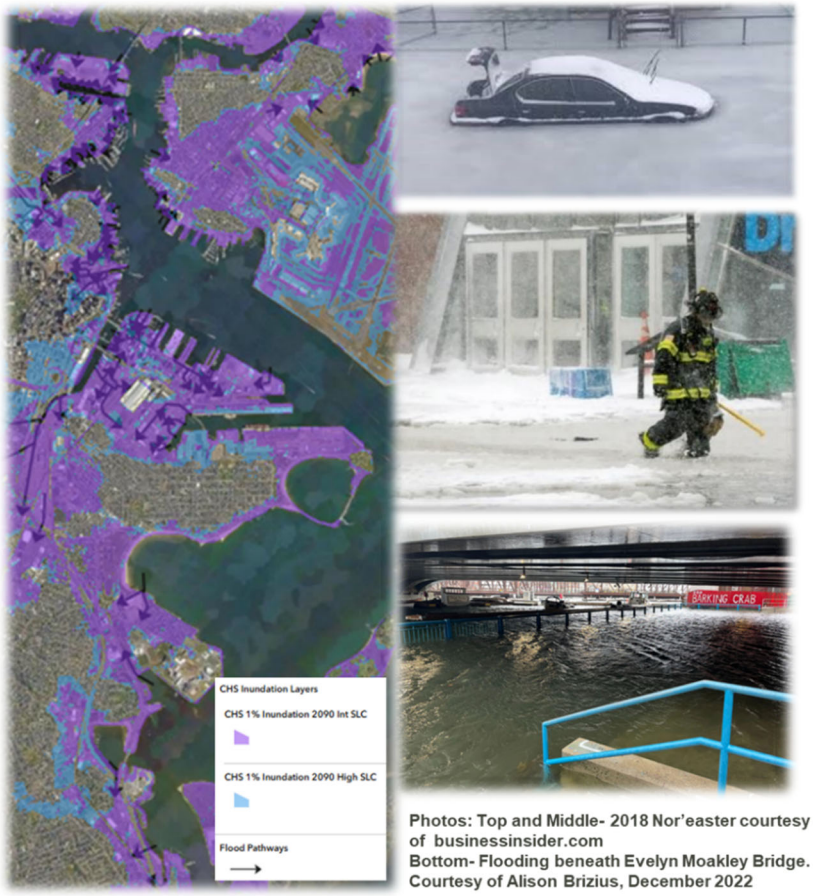
Boston Coastal Storm Risk Management Study

Draft Integrated Feasibility Report and

Programmatic Environmental Assessment



Photos: Top and Middle- 2018 Nor'easter courtesy of businessinsider.com
Bottom- Flooding beneath Evelyn Moakley Bridge. Courtesy of Alison Brizius, December 2022

NEPA ID: PEAX-202-00-E6R-1776854417

USACE New England District | City of Boston

US Army Corps of Engineers

City of Boston Coastal Storm Risk Management Study
Civil Engineering Appendix

Introduction

Purpose & Scope

The purpose of this study is to investigate the feasibility of managing coastal storm risk along the 47 miles of Boston Harbor's shoreline. The project area is at risk of flooding from coastal storm inundation during tropical events, extra-tropical events, extreme tides, and future sea level change (SLC). These hazards pose risk of damage to public safety, public infrastructure, private property, and associated impacts to the City of Boston and Boston Harbor communities. The risk is expected to increase over time because of climate change, including relative sea level change (RSLC). This appendix outlines the civil engineering efforts undertaken to develop feasibility-level designs to address risk to the study area.

Study Area

The study area is primarily focused along the coastline of the City of Boston, but large areas inland from the coast within the City, are at risk of flooding from coastal storms. The study area was separated into five distinct neighborhoods for evaluation: Charlestown, Dorchester, South Boston, East Boston, and Downtown/North End. Each neighborhood consists of a distinct mix of residential, commercial, industrial, and recreational spaces.

Existing Information and Data

Topography & Imagery

Existing topography is derived from the 2021 USGS LiDAR for Central/Eastern Massachusetts, obtained via the NOAA Data Access Viewer in point (.LAZ) format. Targeted topographic surveys were conducted by the USACE New England District Survey Section in select areas where additional precision was necessary for alternative formulation. NOAA Navigation Charts were utilized to identify approximate water depths as necessary.

Google Earth aerial imagery and StreetView were used in conjunction with site walks to evaluate existing site conditions. Aerial imagery displayed on plans was captured from Microsoft Bing Maps, the imagery source native to Autodesk Civil 3D, in March 2025 and is considered approximate.

Datums

For this project, the horizontal datum utilized is NAVD88 and the vertical datum is NAD83 Massachusetts State Plane, Mainland Zone (2001). However, the City of Boston utilizes Boston City Base (BCB) as the local vertical datum. BCB is 6.46 feet below NAVD88. Thus, 6.46 feet should be added to NAVD88 to convert from NAVD88 to BCB. This conversion was applied throughout the project when working with historic or as-built drawings from prior City of Boston work.

The local tide gauge for water level references is NOAA Station ID 8443970 (Boston, MA). The mean range of tide is 9.49 feet and MLLW is -5.50 feet NAVD88.

Utilities & Infrastructure

Utility Data

While utility information cannot be publicly shared in this report, the information was utilized by the project team to optimize alignments where possible and inform project cost estimates. Additional utility information will be acquired in the Preconstruction, Engineering, and Design Phase (PED) to further develop detailed designs:

- **Boston Water and Sewer Commission (BWSC):** Stormwater and sewer obtained via BWSC GIS database
- **National Grid**: Natural gas mains
- **Eversource**: Existing electric transmission and distribution, as well as proposed transmission upgrade projects.

Tunnels

Tunnels are a critical component of transportation infrastructure throughout the City of Boston, carrying vehicular and rapid transit (subway) traffic. Tunnels were documented on project plans to inform the type of project feature, associated construction complexity, and cost. Further consideration will be given to construction of project features that cross or bridge over tunnels in PED, but current cost estimates capture contingency for these areas:

- **Sumner and Callahan Tunnels**: Supports Route 1A, connecting Downtown Boston to East Boston.
- **Ted Williams Tunnel**: Supports I-90, connecting South Boston and East Boston in the vicinity of Logan Airport.
- **Fort Point Channel:** Multiple tunnels traverse Fort Point Channel including a series of I-90 tunnels, the MBTA Silver Line Way between South Station (Downtown) and Courthouse (South Boston), and the MBTA Red Line between South Station and Broadway.

- **Blue Line Tunnel:** Supports the MBTA Blue Line between Aquarium (Downtown) and Maverick (East Boston)

Ferry Terminals

The MBTA (Massachusetts Bay Transportation Authority), as well as a number of private or public-private entities, operate a series of ferries throughout Boston Harbor and the greater Massachusetts Bay. Ferry terminal locations were documented, with the intent of maintaining access through or over proposed project segments, depending on available space. Grouped by neighborhood, these include:

- **Downtown**: Long Wharf (North and South), Rowes Wharf, Aquarium, Lovejoy Wharf
- **South Boston**: Seaport Fan Pier, Commonwealth Pier East, Pier 10 (Drydock Ave)
- **Charlestown**: Navy Yard
- **East Boston**: Lewis Mall

Alternative Development and Layout Approach

General

Three primary structure types were developed for implementation along the proposed line of protection in each neighborhood. These represent conservative project "typicals," but will be refined on a site-by-site basis in PED. *Table 1* catalogues the total lengths of each project segment type evaluated in this feasibility study. Additional detail on each structure type is available in the Geotechnical and Structural Engineering Appendices (Appendix G and Appendix H, respectively):

- **Floodwall**: A pile-supported T-wall with a sheet pile cutoff was selected as the typical floodwall feature for land-based applications.
- **Outboard Floodwall:** A pile-supported L-wall with a sheet pile cutoff was selected as the typical floodwall feature for water-based applications. In these instances, the proposed floodwall is to be constructed in the water beyond any existing seawalls or bulkheads, with fill between the existing feature and proposed cutoff wall.
- **Levee**: In areas where there is sufficient space to accommodate the segment footprint, a levee with 10' crest and 1V:3H slopes constructed from low-permeability soil was applied. The levee will also incorporate a sheet pile cutoff wall. A 15'-wide buffer/vegetation free zone is required from the toe of the levee to both maintain maintenance access and ensure vegetation does not damage the levee.
- **Shallow Foundation Wall**: An alternative to the pile-supported T-wall for areas in which piles cannot be driven (e.g., over tunnels), which utilizes ground improvement instead of piles.

- **Closure Structure**: Swing gates, rolling gates, stop logs, or other deployable structure included in the line of protection to enable access or vehicular traffic flow during day-to-day operations, but closed/activated ahead of a storm event.
- **Road Raising**: To eliminate the need for closure structures at some locations, the proposed feature is a road raising to achieve the target elevation. This is considered a variation on the levee feature, as the road raising functions in a similar manner.

Table 1. Total Evaluated Project Segment Types and Lengths

		Charlestown	Dorchester	East Boston	South Boston	Downtown	*Total*
T-Wall	(feet)	6,585	3,390	20,150	15,710	4,490	*50,325*
Outboard Wall	(feet)	3,550	370	550	4,725	13,490	*22,685*
Shallow Foundation Wall	(feet)	-	-	-	-	590	*590*
Berm/Levee/Road Raising	(feet)	700	10,840	3,335	220	270	*15,365*
Closures (#)	(#)	12	-	15	20	13	*60*
Total Length of Features	*(feet)*	*10,835*	*14,600*	*24,035*	*20,655*	*18,840*	***88,965***
	(miles)	*2.05*	*2.77*	*4.55*	*3.91*	*3.57*	***16.85***

To evaluate project feasibility for such a large total length of project segments, the project team needed to strike a balance between site-by-site detail and sweeping, high level assumptions. To do so, the project team generated a series of "buckets" of typical features. These buckets categorized features based on a range of heights: less than 3-feet, between 3 and 6 feet, and between 6 and 9 feet. This enabled the project team to develop a series of typical sections that captured the feature needs and varying topography across the five neighborhoods. It also supported cost in developing a more robust estimate that conservatively captured the different material needs for taller project segments.

Concurrent Project Coordination

Independent of this CSRM feasibility study, the City of Boston and its partner agencies are currently undertaking a series of resilience projects throughout the study area. The project team sought to coordinate with the City of Boston on these alignments and adopt the proposed features where the City proposals are also in the federal interest. These projects include, but are not limited to:

- East Boston Resilient Waterfront (East Boston)
- Piers Park II (East Boston)
- Wharf District Council (Downtown/North End)
- Christopher Columbus Park (Downtown/North End)
- North End Waterfront Climate Alliance (Downtown/North End)

- Moakley Park & Moakley Park Connectors (Dorchester)
- Tenean Beach (Dorchester)
- Fort Point Channel Surge Barrier (South Boston)
- Raymond L. Flynn Marine Park (South Boston)
- Ryan Playground Phase I (Charlestown)

Site-Specific Analysis

The following sections document additional neighborhood- and site-specific considerations for each project segment. These include, but are not limited to: access routes and available space, bridge clearances, maintained access to Chapter 91 harborwalk, and utility conflicts. Project segments were consolidated into a series of alternatives as outlined in the main report.

Charlestown

Conceptual plans in Charlestown are a combination of T-walls and outboard walls based on available space and perceived complexity at target locations. Refer to Sheets CH100 through CH501 for conceptual drawings in Charlestown:

Navy Yard: The Navy Yard project segment consists of a section of t-wall floodwall on land with a primarily outboard, water-based floodwall. This approach was selected given space constraints and anticipated complications with existing infrastructure on the landward side in this historic area. The existing pile-supported harborwalk indicated that piles could be installed outboard to install a floodwall with integrated harborwalk. The project segment ties in to high ground on 16th Street with a series of closures to maintain access to the Spaulding Rehabilitation Hospital, which has independently floodproofed and expressed a preference to remain outside of the proposed line of protection. Another series of closures along the project segment are included to maintain access to a series of piers as well as pedestrian access to the Charlestown Navy Yard MBTA Ferry Terminal.

Chelsea Street: This project segment at the intersection of Chelsea Street and Vine Street was developed as an alternative to the full perimeter project segment in the Navy Yard. This feature closes off a low point along Chelsea Street with a T-wall and closure structure at Vine St.

Little Mystic Channel: The Little Mystic Channel project segment includes an outboard floodwall given the limited space between the CharlesNewtown housing development and the water. Sections of the existing block wall are failing, and the questionable state of the existing wall established a preference to construct outboard of the existing wall. to both create more space and mitigate issues in the vicinity of the existing wall. The tie-ins to high ground at the Charlestown High School track and Chelsea Street bridge consist of T-walls.

The walkway on the protected side of the floodwall is to be graded such that it can cross over the wall and integrate with the existing harborwalk. Any equipment brought to the project site by water for construction must be able to fit under the Chelsea Street Bridge.

Schrafft's Center: The Schrafft's Center project segment consists of a floodwall along the perimeter of the 425 Medford Street development. To the west, this ties into the ongoing construction at Ryan Playground and incorporates a future berm edition along the eastern edge of Ryan Playground. The feature follows the perimeter of the parcel and ties in to high ground near Medford Street. This alignment crosses an existing, though unused, railway right of way, which must be further investigated in a future design stage.

Dorchester

Conceptual plans in Dorchester include typical floodwalls as well as levee features. This is the result of additional space available in Dorchester and network of parks and open space that could accommodate the increased footprint required for levees. Refer to Sheets DC100 through DC501 for conceptual drawings in Dorchester:

Neponset River: This project segment primarily consists of a levee feature at Pope John Paul II Park. Future design will optimize the levee location to maximize utilization of the existing sports fields. The levee transitions to floodwall as available space decreases, and then to an outboard wall in the vicinity of the existing Planet Fitness. At Planet Fitness, there is a harborwalk with limited space that necessitates going outboard of the existing path. The Neponset Ave bridge poses overhead restrictions for a section of the outboard wall, and pile splicing will be required to complete. The northern terminus of this segment ties-in to high ground at a railroad embankment that supports the MBTA and heavy rail.

Tenean Beach: The Tenean Beach project segment consists of features at two locations. Along the beach, a levee and road raising close the flood pathway under I-93 along Conley St. This design is compatible with future Massachusetts Department of Conservation and Recreation (DCR) improvements to the remainder of the park. The levee terminates at the I-93 highway embankment. On the western side of I-93, a floodwall along the rail closes the flood pathway to inland Dorchester. Substantial railway coordination will be required for survey, design, and construction of this floodwall feature.

Victory Road: This project segment consists of a small berm along the Exit 13A ramp from I-93 and regrading of the Dorchester Shores Reservation parking area. The intent is to integrate the berm into the landscape and eliminate the need for a closure structure at the park entrance. Construction may require temporary closure of the exit to complete.

Morrissey Boulevard: This project segment includes construction of two floodwalks flanking the Morrissey Blvd near the Dorchester Bay Basin approaching the I-93 underpass.

This configuration closes the flood pathway under I-93 without using closure structures and thus impeding traffic. The floodwall on the southbound side of Morrissey Blvd terminates at the I-93 highway embankment and may require coordination with MassDOT for design and construction.

Pattens Cove: The Pattens Cove project segment comprise levee, floodwall, and road raising in the vicinity of the Morrissey Blvd and Bianculli Blvd intersection. The road raising may also necessitate replacement of the Morrissey Blvd bridge at Pattens Cove. There is also a major stormwater outfall at Savin Hill Cove along the northbound lanes of Morrissey Blvd. to consider during design.

Columbia Point: The Columbia Point project segment connects Moakley Park to a primarily levee feature along the perimeter of the Harbor Point development. This includes relocating existing harborwalk onto a levee along the waterfront. Portions of the levee must be built out into the water to preserve inland park space. These sections will include stone armoring on the seaward side, akin to a revetment. Floodwall segments are included in areas where the levee footprint could not be accommodated due to space constraints. The northern tie-in includes the Moakley Park Southern Connector, extending the line of protection to the southern end of Moakley Park, described below.

Moakley Park: Proposed project alignments for this project segment were coordinated with the City of Boston's ongoing Moakley Park and Connectors design project. This includes both work in Moakley Park and the Northern Connector tie-in. Moakley Park involves a reenvisioning of the park with resilience in mind, and the feasibility approach included in this report incorporates the "spine" flood protection feature through the park. The northern connector is the means of continuing the line of protection from the park into high ground along Columbia Road using a combination of road raisings, floodwall, and a berm. Construction must consider infrastructure surrounding the MWRA Columbus Park Headworks.

East Boston

While assessed as one neighborhood, East Boston consists of three distinct areas with flood pathways to address: the Boston Harbor Waterfront area, the Chelsea Creek area, and the Constitution Beach area. Refer to Sheets EB100 through EB501 for conceptual drawings in East Boston:

Border Street & East Boston Waterfront: Located along the most developed lengths of East Boston, this project segment extends from the Umana School at the north to Piers Park II at the south. The segment primarily comprises floodwall with a section of outboard wall where existing roadway is built on piles. Design and construction are complicated by the

Sumner and Callahan Tunnels below LoPresti Park, the large number of distinct real estate parcels required to implement a continues feature, and the combination of new development and industrial waterfront usage. Several closures are included to maintain access to the working waterfront. Two alternatives are proposed in this area: one that maintains the full perimeter in the Atlantic Works area and one that ties in inland along Border St to bypass new development on New St. The East Boston Waterfront system also includes an approximately 2' targeted road raising across Marginal St to tie the recently completed Piers Park project into high ground.

Tomahawk Drive: This project segment is designed to close the local flood pathway while preserving recreation opportunities at Porzio Park and the Massport Harborwalk Park. It consists of a road raising at Tomahawk Drive connected to a floodwall that extends from Tomahawk Drive to LoPresti Park. This configuration avoids floodwall installation in the vicinity of a major stormwater outfall with tide gates. Construction in this area will require coordination with Massport. The included closure structures are included to maintain pedestrian access.

Wood Island Marsh: This project segment consists of a levee along the perimeter of Massport Logan Airport Support Facilities and in the vicinity of the East Boston Greenway. The segment follows an alignment similar to that included in the Massport Logan North Service Area Resiliency Berm plan, but extends beyond the Massport property. Construction will occur in the vicinity of the Wood Island Bay Marsh and will need to employ techniques to protect the marsh during construction.

Constitution Beach: The Constitution Beach project segment includes a floodwall feature along the perimeter of the DCR Constitution Beach property. This configuration is intended to limit disruption to and facilitate connectivity of the waterfront and the rest of the park. The floodwall alignment parallels the East Boston Greenway. The proposed closure is intended to make this alignment a complete and separable entity, but if a closure is constructed at the Suffolk Downs MBTA station as described below, this closure will not be necessary. The proposed levee section along the beach will receive coastal armoring as it will be exposed to the water, then transitions back to a wall and ties in at the Orient Heights Yacht Club with a raising of the entrance to the parking lot.

Orient Heights Railyard: The project segment at the Orient Heights Railyard comprises a floodwall along the railyard perimeter upland of the surrounding marsh. The intent is to construct a feature while limiting disturbance to the marsh, as well as limiting disruption to MBTA rail operations. As a functioning railyard, the ailyard infrastructure (i.e., train tracks and overhead power lines) will be major site features to consider during construction.

Suffolk Downs MBTA: The MBTA Blue Line route is a low point in the East Boston area that acts as a channel for water under modeled storm conditions. To cut-off the flooding along this pathway, a rail closure is proposed. The location was selected by identifying an area in which the closure could tie into the appropriate elevation of protection, which was determined to be directly south of the station. To instead locate the closure north of the station and keep the station in service when the closure is activated, a much more substantial floodwall-closure system would be necessary and was not further explored as part of this study.

Chelsea Creek & Route 1A: There are two proposed project segment alternatives along Chelsea Creek: Chelsea Creek and Route 1A. The intent is to close a flood pathway from Chelsea Creek, while also preserving use of Route 1A a critical access corridor through East Boston. The Chelsea Creek alternative protects the entirety of 1A at this location, utilizing an existing rail easement along the waterfront. The Route 1A alignment locates the floodwall in the median of Route 1A, only protecting the northbound lanes of 1A in a flood event. The Route 1A alternative provides a viable option for installation of the wall should issues obtaining access to the rail easement arise.

South Boston

Two distinct lines of protection were developed in South Boston: a perimeter and an interior alignment. The perimeter alignment follows the full perimeter of the Seaport area of South Boston, to include the Raymond L. Flynn Marine Park. The interior alignment encompasses some of the same project segments, but terminates internal to South Boston at high ground. Refer to Sheets SB100 through SB502 for conceptual drawings in South Boston. The components of each of these alignments are as follows:

Fan Pier: The Fan Pier project segment comprises an outboard wall extending from the Moakley Courthouse to Commonwealth Pier. In some locations, this will require removing existing pile-supported harborwalk and replacing with floodwall with integrated harborwalk design. Construction will occur in the water, offset from any existing wall or bulkhead infrastructure. Access to marinas and ferry terminal piers will be maintained over the proposed wall. The segment terminates at the western edge of Commonwealth Pier, integrating with the pier-level resilience solutions currently under construction.

Seaport Blvd: This project segment comprises floodwall extending from the eastern edge of Commonwealth Pier to Leader Bank Pavilion. Utility infrastructure in the roadway (Seaport Blvd/Northern Ave) poses the greatest challenge to construction of this feature.

Raymond L Flynn Marine Park: This project segment encompasses the entire perimeter of the Raymond L Flynn Marine Terminal property, transitioning to an interior floodwall at the

Massport Cruiseport. This is part of the full South Boston perimeter alternative. This feature is proposed as a land-based floodwall, consistent with the Raymond L Flynn Marine Park Flood Mitigation Planning and Feasibility study. Closures are incorporated to facilitate access to the workout waterfront. At the Boston Ship Repair Drydock, the proposed element includes replacing the drydock closure with one that meet the target elevation requirement.

Pappas Way: This feature includes a floodwall along the interior of the Reserved Channel, tying in at high ground at E 1st Street. The alignment crosses a major stormwater outfall at the southern end of the waterfront park along Pappas Way, which must be further integrated into the design at a future stage. Pappas Way will tie into either the D Street segment of the Raymond L Flynn Marine Park segment, depending on whether an interior or perimeter alternative is pursued.

D Street: Combined with Pappas Way, the D Street segment completes the Interior alternative tie-in. To the north of I-90, this comprises a floodwall and regrading of intersections to facilitate continuous operations of the MBTA Silver Line MBTA, as well as vehicular traffic along Congress St. South of I-90, the segment incorporates a combination of floodwall and roadway regrading. A railroad easement (rail currently unused) runs parallel to Haul Road, which will inform if a wall or closure will be permissible at the crossing of the rail.

Parapet Wall: The I-90 Ted Williams Tunnel daylights in this area in the interior of South Boston. At grade, a 3-foot tall parapet wall surrounds the tunnel area. This project segment comprises extending the existing wall by approximately 1 foot to reach the targeted level of protection. It also includes the addition of a closure structure at the Massachusetts State Police on-ramp. This work is only necessary as part of the broader Interior project configuration.

Fort Point Channel Surge Barrier: The proposed Fort Point Channel Surge Barrier is intended to protect the lower-lying areas along Fort Point channel via closure of the channel at its mouth. This represents a more constructable, cost effective alternative to construction of project segments along the majority of the Fort Point Channel perimeter. At this stage of design, designs included in the Fort Point Channel Storm Surge Barrier component of the 2024 BWSC Coastal Stormwater Discharge Analysis Report have been utilized for conceptual proposals and cost estimating purposes.

Downtown/North End

The primary project feature in the Downtown neighborhood includes three alternative lines of protection: Perimeter, Interior, and Hybrid. Ancillary features on the Charles River side of

Downtown are included to close off key flood pathways to the north. Refer to Sheets DT100 through DT502 for conceptual drawings in Downtown/North End:

Perimeter: The Perimeter project segment is an outboard solution around the downtown Boston piers and wharves between the Coast Guard Station Boston and Fort Point Channel. As much of the perceived "land" is pier-supported structures built over the water, a traditional T-wall approach is not feasible. At locations around piers with open water underneath, the alignment incorporates areas of substantial fill. Other targeted fill areas are strategically used to generate clean lines and limit the number of small direction changes for the proposed wall.

Interior: With a similar intent as the Perimeter solution, the Interior alternative is a shorter alignment that does not follow the perimeter, but instead more closely follows Atlantic Ave. This eliminates outboard wall construction, but does introduce shallow foundation walls at locations where the alignment is directly above tunnels. While utilizing more traditional wall construction, his alignment presents significant challenges with existing infrastructure, including utilities, roads, sidewalks, and bike paths and requires a series of closure structures that must be activated for the line of protection to be complete.

Hybrid: This project segment combines the Perimeter and Interior alternatives. It is the same as the Perimeter alignment from the south, but utilizes same northern tie-in location on Fleet Street as the Interior alignment. This eliminates a significant amount of under-pier fill included in the northern reach of the Perimeter alignment while preserving most of the benefits it affords.

Paul Revere Park: This project segment involves the construction of a small berm in Paul Revere Park to match the elevation of protection provided by the Charles River Dam. As there are limited constructability challenges in the park, access being the primary consideration, construction of future adaptations would be reasonably achievable. Thus, the decision was to propose a feature with a lower level of protection with the understanding that future adaptation may be needed.

Lovejoy Wharf: Similar to Paul Revere Park, the level of protection is currently constrained by elevation of Charles River Dam. Unlike in Paul Revere Park, access to the site and disruption caused by construction would be more significant in this area. Given the construction constraints in a highly urban, coastal environment, the decision was to develop feature to the high scenario to avoid additional remobilization and construction at the site. Presently, Lovejoy Wharf is built on piles over the water, so a substantial amount of fill between the proposed wall and existing building will be necessary to construct the wall without either trapping water or leaving the existing pier exposed to potential uplift.

Commercial Street: The proposed approach for the floodwall and road-raising on Commercial Street is similar to that of Lovejoy Wharf: addressing the high scenario to prevent additional construction mobilization to the site. This project segment involves a floodwall along Commercial St near the Eliot School, tying into to high ground on Hull St using elevation of the intersection.