</td>
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### Scoring Details:

- **Social Equity & Access**
  - Waterfront: Neutral
  - Over Water: Positive

- **Environmental & Additional Benefits**
  - Waterfront: Neutral
  - Over Water: Negative

- **Feasibility**
  - Waterfront: Neutral
  - Over Water: Neutral

- **Adaptable**
  - Waterfront: Neutral
  - Over Water: Neutral

- **Adaptive**
  - Waterfront: Neutral
  - Over Water: Neutral
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<th>Location: Harbor Walk</th>
<th>Solution: Waters Edge Harborwalk</th>
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<td>Feasibility</td>
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<td>Effectiveness</td>
<td>Resources</td>
<td>Design Focus</td>
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**Notes:**
- Strategic DFE island: 16 A
- Minimum DFE: 15
- Ratio must be between 0.9 to 1.0

### Scoring:

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<td>Resources</td>
<td>Design Focus</td>
<td>Score</td>
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</table>

- **Harbor Walk:**

  - **Waters Edge Harborwalk:**
    - **Solution:**
      - **ELEVATED OR CONSTRUCTED LAND**

  - **Social Equity & Access**:
    - Resources:
      - Design Focus: Score

  - **Environmental & Additional Benefits**: Resources:
    - Design Focus: Score

  - **Feasibility**: Resources:
    - Design Focus: Score

  - **Adaptability**: Resources:
    - Design Focus: Score
### Scoring

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</table>

### Fort Point Channel

- **Location:** Wharf District Resiliency Plan
- **Solution:** Elevated Dock
- **Adaptability:** 5
- **Feasibility:** 5
- **Effectiveness:** 1
- **Social Equity & Access:** 3

### Notes
- Strategy: DSC Island
- Minimum DFE: 15
- Minimum Elevation of Alignment: 3

### Ground Elevation at Alignment

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<tr>
<th>Ground Elevation at Alignment</th>
<th>Assessment Score</th>
<th>Model</th>
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### PJN: 286982-00

- **Assessment Score:** 5
- **Model:**       |      |      |      |                  |
- **Positive:**    |      |      |      |                  |

### PJN: 286982-00

- **Assessment Score:** 5
- **Model:**       |      |      |      |                  |
- **Positive:**    |      |      |      |                  |
APPENDIX E

Detailed Cost Estimate
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<th>Methodology</th>
<th>Accuracy Range</th>
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<td>Rough Order of Magnitude</td>
<td>Planning Schematic Design</td>
<td>0% to 5%</td>
<td>Parametric Models</td>
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<td>Capacity Factored</td>
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<td>4</td>
<td>Concept Feasibility</td>
<td>Planning Schematic Design</td>
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<td>Equipment Factored</td>
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<td>Parametric Models</td>
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<td>Preliminary Design Engineering</td>
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<td>Detailed Unit Cost</td>
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<td>Design Documents</td>
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<td>Detailed Take-Off</td>
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<td>Detailed Design Engineering</td>
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<td>Detailed Unit Cost</td>
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<td>Construction Documents</td>
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<td>Detailed Take-Off</td>
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PROJECT NOTES & BASIS OF ESTIMATE

1 Basis of Pricing / Methodology
The cost estimate is classified as a Class 5 estimate according to the Association for the Advancement of Cost Engineering’s (AACE) estimate classification matrix. The accuracy range of this estimate has been determined to be -40% and +65%. The accuracy range is a gauge of likely bid prices if the project was issued to tender at this current stage.

Pricing shown reflects probable construction costs obtainable for the infrastructure works on the date of this statement of probable costs. This estimate is a determination of fair market value for the construction of this project. It is not a prediction of low bid. Pricing assumes competitive bidding for every portion of the construction work for all subcontractors, that is to mean 4 to 5 bids. If fewer bids are received, bid results can be expected to be higher.

Base date of estimate is Q2 2023, with prices shown in USD$.

2 Scope of the Project
The scope of this cost estimate includes for the followings works:
- Construction of multiple different kinds of resiliency measures designed to protect waterfront and inland property from flooding, sea level rise, and storm surge.
- Scope is divided into three different phases to be completed at different points in time: near-term, mid-term, and long-term. Each phase is treated as an independent project.

3 Below the Line (BTL) Costs
Indirects includes contractor’s costs for general conditions, site supervision, flaggers and public protection, temporary works not included in direct costs, site facilities and laydown areas.
Mobilization & Demobilization includes contractor’s costs for mobilizing and demobilizing their crews, equipment, and materials to the job site.
Overhead & Profit includes overhead and profit for the general contractor’s head office.

4 Contingency and Escalation
- Contractor’s Contingency is included at 15% to cover variation in pricing.
- Owner’s Contingency is included at 20% to cover additional costs triggered by realized project risks.
- Escalation has been included at 4% per annum. Prices have been escalated to the mid-point of construction based the phase the construction work is intended to be completed. The midpoints for near-, mid-, and long-term are 2030, 2050, and 2070 respectively.

5 Soft Costs
Soft costs have not been included for this estimate. (detail design, construction management, program management, financing, etc.)
Legal / Permits / Fees include costs associated with any legal requirements, permits, and/or fees required by the delivery of this project.
Geotechnical and Environmental Investigations include costs to investigate the geotechnical characteristics of the project site and related environmental impacts.
Preliminary Design includes costs to prepare preliminary designs for the construction of this project.
Detailed Design includes costs to prepare detailed designs that can be passed on to the contractor to construct this project.
Assumptions

- Cost estimate assumes the project will be procured using a Design-Bid-Build model.
- Sheet Pile Bulkheads are assumed to be barge driven with a deadman system and concrete coping beam.
- King Pile Bulkheads are assumed to be barge driven with a deadman anchorage system and concrete coping beam. King Piles Bulkheads are
  reinforced and offer greater strength than Sheet Pile Bulkheads.
- Stone Walls are assumed to be installed in front of newly installed Sheet Pile Bulkheads on top of a base plate. These walls are not designed to carry
  structural load.
- Stone Walls are assumed to be sourced with stones that look comparably to the existing stone sea walls.
- Permanent Floodwalls are assumed to be 1.5' thick reinforced concrete walls.
- Glass Floodwalls are stainless steel framed toughened laminated safety glass flood barriers that are assumed to be built on top of the seawall capping
  beams to add additional flood protection to the harbor walk.
- The unit rate for Glass Floodwalls are derived from an April 4th 2023 quote from Flood Control International.
- Automatic Deployable Floodbreak Barriers are walls that are stored below ground that can be deployed vertically out of their storage cavity in the
  event of a floods. They are assumed to be installed by certified installers after initial civil infrastructure (trench and reinforced concrete walls and
  foundations with associated drainage and electrical connections) is complete.
- The unit rate for Automatic Deployable Floodbreak Barriers are derived from an April 3rd 2023 quote from FloodBreak. Civil infrastructure works and
  a 30% markup for installation costs are included in the unit rate to align with recommended budget pricing from FloodBreak. Unit rates for the
  "Roadway" and "Vehicle" barriers are directly derived from the quote on a per-square-foot basis, and the "FreeView" unit rate is prorated based the
  design differences.
- "Roadway" and "Vehicle" FloodBreak barriers are each rated for vehicle loads. "Roadway" barriers are more robust and intended for larger loads and
  areas than the "Vehicle" barriers. "FreeView" barriers are not designed for vehicle loads and are intended to be placed along waterfronts and
  pedestrian zones.
- Retaining Walls are assumed to be reinforced cast-in-place cantilevered concrete retaining walls on land.
- Underground Slurry Walls are assumed to be slurry trenches with non-reinforced concrete. The unit rate is assumed to include excavation.
- Lightweight Structural Fill is assumed to be artificially engineered aggregate.
- Flowable Fill is assumed to be slurry fill to be placed underneath existing harbor walk deck. The unit rate includes dewatering required for the
  sectioned area.
- Dewatering for Harbor Towers Allowance is a lump sum that covers the scope associated with dewatering Harbor Towers to accommodate associated
  works.
- Dewatering for Rowes Wharf Allowance is a lump sum that covers the scope associated with dewatering and rewatering Rowes Wharf to
  accommodate associated works.
- Cofferdams are assumed to be supported by soldier beams & lagging with wood sheeting. The unit rate includes dewatering.
- Privacy Screening is assumed to be a 10' tall wood screening fence.
- Social Stepped Stairway Landform is assumed to be a linear landscape feature with soil formed into steps with a vertical face of concrete or plank
  running length-wise to support the soil. A tie-back system is included in this line item. The cost for excavation for this mass of soil is included under the
  "Excavation" line item.
- Building A is assumed to be the Boston Harbor Cruises Gift Shop on Long Wharf. The building area is assumed to be 1350 SF and the new building is
  assumed to be the same size as existing.
- Building B is assumed to be the Landing at Long Wharf. The building area is assumed to be 800 SF and the new building is assumed to be the same
  size as existing.
- The Flood Protection Island is assumed to be a combination of soil infill, rip rap, and plantings in the water adjacent to the harbor walk.
- **Rip Rap Armour Stone Revetment** is assumed to create a "Living Shoreline" along the side of the bulkhead. The dimensions of the revetment are assumed to be 12' from bulkhead to the outside of the base with a total height of 35'.
- **Emerald Tutu** is a proprietary technology still under development. Each module is assumed to be a 6' diameter oblong sphere of biomass encased by a metal frame and synthetic fiber netting, covered by salt marsh vegetation, attached in a network, and anchored by a conservation mooring. Attachments are assumed to be synthetic fiber lines.
- The unit rate for Emerald Tutu Module is derived from an April 13th 2023 quote from Emerald Tutu.
- **Permanent Floating Dock / Breakwater** assumed to be one of the SF Marina breakwater models (SF 300, 400, 500, 600 or 1200BW).
- The unit rate for Permanent Floating Dock / Breakwater is derived from an April 10th 2023 quote from SF Marina. It includes 20 meter long attenuator units, 30" steel piles, cable connections, joint plates, cleats, rub rails, and basic utility ducts for lighting and water routing. An average unit rate per square foot is used because detailed designs have not been developed for this element. Sizing of breakwaters may vary by location, however more detailed analysis is required for more detailed breakdown of costs by size.
- **Underground Stormwater Storage Tank** is assumed to be a reinforced concrete water storage tank 7' deep underground. The cost for excavation associated with this tank is included under the "Excavation" line item.
- **Under Pier Stormwater Storage Tank** is assumed to be reinforced concrete water storage tanks with dimensions of 20'x40'x14' and 20'x50'x14'. The assumed construction methodology for this element is assumed to be as follows (the scope of the items other than the storage tanks and anchors are captured in other line items):
  - Permanently build sheetpile bulkhead walls surrounding Rowes Wharf with the area between North Wharf and Central Wharf buildings (considered the "drop-zone") being included in the land-side of the bulkhead.
  - Dewater the land-side area of Rowes Wharf.
  - Infill structural fill underneath the piers that the buildings rest on to serve as the base.
  - Rewater the land-side area of Rowes Wharf to a medium-level depth - enough for the storage tanks to float and be moved easily with enough clearance for them to travel beneath the pier decking.
  - Drop storage tanks in from a barge (sitting on the east side of the bulkhead) with a crane into the land-side of Rowes Wharf in the "drop-zone".
  - Move the floating storage tanks into position in between the piers.
  - Dewater the land-side area of Rowes Wharf.
  - Anchor the tanks to the ground atop the structural fill.
  - Connect the tanks with stormwater culverts.
  - Infill over top of the tanks - flowable fill under the piers / pier decking and typical fill in the "drop-zone".
- All linear pipes include excavation and backfill in their unit rates. However, the cost to reinstate pavement along the path of the pipe will be captured under the "Construct Walkway / Plaza" or "Construct Roadway / Street" line items.
- **Underground Stormwater Culverts** are assumed to be 36" reinforced concrete drain pipe. The unit rate includes excavation and backfill.
- **Overflow Protection Pipes** are assumed to be 36" reinforced concrete drain pipe. The unit rate includes excavation and backfill.
- **Underground Stormwater Manhole Accesses** are assumed to be 6-foot diameter concrete manholes.
- **Surface Drainage Pipes** are assumed to be 6" diameter perforated PVC pipe wrapped in nonwoven geotextiles, 5' deep minimum. The unit rate includes excavation and backfill.
- **Main Connector Pipes** are assumed to be 12" diameter solid PVC pipe, 5' deep minimum. The unit rate includes excavation and backfill.
- **Stormwater Treatment Box** is assumed to be a large debris separating baffle box.
- **100 HP Submersible Pump** is assumed to be a 100 horsepower submersible pump, with a flow rate of 10,000 GPM at 30 ft.
- The unit rate for 100 HP Submersible Pumps are derived from an April 13th 2023 quote from KSB for the KRTK 400-500 / 7510XNG-S model.
- **20 HP Submersible Pump** is assumed to be a 20 horsepower submersible pump, with a flow rate of 1,700 GPM at 35 ft.
- The unit rate for 20 HP Submersible Pumps are derived from an April 13th 2023 quote from KSB for the KRTK 200-316 / 186XEG-S model.
- **Pump Control House** assumes a 30' wide by 17' long by 10' high pumps house with pump controllers (motor control center, variable frequency drivers, sensors, gauges).
- **Emergency Backup Power** is assumed to include a 300kW/375 kVA 480/277V generator with 500 LF of gas pipe and electrical wiring.
- **Wetwell** is assumed to be a 50' wide by 30' long by 10' high temporary holding tank for stormwater made of reinforced concrete.
- **Manual Sluice Gates** are assumed to be prefabricated slide gates to be installed within existing sewer manhole structure.
- **Automatic Tide Gates** are assumed to be 72" diameter flap gates to be installed within existing sewer manhole structure.
- Additional assumptions are noted throughout the estimate.
PROJECT NOTES & BASIS OF ESTIMATE

7 Allowances
- The unit rate for Lightweight Structural Fill Anchoring System is assumed as a lump sum allowance because detailed designs have not been developed for this element.

8 Items excluded from the Cost Estimate
- All resiliency measures to be taken for buildings within the district including, but not limited to, reconstruction, entry protection, and waterproofing (unless stated)
- Grass, shrubs, ground cover, and low-height plantings.
- The costs or impacts of latent environmental issues that result in litigations or development delays
- Protection, relocation, or removal of existing utilities (unless stated)
- New utilities required (unless stated)
- Owner's facilities onsite
- Owner's direct management costs, running, and maintenance costs
- Planning and enquiry costs, including legal expenses and fees (beyond what is accounted for in below the line costs)
- Land acquisition costs
- Risk-based contingency analysis
- Tests and inspections performed by others (beyond geotechnical and environmental investigation)
- Compensatory costs to other interested parties
- Cost benefits and impacts associated with improvements in construction technology, more severe regulatory requirements, and future construction that may impact the work contemplated under this project
- Hazardous or contaminated mitigation
- Agency engineering, management and administrative costs.
- Quality Assurance to be carried out by the Owner
- Discovery of archaeological artifacts and their consequential effect on the project
- Local taxes and duties

9 Items that may affect the cost estimate
- Modifications to the scope of work included in this estimate.
- Special phasing requirements.
- Restrictive technical specifications or excessive contract conditions.
- Any other non-competitive bid situations.

10 Statements of Probable Cost
ARUP has no control over the cost of labor and materials, general contractor’s or any subcontractor’s method of determining prices, or competitive bidding and market conditions. This opinion of probable cost of construction is made on the basis of the experience, qualifications, and best judgment of the professional consultant familiar with the construction industry. ARUP cannot and does not guarantee that proposals, bids, or actual construction costs will not vary from this or subsequent cost estimates.

11 Recommendation for Cost Control
ARUP recommends that the Owner carefully review this document, including line item descriptions, unit prices, clarifications, exclusions, inclusions and assumptions, contingencies, escalation and markups. If the project is over budget, or if there are unresolved budgeting issues, alternate systems schemes should be evaluated before proceeding into the construction phase.

12 Request for Modifications
Requests for modifications of any apparent errors or omissions to this document must be made to ARUP within thirty (30) days of receipt of this estimate. Otherwise, it will be understood that the contents have been concurred with and accepted.
**Boston Wharf District Resiliency Plan**

**Class 5 Estimate Summary**

<table>
<thead>
<tr>
<th>Total Project Cost Estimate</th>
<th>Long Wharf</th>
<th>Central Wharf</th>
<th>Harbor Towers</th>
<th>Rowes Wharf</th>
<th>Northern Ave</th>
<th>Fort Point Channel</th>
<th>Total Term Estimate</th>
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<td><strong>Near Term (2030)</strong></td>
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<td>$103,882,700</td>
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**Project Cost by Area and Phase**

- Long Wharf
- Central Wharf
- Harbor Towers
- Rowes Wharf
- Northern Ave
- Fort Point Channel
## Long Wharf

<table>
<thead>
<tr>
<th>Description</th>
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<tr>
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<tr>
<td>Underground Stormwater Collector</td>
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<tr>
<td>Underground Stormwater Monitoring Access</td>
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<tr>
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<td>Pump Station</td>
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<tr>
<td>Life Safety Systems</td>
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## Central Wharf

<table>
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<tbody>
<tr>
<td>Access</td>
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## Boston Wharf District Resiliency Plan

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Unit</th>
<th>Cost</th>
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<td>Drainage System</td>
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<tr>
<td>Docks</td>
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</tr>
<tr>
<td>Natural Flood Protection</td>
<td></td>
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<tr>
<td>Parking</td>
<td></td>
<td>-</td>
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</tr>
<tr>
<td>Harborwalk</td>
<td></td>
<td>-</td>
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</tr>
<tr>
<td>Building Works</td>
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<tr>
<td>Floodwall</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Dredging</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Dewntown</td>
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<td>-</td>
<td></td>
</tr>
<tr>
<td>Removal</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>River</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Cofferdams</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Pumps</td>
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<td>-</td>
<td></td>
</tr>
<tr>
<td>All Access to Harborworks</td>
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<tr>
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<td>Wood</td>
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<tr>
<td>Metal</td>
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<tr>
<td>Concrete &amp; Brick</td>
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<td>-</td>
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</tr>
<tr>
<td>Shade Trees</td>
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<td>-</td>
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</tr>
<tr>
<td>Social Delineation</td>
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</tr>
<tr>
<td>Building A</td>
<td></td>
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<tr>
<td>Dredging Building A</td>
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<tr>
<td>Demolish Building B</td>
<td></td>
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</tr>
<tr>
<td>Reconstruct Building B</td>
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</tr>
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<td>Building</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Floodwall</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Dredging</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Dewntown</td>
<td></td>
<td>-</td>
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</tr>
<tr>
<td>Removal</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>River</td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Cofferdams</td>
<td></td>
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<tr>
<td>Pumps</td>
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## Total Cost Summary

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Unit</th>
<th>Cost</th>
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</thead>
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<td>Total</td>
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<tr>
<td>Project Description</td>
<td>Unit Price</td>
<td>Quantity</td>
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<td>------------</td>
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<tr>
<td>Bulkhead Improvement</td>
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<td>Earthwork &amp; Excavating</td>
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<td>Flood Protection Island</td>
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<tr>
<td>Natural Flood Protection</td>
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<td>CY</td>
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<tr>
<td>Parking &amp; Pavement</td>
<td>$100</td>
<td>CY</td>
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<tr>
<td>Stormwater Pipe Retrofit &amp; Reinforcement</td>
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<td>CY</td>
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<td>Stormwater Treatment</td>
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<td>Urban Stormwater</td>
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<tr>
<td>Underground Stormwater Storage Tank</td>
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<tr>
<td>Wetwell</td>
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<td>CY</td>
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<tr>
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<tr>
<td>parking Ramp</td>
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<td>CY</td>
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Boston Wharf District Resiliency Plan
Class 5 Estimate Mid Term Estimate

Mid-Term Estimate
Line Items
Unit Rate
Bulkhead / Wall
Bulkhead
Sheet Pile Bulkhead
$
150
King Pile Bulkhead
$
175
Remove Stone Wall
$
25
Rebuild Stone Wall
$
25
Stone Wall
$
100
Floodwall
Permanent Floodwall
$
110
2.5' tall Glass Floodwall
$
1,050
3' tall Glass Floodwall
$
1,150
Automatic Deployable Floodbreak Barrier
Roadway Barrier
$
1,200
Vehicle Barrier
$
1,600
FreeView Barrier
$
1,000
Retaining Wall
$
100
Underground Slurry Wall
$
50
Earthwork & Dewatering
Excavation
$
50
Soil Infill
$
50
Structural Infill
$
75
Lightweight Structural Infill
$
100
Lightweight Structural Fill Anchoring System $ 150,000
Flowable Fill
$
500
Dewatering for Harbor Towers Allowance $ 25,000
Dewatering for Rowes Wharf Allowance
$ 50,000
Pavement
Remove Walkway / Plaza
$
10
Remove Street / Roadway
$
5
Construct Walkway / Plaza
$
30
Construct Street / Roadway
$
30
Harborwalk
Deconstruct Harborwalk
$
50
Wood
Concrete
Concrete & Brick
Construct Harborwalk
$
500
Wood
Metal
Concrete
Concrete & Brick
ADA Access to Harborwalk
$
30
Pedestrian Bridge
$ 80,000
Prefabricated Metal Stairs
$ 15,000
Landscaping / Urban Realm Improvements
Privacy Screening
$
40
Shade Structure
$ 32,000
Bus Stop Relocation
$
1,500
Shade Trees
$
750
Social Stepped Stairway / Landform
$
75
Park Landscaping
$
5
Building Works
Demolish Building A
$ 20,000
Demolish Building B
$ 15,000
Reconstruct Building A
$ 285,000
Reconstruct Building B
$ 100,000
Natural Flood Protection
Flood Protection Island
$
105
Rip Rap Armour Stone Revetment
$
800
Emerald Tutu Module
$
750
Docks
Remove Existing Dock
$
20
Relocate Existing Dock
$
45
Construct Permanent Dock / Breakwater
$
155
Dock Gangway / Accessibility Ramp
$ 11,300
Drainage System
Underground Stormwater Storage Tank
$
500
Underpier Stormwater Storage Tank
$
650
Underground Stormwater Culverts
$
300
Underground Stormwater Manhole Access $
7,000
Stormwater Treatment
$ 450,000
Overflow Protection
$
300
Surface Drainage Pipe
$
50
Main Connector Pipe
$
185
Stormwater Pipe Retrofit / Reinforcement $ 150,000
Pump Station
100 HP Submersible Pump
$ 130,000
20 HP Submersible Pump
$ 30,000
Pump Control House
$ 55,000
Emergency Backup Power
$ 90,100
Wetwell
$ 32,000
Storm Sewer Outfall Protection
Manual Sluice Gates
$ 18,600
Automatic Tide Gates
$ 20,400
Total Direct Cost
Indirect Costs / General Requirements
10%
Mobilization & Demobilization
2%
Overhead & Profit
10%
Contractor's Contingency
15%
Total Construction Price
Legal / Permits / Fees
2%
Geotechnical and Enviornmntal Investigations 2%
Preliminary Design
3%
Detailed Design
6%
Escalation
188%
Owner's Contingency
20%
Lower Bound
-40%
Total Project Price
Upper Bound
65%

Unit

Long Wharf
Quantity Subtotal Cost
$
12,155,500

Central Wharf
Quantity Subtotal Cost

Harbor Towers
Quantity Subtotal Cost

Rowes Wharf
Quantity Subtotal Cost
$
10,580,400

SF
SF
SF
SF
SF

75,000
0
0
0
6,250

$
$
$
$
$

11,250,000
625,000

55,000
0
0
0
20,400

$
$
$
$
$

8,250,000
2,040,000

SF
LF
LF

2,550
0
0

$
$
$

280,500
-

1,640
0
0

$
$
$

180,400
-

SF
SF
SF
SF
CF

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2,220
1,480
7,770
1
0
0
0

SF
SF
SF
SF

23,000
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21,000
0

$
$
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10,996,000
50,000
1,736,500
157,500
8,500
1,519,500
51,000
725,000
650,000

SF
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SF
SF
SF
SF
SF
SF
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EA

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22,500
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60,500
111,000
111,000
777,000
150,000
860,000
230,000
630,000
11,295,000
-

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110
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CY
CY
CY
CY
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11,250,000

SF
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SF

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320,000
22,500
1,050,000
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LS
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SF
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0

SF
SF
SF
EA

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CY
CY
LF
EA
EA
LF
LF
LF
EA

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EA
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13,000
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13,000
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15,600
2,500
0
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## Boston Wharf District Resiliency Plan

### Long Wharf

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### Notes

- Escalation
- Detailed Design
- Preliminary Design
- Contractor's Contingency
- Total Construction Price
- LS = Long-Term Estimate
- LF = Long-Term Estimate
- SF = Short-Term Estimate

### Class 5 Estimate

- Northern Ave Fort Point Channel
- Long Wharf
- Central Wharf
- Harbor Towers
- Rowes Wharf

### Landmark

- $1,000,000
- $1,000,000
- $1,000,000
- $1,000,000
- $1,000,000

### ARUP

- **ARUP**

### Image

- **Image**
APPENDIX F

Coastal Structures Assessment
Introduction
This assessment is intended to inform concept-level resiliency strategies for the Wharf District Council Conceptual District Protection and Resiliency Plan. For recommendations refer to the project Final Report.

This information is based on site walks that took place on the following dates at low tide:
    Thursday 21st June (11am – 2pm)
    Tuesday 28th June (6.30am – 8.30am)

A desk study was also carried out to review available existing information pertaining to the seawalls and decks. Where this information was available, a summary has been noted at the start of each section under “background”.

The condition of the seawalls and some selected piers (piles and deck) has been assessed using the following scale:
The majority of the seawalls in question are granite block walls. There are various types of damage or defect that are common for block walls, including:

- Settlement behind the wall indicating washout.
- Displacement of wall, visible either based on movement of face outwards into channel or irregular movement of horizontal joints.
- Displacement or loss of individual blocks, cracking or breakage of individual blocks, either localized or widespread.
- Condition of joint material, open with loss of mortar/pointing or vegetation growth.

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
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<tbody>
<tr>
<td>&quot;Good&quot;</td>
<td>No visible damage or <strong>only minor problems noted.</strong> Structural elements may show some very minor deterioration, but no significant reduction in structural capacity.</td>
</tr>
<tr>
<td>&quot;Satisfactory&quot;</td>
<td><strong>Limited Minor to moderate defects and deterioration</strong> observed, but no significant reduction in structural capacity.</td>
</tr>
<tr>
<td>&quot;Fair&quot;</td>
<td>All primary structural elements are sound; but minor to moderate defects and deterioration observed. <strong>Localized areas of moderate to advanced deterioration</strong> may be present but do not significantly reduce the structural capacity.</td>
</tr>
<tr>
<td>&quot;Poor&quot;</td>
<td>Advanced deterioration or overstressing observed on widespread portions of the structure. Some reduction in structural capacity.</td>
</tr>
<tr>
<td>&quot;Serious&quot;</td>
<td>Advanced deterioration, overstressing or breakage <strong>may have significantly affected the load bearing capacity of primary structural components.</strong> Local failures are possible.</td>
</tr>
<tr>
<td>&quot;Critical&quot;</td>
<td>Very advanced deterioration, overstressing, or breakage <strong>has resulted in localized failure(s) of primary structural components.</strong> More widespread failures are possible or likely to occur.</td>
</tr>
<tr>
<td>&quot;Not Inspected&quot;</td>
<td>Structural element was not visible and therefore <strong>not inspected.</strong></td>
</tr>
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</table>
The condition assessment consisted of a visual appraisal only. The information gathered is limited to observations made from publicly accessible vantage points. Due to the distance between the viewer and the structures, the condition of individual structural elements has not been assessed and any opinion offered on the condition of elements will need to be confirmed through a detailed study.

A summary of the condition assessment provided in the graphic below. Relevant images and notes for each property assessed are included on the following pages.

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<table>
<thead>
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<th>Rating</th>
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<tr>
<td>&quot;Good&quot;</td>
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<tr>
<td>&quot;Critical&quot;</td>
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</tr>
<tr>
<td>&quot;Not Inspected&quot;</td>
<td>Structural element was not visible and therefore not inspected.</td>
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Notes:
1. Not able to observe due to site conditions and/or access constraints.
2. Site is under development or anticipated for development.
4. Some parts of structure visible, others not. Condition of visible elements varies, overall condition cannot be assessed.
5. Assessment provided for granite seawall. Building concrete wall located behind seawall wall not assessed.
Background: granite block seawall, no visible pointing. 1976 Chapter 91 drawings available showing typical section and indicating repairs and maintenance occurred. Seawall sits on timber piles. Concrete slab added spanning back from seawall to new steel pipe piles inboard.

A – View of sea wall, note displacement of top of wall.
B – View of seawall, note some loss of blocks and opening of joints. Moderate portions have this level of damage.
P02 – Long Wharf

Background: Base construction is granite block seawall. Historical drawings for north side indicate areas of concrete wall and loose slopes are also present. East end has steel sheet pile toe stabilization of granite wall in places. South side has some concrete wall sections behind granite or new wall foundations consisting of concrete filled steel sheet piling.
B – Typical South edge conditions – rebuilt granite seawall and existing granite seawall with concrete wall behind
C – North edge conditions
D – Documented wall types
**P03 – 255 State St. (Legal Seafoods)**

**Background:** Granite block seawall, no visible pointing. No drawings available.

<table>
<thead>
<tr>
<th>A – View of seawall</th>
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<tr>
<td>Note visible opening up of wall joints, tilt and rotation of stones, widespread loss of blocks. Deterioration is widespread over this length of wall.</td>
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| B – View of seawall |
P04 – Harbor Garage

Background: Granite block wall, Chapter 91 section indicates on concrete footing over rock fill. Constructed 1967.

A – View of seawall, bearing failure at far end visible
B – Detail showing crack/displacement at deck interface
C – Capstone misalignment
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P06 – Harbor Towers

Background: 2012 drawings available showing proposed repairs to granite block sea wall at nine (9) locations. Repairs involved creation of rip rap berm to stabilize the toe of the existing granite block wall and addition of non-shrink grout at capstone joint. On Northern edge of site, a steel sheet pile wall has been placed behind the existing seawall. Control density fill was added at the NE corner of the site to fill voids and raise the settled slab. Areas have been repointed.
B – View of seawall (location 1)

Gaps between blocks and misalignment.
C – View of seawall (location 2)

Displacement of blocks, moderate/widespread.
D – View of seawall (location 3) Bowing corrected with capstone, potential settlement behind wall.
E – View of seawall (location 4)

Wall has been repointed. Some blocks look to be missing.
F – View of seawall (location 5) Settlement and cracking behind wall.
H – View of seawall (North edge)

Note bowing, cracking and movement of wall likely due to washout. Note that this portion of wall has sheet piling behind.
| Background: Building development drawings are available which show a new sheet pile wall in front of a new RC concrete slurry wall which forms the building basement. The concrete wall is set back by ~10ft or more from the sheet pile wall. |

| A – View of sheet pile seawall |
| Note that from vantage point, alignment or condition of individual piles was not visible. Corrosion and flaking of sheet pile surface was visible, unclear if moderate or major damage. |
B – View of deck and sheet pile wall

There is an RC concrete beam/slab deck supported by RC concrete piles outboard of the sheet pile wall. The width of this deck varies across the site. Note cracking in deck beams and marine growth on RC columns.
P09 – 400 Atlantic

Background: 2020 drawing available from timber deck pile repairs (concrete filled fiberglass jacket around existing concrete pile). Brick building sitting on existing granite block seawall with open joints.

A – View of seawall and piles
Timber deck supported by concrete filled, fiberglass jacketed, piles. Some rusting of timber deck to pile steel connection brackets. Decking not inspected. Piles recently repaired so in good condition. Seawall not visible so not inspected.

B – View of building facade

Seawall is set back below existing building façade. Note cracking in façade indicative of movement of seawall.
P10 – Coast Guard Building (GSA)

No existing drawings or plans available.

A – View of seawall

Note that seawall is not properly visible from vantage point therefore has not been inspected. Seawall has been repointed.
B – View behind seawall

Note settlement of pavement behind seawall. There was reported washout of fines from this wall by geotechnical engineer which resulted in repointing of wall.
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P12 – Independence Wharf

Background: 2017 building repair plans for foundations indicate the granite seawall as the limit of land subject to coastal storm flowage. The granite seawall looks to be abandoned.

A – View of severely deteriorated granite seawall with rocky intertidal shores in front. Building concrete wall visible behind. Blocks are loose with large joints, many blocks are destabilized.
B – View of building supports

Building edge aligns with adjacent decks and is supported by a concrete waffle slab in turn supported on concrete beam/column system with fiberglass jackets/piles at sea level. Both were repaired in 2017.
C – View of Easternmost corner

NE face adjacent to Seaport Blvd bridge consists of an RC wall sitting on existing block seawall. RC wall is in poor condition with exposed reinforcement. Unclear how this ties into new RC seawall where present, there may be a void behind this wall.
P13 – Intercontinental Hotel

Background: 1998 Plans and sections available. Concrete slurry wall with battered sheet pile wall in front. Existing stone or wooden seawall behind and abandoned in place.

A – View of piers and deck with sheet pile sea wall visible in background

Note lack of proximity to sheet pile wall – details including alignment and interlock not visible. Binocular view of sheet piles indicated corrosion and flaking of surface.
B – Side angle view showing gap in piles for silver line tunnel passing below.
No disintegration or spalling of concrete observed. Concrete deck in front of slurry/sheet-pile wall, supported by concrete beams and square concrete piles. On a dry day following some wet weather, water was observed dripping through the deck.
P14 – Russia Wharf Condos

Background: 2008 drawings available. New concrete slurry wall behind existing seawall.

A – View of seawall

Note isolated debris at base, some isolated distortion or settlement of blocks observed. Pointing present.
B – View of Pier Structure

Appears to consist of concrete filled steel tubular piles (moderate to severe steel section loss suspected) supporting concrete beams and concrete deck above. No visible cracking or settlement of concrete beams. Surface of piles is rusting/pitted – moderate damage but no spalling observed.
C – Pier support detail view showing condition of piles.
This memorandum provides an updated assessment of permitting and agency review requirements for the Wharf District Flood Resiliency Plan (the “Resilience Plan”) based on the conceptual-level plans for each of the study area’s six sub-districts. This memo is intended to support the processes of securing regulatory approvals. As the Resilience Plan is advanced to the schematic design stage and beyond, compliance with applicable regulations and policies should be continuously reviewed. The actual permits and reviews required may differ from those presented below based on the details of the final construction documents. The proposed flood protection systems for each of the sub-districts are referred to herein as the “projects,” collectively.

1. **Key Findings**

   - All projects must file a Notice of Intent (NOI) with the Boston Conservation Commission.
   - All projects require approval under Chapter 91, most likely in the form of a new or amended license.
   - All projects could potentially be approved under the existing Chapter 91 regulations at 310 CMR 9.00. However, specific changes (identified in Table 2 below) would clarify and confirm licensing eligibility.
   - All projects are likely to be subject to review under the Massachusetts Environmental Policy Act (MEPA), pending final design, because they require a Chapter 91 License, and they exceed at least one Environmental Notification Form (ENF) threshold (see Table 1 below).
   - While no Environmental Impact Report (EIR) thresholds are likely to be exceeded, EIRs would be required due to the projects’ proximity to Environmental Justice (EJ) populations in compliance with MEPA’s EJ Protocols.
   - The preferred projects for Long Wharf, Rowes Wharf, Northern Ave, and Fort Point Channel impact historic resources and will require review by the Massachusetts Historical Commission (MHC).
   - All projects include work within the FEMA 1% annual chance floodplain. The Long Wharf Phase 1 project includes measures that would be subject to the flood-related portions of the MA Building Code (wet and/or dry floodproofing strategies at the Chart House and Customs House).
   - All projects include at least one element in the public right-of-way, and as such would require review by the City’s Public Improvement Commission (PIC).
   - The projects at Long Wharf and Central Wharf will require review by and coordination with the Boston Transportation Department (BTD).
   - The Long Wharf project will require review by and coordination with the Boston Fire Department (BFD).
   - All projects have at least one element within 100 feet of land considered to be a park, and as such would require review by the Boston Parks Commission.
Consultations with the Massachusetts Department of Environmental Protection (DEP) Waterways Department and MEPA Office are recommended as next steps.

2. Applicable Permitting and Review Processes

VHB’s Initial Permitting Assessment (June 10, 2022) provided a summary of the potentially applicable regulations, plans and guidelines, as well as constraints they may have on constructing district-scale flood protection measures. That assessment found that none of the regulations, plans or guidelines categorically prohibit alterations to the shoreline\(^1\) for the purpose of increasing resilience to flooding.

Table 1 below identifies which of the following permitting and review processes are likely to be required for each of the six sub-districts:

- Wetlands Protection Act (WPA) (310 CMR 10)
- The Boston Wetlands Ordinance
- Chapter 91 (310 CMR 9.00)
- Massachusetts Environmental Policy Act (MEPA) (301 CMR 11.00)
- Massachusetts Building Code (780 CMR)
- Historic Resources (Section 106)
- City of Boston approvals (Public Improvement Commission, Transportation Department, Fire Department, and Parks and Recreation Department)

The proposed Resilience Plan does NOT require compliance with the following, as described below:

- Boston Zoning Code
- Clean Water Act (Sections 401 & 404)
- Rivers and Harbors Act (Section 10)

Compliance with the Boston Zoning Code is required when there is any change in the use of a building or land and when reconstruction, extension or structural changes to buildings is undertaken. Although the zoning code is technically also applicable to structures other than buildings (bridge, trestle, tower, framework, retaining wall, tank, tunnel, tent, stadium, reviewing stand, platform, bin, fence, sign, flagpole, or the like), in practice it does not identify requirements for structures such as piers, wharfs, and coastal engineering structures. Further, implementation of the Resilience Plan does not trigger large or small project review under Article 80.

Due to the presence of the Magenta Zone (an area along the waterfront of the Boston Inner Harbor and the Fort Point Channel designated in 1968 by Congress (PL 90-312) to be “not a navigable water of the United States,” even though the area is factually navigable), the proposed Resilience Plan projects are NOT subject to Section 404 of the Clean Water Act, which requires a permit from the U.S. Army Corps of Engineers before dredged or fill material may be discharged into navigable waters of the United States. Since no federal permits are required for discharging fill, Section 401 of the Clean Water Act, wherein a federal agency may not issue a permit or license to conduct any activity that may result in any discharge into waters of the United States unless a Section 401 water quality

\(^1\) The term “shoreline” means the mean high water line, which, within the Study Area, is generally the face of the existing coastal engineering structures or the perimeter of piers or wharfs.
certification is issued, is NOT applicable. Section 10 of the Rivers and Harbors Act, which requires authorization from the Secretary of the Army, acting through the Corps of Engineers, for the construction of any structure in or over any navigable water of the United States, is also NOT applicable.
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<tr>
<td>WPA Notice of Intent (Performance Standards)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>Coastal Bank a</td>
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<tr>
<td>Land Subject to Coastal Storm Flowage (LCSF)</td>
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<td>✓</td>
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<td>BWO Notice of Intent (Performance Standards)</td>
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<td>Coastal Bank</td>
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<tr>
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<td>Coastal Flood Resilience Zone b</td>
<td>Likely</td>
<td>Likely</td>
<td>Likely</td>
<td>Likely</td>
<td>Likely</td>
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<td>Chapter 91 (New or Amended Waterways License)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
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<td>Commonwealth Tidelands</td>
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<td>✓</td>
<td>x</td>
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<td>Private Tidelands c</td>
<td>x</td>
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<td>✓</td>
<td>✓</td>
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<td>MEPA Review (Environmental Notification Form Threshold + Environmental Justice Policy = EIR-Level Review)</td>
<td>✓</td>
<td>✓</td>
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<td>301 CMR 11.03(3)(b)1.a. Alteration of Coastal Bank a  d</td>
<td>✓</td>
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<td>301 CMR 11.03(3)(b)1.e. New or Expanded fill or structure (except pile supported) in a velocity zone d</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
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<td>301 CMR 11.03(3)(b)1.f. alteration of ½ or more acres of any other wetlands (LCSF) d</td>
<td>x</td>
<td>✓</td>
<td>x</td>
<td>x</td>
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<td>301 CMR 11.03(3)(b)6. Construction, reconstruction or Expansion of an existing solid fill structure of 1,000 or more sf base area or of a pile-supported or bottom-anchored structure of 2,000 or more sf base area in flowed tidelands</td>
<td>✓</td>
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<td>Massachusetts Historical Commission (MHC) Review</td>
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<td>MA Building Code (780 CMR)</td>
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<td>Special Flood Hazard Area Floodproofing Requirements (A Zone)</td>
<td>x</td>
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<td>x</td>
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<td>City of Boston Approvals</td>
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<tr>
<td>Public Improvements Commission (PIC)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓*</td>
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<tr>
<td>Boston Transportation Department (BTD)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Boston Fire Department (BFD)</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Parks Department Review (100’ Rule, Section 7-4.11)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓*</td>
<td>✓*</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

✓ = Applicable; x = Not Applicable  
* Redundant alignment only  
a Confirm with DEP whether Coastal Engineering Structure (CES) itself would be considered bank.  
b The extent of the Boston Wetlands Ordinance’s Coastal Flood Resilience Zone has not yet been established.  
c Requires confirmation via a title search to determine whether the property has ever been owned by the Commonwealth or a political subdivision thereof.  
d Provided a permit (e.g., Ch91 License or WPA Superseding Order of Conditions) is also required.
3. Regulatory Compliance

Table 2 below identifies how each sub-district project could demonstrate compliance with the applicable performance standards and regulatory requirements that impact design. It also identifies regulatory adjustments that would help facilitate the permitting process. As design progresses compliance with existing and proposed regulations should be continuously reviewed.

Please note the following pertaining to fill in Boston Harbor:

- While restrictions on fill within Boston Harbor do exist, they are nuanced and depend on several specific factors such as intended use and potential adverse impacts.
- There is no categorical restriction applicable to the Resilience Plan projects in the Chapter 91 regulations (see 310 CMR 9.32 Categorical Restrictions on Fill and Structures in Table 2).
- There is no categorical restriction applicable to the Resilience Plan projects in the WPA (see performance standards for 310 CMR 10.25 Land Under Ocean in Table 2; this should not be confused with the resource area described in 310 CMR 10.56 Land Under Waterbodies and Waterways, for which there ARE restrictions on fill).

The sub-districts include a mixture of private and Commonwealth tidelands under Chapter 91. Because the uses are categorized as water-dependent, the additional requirements for activation of Commonwealth tidelands for public use at 310 CMR 9.53 are not applicable (although the projects would not diminish the capacity of the sites to meet such requirements if they were applicable).

4. Next Steps

The biggest hurdles to implementing district-scale flood protection measures are likely to be related to agency positions and unofficial policies rather than to actual regulatory constraints. While the concept of resilience to the impacts of sea level rise is promoted at the local and state levels, some agencies, particularly the Boston Conservation Commission and the Massachusetts Office of Coastal Zone Management (CZM), are not in practice comfortable with placing fill in waterways, raising seawalls, and/or placing fill in the floodplain. Barring any changes to the MEPA regulations at 301 CMR 11.00 that may alter review thresholds related to wetlands and waterways, the projects recommended in the Plan are likely to be subject to MEPA review, which will in turn provide a venue for CZM input.

Consultations with the following are recommended:

1. DEP Waterways Department
   a. Present the Resilience Plan to identify any potential issues related to Chapter 91 licensing.
   b. Suggest regulatory changes and explore a timeline for their implementation.
   c. Discuss potential permitting strategies, including the potential for minor modifications and/or a Consolidated Written Determination.
d. Discuss the implications of the Magenta Zone to confirm that permitting under Sections 401 and 404 of the Clean Water Act and Section 10 of the Rivers and Harbor Act is not required (it may be necessary to get feedback from additional DEP departments).

2. MEPA Office
   a. Present the Resilience Plan to get initial feedback.
   b. Explore the potential to allow each of the six sub-district projects to move through review and permitting individually, or to set up a Special Review Procedure to cover review of the entire Resilience Plan.
   c. Obtain a recommendation for how to address potential impacts on adjacent properties through flow path analyses or other modeling efforts.

Once design has reached the 30-60% phase, the projects can begin the permitting process. Chapter 91 Licenses cannot be issued until the WPA and MEPA processes are complete and projects are in the 100% design phase (stamped engineering plans are required). Once permitting strategies are agreed upon by the proponent(s) and agencies, the processes required to comply with the WPA, MEPA, and Chapter 91 could take between 17 and 24 months (combined) to complete from the time of submission.
<table>
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<tr>
<th>Regulation</th>
<th>Summary of Standard</th>
<th>Compliance</th>
<th>Suggested Regulatory Changes</th>
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<tbody>
<tr>
<td>Wetlands Protection Act 310 CMR 10.00</td>
<td>Projects...which affect nearshore areas of land under the ocean shall not cause adverse effects by altering the bottom topography so as to increase storm damage or erosion of coastal beaches, coastal banks, coastal dunes, or salt marshes.</td>
<td>Pile supported structures and fill placed for the purposes of flood control will be designed by a coastal engineer to avoid such adverse effects.</td>
<td>None.</td>
</tr>
<tr>
<td>Land Under Ocean 10.25(5)</td>
<td>Projects...which affect land under the ocean shall if water-dependent be designed and constructed, using best available measures, so as to minimize adverse effects on marine fisheries habitat or wildlife habitat caused by: (a) alterations in water circulation; (b) destruction of eelgrass (Zostera marina) or widgeon grass (Rupia maritima) beds; (c) alterations in the distribution of sediment grain size; (d) changes in water quality, including, but not limited to, other than natural fluctuations in the level of dissolved oxygen, temperature or turbidity, or the addition of pollutants; or (e) alterations of shallow submerged lands with high densities of polychaetes, mollusks or macrophytic algae.</td>
<td>Pile supported structures and fill placed for the purposes of flood control will be designed by a coastal engineer to minimize or avoid such adverse effects. In-water work may be subject to Time of Year (TOY) restrictions established by the Division of Marine Fisheries (DMF).</td>
<td>None.</td>
</tr>
<tr>
<td>Land Under Ocean 10.25(6)</td>
<td>Any project on such a coastal bank or within 100 feet landward of the top of a coastal bank [that is considered a vertical buffer] shall have no adverse effects on the stability of the coastal bank.</td>
<td>The projects will be designed to have no adverse effect on bank stability.</td>
<td>None.</td>
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<tr>
<td>Coastal Bank 10.30(6)</td>
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<td>Regulation</td>
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<tr>
<td><strong>Boston Wetlands Ordinance Chapter VII-I.IV</strong></td>
<td>The Commission may, in its sole discretion, permit the following activities provided that the applicant demonstrates to the satisfaction of the Commission that best available measures, as defined by the Ordinance, are utilized to minimize or eliminate adverse impacts on the critical characteristics of and Resource Area Values protected by LSCSF:</td>
<td>The projects meet the criteria for permitting under this section. The projects will protect the resource area values of LSCSF, i.e., storm damage prevention, flood control, and prevention of pollution. However, they will by definition result in the elimination of the resource area, as the adjacent land on the sites will no longer be subject to the 1% annual chance flood event.</td>
<td>It would be helpful to adjust the regulations to acknowledge the allowable loss of the resource area itself while protecting the values identified in the ordinance.</td>
</tr>
<tr>
<td>Land Subject to Coastal Storm Flowage (LSCSF) Part II, Sec. XVII. E.9.</td>
<td>iii. Pedestrian walkways for public shoreline access and nonmotorized use; vii. Projects that are designed and intended to reduce the risk of coastal flooding, inland flooding, extreme weather events, SLR, and other adverse impacts of climate change, including, but not limited to, strategies and plans described in Climate Ready Boston or any successor initiative of the City.</td>
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<tr>
<td>LSCSF Part II, Sec. XVII. F.2.</td>
<td>Notwithstanding the provisions of Section XVII(E), the Commission may permit work or activity that constitutes a Redevelopment, provided that the work or activity shall conform to the following criteria: i. At a minimum, proposed work or activity shall result in an improvement over existing conditions of the capacity of LSCSF to protect at least one of the Resource Area Values described in Section XVII(A)(i.e., storm damage prevention, flood control, protection of wildlife and wildlife habitat, prevention of pollution, erosion and sedimentation control, and to mitigate the impacts of climate change) and adaptations to or mitigation against the impacts of SLR on the project and the area of the proposed work or activity;</td>
<td>The projects will protect the following resource area values of LSCSF: storm damage prevention, flood control, prevention of pollution, and mitigating the impacts of climate change. However, they will by definition result in the elimination of the resource area, as the adjacent land on the sites will no longer be subject to the 1% annual chance flood event.</td>
<td>It would be helpful to adjust the regulations to acknowledge the allowable loss of the resource area itself while protecting the values identified in the ordinance.</td>
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<td>Regulation</td>
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<tr>
<td>Chapter 91 310 CMR 9.00</td>
<td>Projects that are restricted to fill or structures which accommodate the uses specified below are eligible for licensing: 1. fill or structures for any use on previously filled tidelands; 2. fill or structures for water-dependent use located below the high water mark; 3. structures to accommodate public pedestrian access on flowed tidelands</td>
<td>The projects are eligible for a license because they propose fill on previously filled tidelands, structures for water dependent use located below the high water mark, and/or structures to accommodate public pedestrian access on flowed tidelands. The projects can likely be categorized as a water-dependent use as per 9.12(2)(a)11 &amp; 12.</td>
<td>It would be helpful to confirm categorization of the project as water dependent by revising 9.12(2)(a)11. to read &quot;shore protection structures including grey infrastructure such as seawalls, bulkheads, revetments, dikes, breakwaters, and any associated fill, as well as green infrastructure such as vegetation, edging and sills, which are necessary to protect an existing structure from either natural erosion or accretion or flood damage caused by sea level rise, or to protect, construct, or expand a water-dependent use.&quot;</td>
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<tr>
<td>9.35(2)(a)&amp;(b)</td>
<td>The project shall not significantly interfere with public rights of navigation which exist in all waterways. Projects shall not extend seaward of any state harbor line, extend into an existing channel, impair navigational site lines, require the alteration of an established course of vessels, interfere with access to adjoining areas, significantly interfere with the public rights of free passage over and through the water.</td>
<td>The projects avoid the identified adverse effects. No project is anticipated to require alteration of the established course of the F4 Boston-Charlestown or F2/FH Quincy-Hull-Logan-Boston ferries.</td>
<td>None.</td>
</tr>
<tr>
<td>9.35(3)</td>
<td>The project shall not significantly interfere with public rights of fishing and fowling or of on-foot passage on private tidelands in the exercise of these rights and must include reasonable measures to provide on-foot passage on filled tidelands.</td>
<td>The projects do not interfere with public rights. They maintain these rights and accommodate additional activities by making</td>
<td>None.</td>
</tr>
<tr>
<td>Regulation</td>
<td>Summary of Standard</td>
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<td>Suggested Regulatory Changes</td>
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<tr>
<td>9.36(2)</td>
<td>The project shall not significantly interfere with littoral or riparian property owners’ right to approach their property from a waterway, and to approach the waterway from said property.</td>
<td>The projects do not impact the rights of adjacent property owners.</td>
<td>None.</td>
</tr>
<tr>
<td>9.36(3)</td>
<td>The project shall not significantly disrupt any water-dependent use in operation, as of the date of license application, at an off-site location within the proximate vicinity of the project site.</td>
<td>The projects will not significantly impact water-dependents uses in operation in the vicinity of the project sites. Temporary and/or insignificant impacts are anticipated.</td>
<td>None.</td>
</tr>
<tr>
<td>9.37(3)</td>
<td>Projects with coastal or shoreline engineering structures shall comply with the following:</td>
<td></td>
<td>9.37(3)(a) should be altered to include an additional carve out: “or unless its purpose is to provide protection from flooding associated with sea level rise in conjunction with a municipally-sanctioned district scale flood protection measure.”</td>
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<td>(a) any seawall, bulkhead, or revetment shall be located landward of the high water mark unless it must lie below the high water mark to permit proper tieback placement, to obtain a stable slope on bank areas, or to be compatible with abutting seawalls, bulkheads, or revetments in terms of design, size, function, and materials, or unless it is associated with new fill permitted according to the provisions of 310 CMR 9.32;</td>
<td>See narrative for 9.32(1)(a) above.</td>
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<td>(b) any breakwater or similar structure designed to dissipate or otherwise reduce wave energy or to interfere with current flow shall not 1. cause or contribute to water stagnancy; 2. reduce the ability of adjacent water bodies to flush adequately; or 3. cause or contribute to sedimentation problems in adjacent or nearby navigation channels, anchorages, or wetland resource areas, or cause increased erosion to inland or coastal beaches, banks, or other wetland resource areas;</td>
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<td>Regulation</td>
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<td>Suggested Regulatory Changes</td>
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<td>9.52 (1)</td>
<td>A nonwater-dependent use project that includes fill or structures on any tidelands shall not unreasonably diminish the capacity of such lands to accommodate water-dependent use. In the event the project site includes a water-dependent use zone, the project shall include at least the following: (a) one or more facilities that generate water-dependent activity of a kind and to a degree that is appropriate for the project site, given the nature of the project, conditions of the water body on which it is located, and other relevant circumstances. (b) a pedestrian access network of a kind and to a degree that is appropriate for the project site and the facility(ies) provided in 310 CMR 9.52(1)(a).</td>
<td>While the interventions themselves qualify as water dependent use projects, they should not interfere with the ability of the non-water dependent uses on the same parcel to fulfill their obligation to comply with this requirement.</td>
<td>None.</td>
</tr>
</tbody>
</table>
APPENDIX H

Initial Permitting Assessment
To: Derek Anderson, ARUP  
Date: June 10, 2022  
Project #: 15730.00

From: Stephanie Kruel  
Re: WDC Resiliency Plan  
Initial Permitting Assessment

This memo describes the current understanding of the *Wharf District Council Conceptual District Protection & Resiliency Plan* (the "Plan") and provides a summary of the following potentially applicable regulations, plans and guidelines, as well as constraints they may have on constructing district-scale flood protection measures:

**Regulations:**
- Wetlands Protection Act (310 CMR 10) and the Boston Wetlands Ordinance
- Chapter 91 (310 CMR 9.00)
- Massachusetts Environmental Policy Act (301 CMR 11.00)
- Massachusetts Building Code (780 CMR)
- Boston Zoning Code
- Historic Resources (Section 106)
- Parks Review (Section 7-4.11)
- Clean Water Act (Sections 401 & 404)
- Rivers and Harbors Act (Section 10)

**Plans & Guidelines:**
- Climate Resilience Solutions for North End and Downtown
- BPDA Greenway District Planning Study Use and Development Guidelines
- BPDA Coastal Flood Resilience Design Guidelines
- BPDA Downtown Waterfront Design and Use Guidelines
- Public Works Department - Climate Resilient Design Guidelines & Standards
- Coastal Zone Management
- Division of Marine Fisheries Time Of Year Restrictions

1. **Key Findings**

- None of the above regulations, plans or guidelines categorically prohibit alterations to the shoreline\(^1\) for the purpose of increasing resilience to flooding, and many expressly support such activities.

- The biggest hurdles to implementing district-scale flood protection measures are likely to be related to agency positions and unofficial policies rather than to actual regulatory constraints. While the concept of resilience to the impacts of sea level rise (SLR) is promoted at the local and state levels, some agencies, particularly the Boston Conservation Commission and CZM, are not in practice comfortable with placing fill in waterways, raising seawalls, and/or placing fill in the floodplain.

\(^1\) The term “shoreline” means the mean high water line, which, within the Study Area, is generally the face of the existing coastal engineering structures or the perimeter of piers or wharfs.
Designing, permitting, and constructing district-scale flood protection measures will require cooperation and flexibility from multiple stakeholders who may have different goals related to public access, conservation of the natural environment, and protection of property, which often come into conflict with one another.

Stakeholders may also focus on different timeframes (near-term versus long-term) or place differing value on to whom benefits accrue (e.g., the public at large, private site users, and property owners).

Projects recommended in the Plan are very likely to impact jurisdictional resource areas and will require review and approval from the Boston Conservation Commission.

Barring potential changes to the MEPA regulations at 301 CMR 11.00 that may alter review thresholds related to wetlands and waterways, the projects recommended in the Plan are likely to be subject to MEPA review, which will in turn provide a venue for CZM input.

Consultation with MEPA is recommended to determine whether they consider any projects recommended under the plan are individual undertakings or are undertaken under a common plan (regardless of the number of property owners).

Permitting under the WPA, MEPA, and Chapter 91 could take between 17 and 24 months, combined, to complete.

Note: The Magenta Zone

The Magenta Zone is an area along the waterfront of the Boston Inner Harbor and the Fort Point Channel (extending along the entirety of the Study Area shoreline) designated in 1968 by Congress (PL 90-312) to be “not a navigable water of the United States,” even though the area is factually navigable (Figure 1). As a result of this designation:

- Projects within the Study Area are NOT subject to Section 404 of the Clean Water Act, which requires a permit from the U.S. Army Corps of Engineers before dredged or fill material may be discharged into navigable waters of the United States.
- Since no federal permit is required for discharging fill, Section 401 of the Clean Water Act, wherein a federal agency may not issue a permit or license to conduct any activity that may result in any discharge into waters of the United States unless a Section 401 water quality certification is issued, is NOT applicable.
- Section 10 of the Rivers and Harbors Act, which requires authorization from the Secretary of the Army, acting through the Corps of Engineers, for the construction of any structure in or over any navigable water of the United States, is NOT applicable.

2. Project Understanding

The Plan’s “Study Area” comprises the parcels along the shoreline between (and inclusive of) Christopher Columbus Park and Congress Street, as well as the abutting parcels to the west up to the western limit of the southbound side of Purchase Street between North and Congress streets (Figure 1). As we understand it, the goals of the Plan are to:
Create a conceptual district-scale flood protection and resiliency plan to reduce the risk of flooding due to sea level rise,

Obtain buy-in on a conceptual plan from property owners,

Coordinate with city and state regulators, and

Identify a path to permitting the selected design.

The Plan’s recommendations include the following categories of potential district-scale flood protection measures:

- **Outboard**
  - Construct elevated Coastal Engineering Structures\(^2\) (CES) immediately seaward of the existing shoreline
  - Construct elevated CES off-shore to contain new fill (i.e., “landmaking”)

- **Inland**
  - Raise elevations of the existing CES
  - Raise ground elevations landward of the existing CES

- **Building**
  - Elevate structures
  - Floodproof structures

### 3. Detailed Regulatory Considerations

#### 3.1 Wetland Resource Areas

The following wetland resource areas are regulated under the Wetlands Protection Act (WPA) and/or the Boston Wetlands Ordinance (BWO). Work within these areas must be approved by the Boston Conservation Commission under an Order of Conditions.

- **Land Under Ocean** (WPA, BWO)
  - **Definition:** All land seaward of mean low water (MLW), which is -5.2’ NAVD88/1.3’ BCB in Boston Harbor.
  - **In the Study Area:** It is assumed that all areas seaward of the face of the existing coastal engineering structures is LUO, although there may be small areas with shallow conditions, particularly underneath wharves, where the resource area could more accurately be categorized as Land Subject to Tidal Action (LSTA).

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\(^2\) Such as seawalls, bulkheads and revetments
Performance Standards: Work within LUO cannot result in alterations that would increase storm damage or erosion of banks, impact water circulation, alter distribution of sediment grain size, cause changes in water quality, or alter shallow area with a high density of sea life.

Relevant Measures: Outboard

Coastal Bank (WPA, BWO)

Definition: The seaward face or side of any elevated landform, other than a coastal dune, which lies at the landward edge of a coastal beach, land subject to tidal action, or other wetland. MassDEP interprets this to include the land immediately behind a CES. The BWO expands this definition to include seawalls and bulkheads themselves under the definition of Coastal Bank.

In the Study Area: Regulated Coastal Bank is present in the Study Area where there are CESs.

Performance Standards: Work is prohibited from adversely impacting Coastal Bank stability.

Relevant Measures: Inland

Land Subject to Coastal Storm Flowage (LSCSF)(WPA, BWO)

Definition: According to 310 CMR 10.04, LSCSF means land subject to any inundation caused by coastal storms up to and including that caused by the 100-year storm, surge of record or storm of record, whichever is greater. The landward boundary of LSCSF is located where the ground elevation is the same as the Base Flood Elevation (BFE) depicted on the currently effective or preliminary FEMA Flood Insurance Rate Map (FIRM).

In the Study Area: As per FIRM panel 250286, effective March 16, 2016, the northern portion of land within the Study Area is located within an AE zone with a base flood elevation (BFE) of 10 feet NAVD88. A VE zone\(^3\) exists seaward of the existing shoreline with a BFE of 13 feet NAVD88. The Limit of Moderate Wave Action (LimWA)\(^4\) is generally located approximately 25 feet from the shoreline.

Performance Standards: Under the BWO, paved surfaces within LSCSF are considered redevelopment, and work must result in an improvement (i.e., increase in pervious cover) over existing conditions. Currently, there are no performance standards for LSCSF within the state wetlands regulations.

Relevant Measures: Inland

Waterfront Area (BWO)

Definition: The portion of the buffer zone which extends twenty-five (25) feet horizontally from the edge of several resource areas, including coastal bank (BWO Section 7-1.4 b.).

In the Study Area: The area within 25 feet of the shoreline.

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\(^3\) VE zones are areas within the floodplain that have additional hazards associated with storm waves of 3+ feet.

\(^4\) The area between the LimWA and the VE zone is known as the “Coastal A Zone,” and is the area within the floodplain that has additional hazards associated with storm waves of 1.5 and 3 feet.
Performance Standards: The Commission has a strong preference for restoring or maintain a strip of continuous, undisturbed or restored vegetative cover or waterfront public access throughout the Waterfront Area.

Relevant Measures: Inland

Coastal Flood Resilience Zone (BWO)

Definition: The area of land beyond the current boundary of LSCSF or LSTA that the Commission determines has a reasonable probability of becoming subject to future coastal storm flowage or tidal action due to sea level rise (SLR) within approximately the next 50 years.

In the Study Area: The Commission has not yet adopted a map delineating this resource area. However, it is likely to be similar to the extent of the Article 25A Coastal Flood Resilience Overlay District.

Performance Standards: None at this time.

Relevant Measures: Inland

3.2 Chapter 91

Summary: Any construction, placement, excavation, addition, improvement, maintenance, repair, replacement, reconstruction, demolition or removal of any fill or structures, and any change in use of fill or structures in filled or flowed tidelands is subject to jurisdiction under M.G.L. c. 91, the Massachusetts Public Waterfront Act, and its implementing regulations at 310 CMR 9.00 (together, “Chapter 91”).

In the Study Area: The entire Study Area is within Chapter 91 jurisdiction (Private Tidelands), and therefore all proposed work will require a new or amended license or a minor modification to an existing license, depending on the work proposed, issued by the Massachusetts Department of Environmental Protection’s (MassDEP) Waterways Department.

Implications:

- Parcels of land along the shoreline that contain any non–water dependent uses are required to reserve ground-floor spaces in facilities of public accommodation, provide ground-level usable open space, and preserve access or sight lines to the water. These requirements often directly conflict with implementing flood resilience measures such as raising first occupiable floors and seawalls.
  
- In addition, these facilities are supposed to be provided in perpetuity, which presents a conundrum for low-lying areas in the path of SLR impacts.

- While Chapter 91 does not categorically restrict the use of fill for flood protection purposes, it does not expressly allow it for that purpose either. Under the existing regulations, in-water coastal flood protection measures could potentially be licensed as a water-dependent use project, as a water-dependent infrastructure project, or through the variance process.

- The Chapter 91 licensing process can take upwards of 9 months to complete.

- Placing fill within flowed tidelands requires payment of a Tidewater Displacement Fee.
3.3 Municipal Harbor Plan (MHP)

- **Summary:** Based upon a recent court decision, the Downtown Waterfront MHP is not in effect. As a result, projects must comply with the standard Chapter 91 regulations. The following information is being provided in the event that the existing Downtown Municipal Harbor Plan is re-authorized in the future.

- **In the Study Area:** The Downtown Municipal Harbor Plan sets up parameters and funding mechanisms for some sites within the Study Area to pursue coastal resilience strategies. It identifies specific strategies for the Harbor Garage and Hook Wharf sites and identifies amplifications for engineering and construction standards, and for activation of Commonwealth Tidelands for public use. It also identifies a 12-foot wide Water Dependent Use Zone along the waterfront.

- **Implications:**
  - The MHP specifies that areas improved for public open space shall be incrementally elevated (identified as a non-structural alternative) to improve resiliency, as feasible, to be guided by the City’s Design and Use Standards which recommend appropriate increases in elevation for public open spaces in the planning area.
  - It also specifies that all exterior private tideland areas that are planned for public access shall be held to the public activation standard used for Commonwealth Tidelands.
  - Public open space and accessible areas must be designed and constructed with materials that will ensure their continued use by the public after periods of inundation.
  - Waterside infrastructure such as new docks, piers, as well as bulkhead and seawalls, must be designed and constructed to withstand storm surge, wave action and future sea level rise.
  - Materials for public spaces should also be of a higher albedo to assist in limiting heat island effect and incorporate vegetation and structural elements that provide shade and refuge from summer heat, as well as wind and precipitation.

- **Relevant Measures:** Outboard, Inland, Buildings

3.4 Massachusetts Environmental Policy Act (MEPA)

- **Summary:** Review under MEPA is required when projects meet or exceed review thresholds related to environmental impacts AND require a related state agency action. MEPA will advise on jurisdiction based on whether projects are considered individual undertakings or are undertaken under a common plan (regardless of the number of property owners).

- **In the Study Area:** Projects within the study area are most likely to trigger MEPA review as follows:
  - CH91 License + alteration of coastal bank OR new fill or structure in a velocity zone OR alteration of ≥0.5 acres of LSCSF.
CH91 License + construction, reconstruction or expansion of an existing solid fill structure of 1,000 or more sf base area or of a pile-supported or bottom-anchored structure of 2,000 or more sf base area provided the structure occupies flowed tidelands or other waterways.

- **Implications:**
  - Projects are likely to be subject to MEPA.
  - The Study Area is within one mile of Environmental Justice Communities, and projects subject to MEPA must therefore conduct extensive outreach and impact analysis as per the recently promulgated EJ policies.
  - The MEPA process must be complete before any state agency actions can occur (such as issuance of licenses or permits or distribution of financial assistance).
  - The MEPA process can take between 4 and 18 months to complete, depending on project details.

3.5 Massachusetts Building Code

- **Summary:** New buildings and substantial improvements to existing buildings within FEMA’s 1% annual chance floodplain as depicted on the Flood Insurance Rate Maps (FIRM) must comply with the flood-related portions of the Building Code, which provide minimum requirements for flood-resistant structural design and building methods and materials (for example, floodproofing materials). The Building Code does not address the design, construction or maintenance of docks, piers, bulkheads or waterway structures.

- **In the Study Area:** Much of the Study Area between Christopher Columbus Park and Rowes Wharf is at least partially within the FEMA Floodplain.

- **Implications:** All changes to buildings should comply with the Building Code as applicable.

- **Relevant Measures:** Buildings

3.6 Boston Zoning Code

- **Summary:** The Boston Zoning Code controls building and site use and bulk/dimensions including floor area ratios and lot coverage; minimum lot sizes; minimum yard setbacks; maximum height; and finish floor elevation. It also sets requirements for open space, parking and loading, and accessory structures. CESs are not subject to zoning.

- **In the Study Area:** Parcels within the Study Area are subject to Zoning under Articles 42A (Downtown Waterfront Subdistrict of the Harborpark: North End Waterfront District), 49A (Greenway Overlay District), and 25A (Coastal Flood Resilience Overlay District).

- **Implications:**
  - Changes to buildings or new structures may trigger compliance with the Zoning Code.
If compliance with Article 25A is required, then building first floor elevations must be set at the required Sea Level Rise Design Flood Elevation (SLR-DFE).

In addition, the project would need to demonstrate consistency with the Coastal Flood Resilience Design Principles related to resilience, urban design and public realm, relationship to district-scale resilience solutions, and sustainability co-benefits.

Relevant Measures: Buildings

3.7 Historic Resources

Summary: Portions of the Study Area are listed in the National Register of Historic Places. Changes to structures and districts with this designation may require review by the Massachusetts Historical Commission (MHC).

In the Study Area: The Long Wharf and Custom House Block (BOS.AQ) is listed as a National Historic Landmark and a National Register District. The Fort Point Channel National Register Historic District (BOS.WZ) includes the seawall between 360-400 Atlantic Avenue and Congress Street.

Implications:

Any project that impacts National Historic Landmarks or Districts that requires federal funding, licenses, or permits must be reviewed by MHC in its role as the State Historic Preservation Office (SHPO), in compliance with Section 106.

If a Project is determined to result in an adverse effect that cannot be avoided or minimized, mitigation stipulations are documented in a Memorandum of Agreement (MOA) signed by the Proponent, the MHC, the lead federal agency, and other consulting parties or participating agencies as needed.

Relevant Measures: Inland

3.8 Parks Review

Summary: Section 7-4.11 of the Boston Code of Ordinances requires that buildings or structures erected or altered within 100 feet of a park or parkway must gain permission from the Boston Parks and Recreation Department (BPRD).

In the Study Area: City-owned parks within the Study Area include Christopher Columbus Park and Long Wharf Park. The Rose Kennedy Greenway may also be considered a Park under Section 7-4.11.

Implications: Work within 100 feet of the areas described above will be subject to review by the BPRD.

Relevant Measures: Outboard, Inland, Buildings
4. **Applicable Plans and Guidelines**

4.1 **Climate Resilience Solutions for North End and Downtown (CRB-NED)**

- **Summary:** This report presents a toolkit that pairs existing edge conditions with possible design approaches, which may be appropriate as stand-alone solutions or in various combinations depending on existing edge conditions.

- **In the Study Area:** The Design Flood Elevation (DFE) target is 15’ NAVD88, while the Modular target is 16.5’ NAVD88. This document identifies the area between Christopher Columbus Park and Rowe's Wharf as a "near-term + catalytic" project because it is vulnerable to flooding with 9 inches of SLR, while the area to the south is designated as a "long-term" project, which should be designed to address risks occurring as a result of 40 inches of SLR.

- **Implications:** Projects within the Study Area should be designed to a minimum elevation of 15’ NAVD88 to facilitate continuous protection throughout the Study Area and within adjacent areas.

- **Relevant Measures:** Outboard, Inland

4.2 **BPDA Greenway District Planning Study Use and Development Guidelines**

- **Summary:** Published in 2010, the Guidelines are specifically for the parcels adjacent to the Greenway and represent an effort to preserve the Rose Kennedy Greenway open space, activate the public realm, maximize the quality of its parks, and balance development.

- **In the Study Area:** The Guidelines present four goals for the Wharf District: 1) Create and enhance access to the waterfront and South Boston; 2) Reinforce the openness of the freestanding pier-like structures; 3) Facilitate the accessibility of the Harborwalk; and 4) Further diversify abutting uses. It mainly focuses on the redevelopment of the Boston Harbor Garage and Hook Lobster/U.S. Coastguard/400 Atlantic Avenue sites. It also identifies areas for programmatic activation, important pedestrian nodes, and pedestrian connections.

- **Implications:** The Guidelines are the culmination of a two-year planning study, and as such represent consensus among stakeholders about issues that may impact the design of the WDC Plan, particularly related to connectivity (both physical and visual) between the Greenway and the waterfront.

- **Relevant Measures:** Inland, Buildings

4.3 **BPDA Coastal Flood Resilience Design Guidelines**

- **Summary:** The Guidelines provide best practices for flood resistant design for new construction and building retrofits and are intended to be used by BPDA staff during review of projects within the CFROD (Article 25A). It warns that "enhancements at a parcel level should not worsen risk at adjacent parcels or restrict future implementation of district coastal resilience plans, and, to the extent feasible, should support the resilience goals and implementation of district coastal resilience plans."
In the Study Area: This document can provide ideas for building-level adaptations.

Implications: These guidelines do not present any specific constraints to designing district-scale flood protection measures.

Relevant Measures: Inland, Buildings

4.4 BPDA Downtown Waterfront Design and Use Guidelines

Summary: The BPDA is developing Design and Use Guidelines to advance the open space and public realm objectives of the 2017 Downtown Waterfront Municipal Harbor Plan & Public Realm Activation Plan. The guidelines are intended to provide consistent design standards for both exterior and interior public spaces, wayfinding elements, landscaping, signage and public amenities to improve connectivity within the district and to adjacent open space resources such as the Greenway and Boston Harbor. Climate resilience will be a priority in the development of the Guidelines to ensure the long-term viability of public spaces. Design options to support a variety of year-round public activation and programming will also be explored. Additionally, the project will develop management concepts to better coordinate vessel berthing, water transportation and shoreside support infrastructure. The final Guidelines will inform new development and public realm improvements to ensure the district is welcoming, active and accessible to all residents and visitors. This effort is currently on hold until the status of the Downtown Waterfront MHP is resolved.

In the Study Area: TBD

Implications: TBD

Relevant Measures: Outboard, Inland, Buildings

4.5 Public Works Department - Climate Resilient Design Guidelines & Standards

Summary: This document includes design, operations, maintenance, and cost considerations for designing resilient flood protection for public rights-of-way. While it recommends that the 2070 climate projections be used to inform design, the guidelines note that if the 2070 DFE is not feasible to achieve immediately due to available funding and/or site constraints, intermediary DFEs should be used to prepare a plan to reach the 2070 DFE elevation incrementally. Temporary, deployable flood barriers may use an intermediary DFE (2030 and 2050 time horizons) but are not considered appropriate for long-term flood defense from SLR and storm surge. The guidelines provide a suite of considerations that should be incorporated into designs, rather than specific designs themselves.

In the Study Area: These guidelines are applicable to designing protection for public ROWs within the Study Area.

Implications: These guidelines do not present any specific constraints to designing district-scale flood protection measures.

Relevant Measures: Inland
4.6 Coastal Zone Management

Summary: The Massachusetts Office of Coastal Zone Management (CZM) implements the federal consistency review process in Massachusetts. Federal consistency review is required for most projects that: 1) are in or can reasonably be expected to affect a use or resource of the Massachusetts coastal zone, and/or 2) require federal licenses or permits, receive certain federal funds, are a direct action of a federal agency. Projects subject to MEPA are reviewed and commented on by CZM.

In the Study Area: The entire study area is within the Coastal Zone.

Implications:
- CZM has a strong preference for resilience solutions that avoid CESs. Alternatives analyses may be scoped in a MEPA certificate.
- Projects subject to Federal Consistency Review would need to demonstrate compliance with all of the Massachusetts Coastal Program Policies.
- Relevant Measures: Outboard, Inland

4.7 Division of Marine Fisheries (DMF) Time Of Year (TOY) Restrictions

Summary: The DMF recommends a TOY from February 15 to November 15 for work in Boston Harbor to avoid impacts to Winter Flounder, Horseshoe Crab and Shellfish (where Suitable Habitat is indicated).

In the Study Area: Any silt-producing activity within the in-water portion of the Study Area is likely to be subject to the TOY, required as a condition of the Boston Conservation Commission’s Orders of Conditions.

Implications: In-water work would likely be limited to the period outside the TOY. Consultation with DMF is recommended during the WPA NOI process.

Relevant Measures: Outboard
Figure 1: Regulatory Constraints

WDC Resiliency Plan | Boston, Massachusetts

Chapter 91 Historic Mean High Water

Chapter 91 Landlocked Tidelands

FEMA Floodplain

Fort Point Channel National Register District

Non-Navigable Waters

Source: VHB, MassGIS, NOAA, FEMA
Flood Layer Data Source: Massachusetts Coast Flood Risk Model (MC-FRM)
Flood Layer Data Source: Massachusetts Coast Flood Risk Model (MC-FRM)
2070 1% Flood Extents and Flood Pathways

Flood Layer Data Source: Massachusetts Coast Flood Risk Model (MC-FRM)
Present-Day 1% Flood Depths

Image Source: Arup Massachusetts Flood Viewer | Flood Layer Data Source: Massachusetts Coast Flood Risk Model (MC-FRM)
2030 1% Flood Depths

Image Source: Arup Massachusetts Flood Viewer | Flood Layer Data Source: Massachusetts Coast Flood Risk Model (MC-FRM)
2050 1% Flood Depths

Image Source: Arup Massachusetts Flood Viewer | Flood Layer Data Source: Massachusetts Coast Flood Risk Model (MC-FRM)
2070 1% Flood Depths

Image Source: Arup Massachusetts Flood Viewer | Flood Layer Data Source: Massachusetts Coast Flood Risk Model (MC-FRM)