COASTAL RESILIENCE SOLUTIONS FOR EAST BOSTON AND CHARLESTOWN

EXECUTIVE SUMMARY

October 2017

Mayor Martin J. Walsh

GREENOVATE CITY of BOSTON

MASSACHUSETTS OFFICE OF COASTAL ZONE MANAGEMENT

Barr Foundation

October 2017

Dear Neighbors,

Climate change is here. It's happening now. This year, we saw its effect in Texas, Florida, Puerto Rico, and across our country and world. In Boston, we are seeing more frequent flooding on our waterfront, hotter summers, stronger rains, and unpredictable weather. It's more important than ever that we work together to make sure our city is ready for the changes ahead.

When we released the *Climate Ready Boston* report in December 2016, we weren't writing a plan that would sit on a shelf. In less than a year, we've made climate resiliency central to all our major planning efforts, including *Imagine Boston 2030*, *GoBoston 2030*, and *Resilient Boston*.

East Boston and Charlestown face specific risks because of sea-level rise and coastal flooding. This report, which was created with the support of the Commonwealth of Massachusetts and the Barr Foundation, helps us understand these risks and how we will address them. We've developed immediate measures we can take, and longer-term standards we can work towards to make sure our City is stronger, safer, and more equitable because we're ready for climate change.

Climate resiliency means many things. It's about protecting public health and safety in our neighborhoods, and using the best available information to do so. It's about focusing on our infrastructure and how our systems work together to make our city more resilient. It's about working with our neighboring municipalities, because climate change knows no borders. We're making sure that any action we take has many benefits for our residents, and that residents are always included in the planning process.

This report shows how we're doing this, and in the coming years we'll bring these types of solutions to other neighborhoods across the city. We look forward to continuing to work with you in your neighborhoods.

Sincerely,

Martin J. Walsh, Mayor of Boston

Attendees at the Charlestown Open House provide feedback and develop their own solutions to protect the neighborhood.

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Community and Steering Committee members participate in a climate resilience walking tour of the East Boston waterfront, organized by The Neighborhood of Affordable Housing.

ACKNOWLEDGEMENTS

The City of Boston wishes to acknowledge the many partners and community stakeholders who supported this project. Without their participation, this project would not have been possible.

A Steering Committee composed of the following partners oversaw the project:

- Boston Environment Department
- Boston Planning and Development Agency
- Boston Parks and Recreation Department
- Boston Public Works Department
- Boston Transportation Department
- *Imagine Boston 2030*
- Mayor's Office of Neighborhood Services
- Mayor's Office of Resilience and Racial Equity
- Boston Water and Sewer Commission
- MA Office of Coastal Zone Management
- Massachusetts Department of Transportation
- Massachusetts Port Authority
- Massachusetts Bay Transit Authority
- City of Cambridge
- City of Somerville
- Green Ribbon Commission
- UMass Boston School of the Environment
- Neighborhood of Affordable Housing

The following organizations helped us engage with their stakeholder communities:

- Neighborhood of Affordable Housing
- Green Ribbon Commission
- Boston Harbor NOW
- Harborkeepers
- The John Flatley Company
- East Boston Harborwalk Group
- Greenway Council
- Friends of the Charlestown Navy Yard
- Harbor View Neighborhood Association
- Eagle Hill Neighborhood Association
- Orient Heights Neighborhood Association
- Jeffries Point Neighborhood Association

The City of Boston would like to thank the Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs and the Barr Foundation for their generous support.

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Historic map with outline of the project sites.

01 EXECUTIVE SUMMARY

PROJECT OVERVIEW

Climate Ready Boston is the City of Boston's ongoing initiative to adapt to climate change. Working with partners at all levels of government and in the private sector, we can protect Boston as severe weather and sea level rise create more challenges. There is much more to be done. That's why Boston is getting started now.

This report recommends ways to protect East Boston and Charlestown. In the near term, smaller-scale projects, including installing a deployable flood wall in the East Boston Greenway and elevating a section of Main Street in Charlestown, can block likely pathways for current flood risks. Those two actions would cost less than $4 million and protect more than 4,500 residents, at least 130 businesses, and some critical infrastructure such as transportation tunnels.

More extensive measures combining green and gray infrastructure and new open space can be built and expanded over time to address risks from 1% annual chance floods with over 36 inches of sea level rise (by the 2070s). These measures include waterfront open spaces with strategic elevated areas at the Greenway entrance, Piers Park II, and Border Street in East Boston, and at Schrafft's Center in Charlestown. Achieving these measures will require both direct public investments and private action guided by regulatory tools such as modified zoning and municipal harbor plans. Together the measures will provide flood protection, waterfront access, recreation, and mobility. Even at the level of the 1% annual chance flood with nine inches of sea level rise (2030s), they would protect over 11,100 residents, at least 310 businesses, drainage and combined sewer systems, critical highway and transit infrastructure, first responder facilities, healthcare facilities, and redevelopment areas.

Estimated Costs and Benefits of Near and Long-Term Actions

**Benefit calculations are over the lifetime of the asset and calculated individually. Early implementations may have values that skew higher as new projects come on line.*
More details on p.53 of the Full Report.

PROJECTED IMPLEMENTATION TIMELINE	STUDY AREA	COST	NET PROJECT BENEFIT	BENEFIT - COST RATIO
PRIORITY	EAST BOSTON GREENWAY FLOOD WALL	$100,000	$17 MILLION	170
	CHARLESTOWN MAIN STREET ELEVATION	$2-3 MILLION	$0.3 - 1.3 MILLION	1.1 - 1.7
NEAR AND LONG-TERM	EAST BOSTON	$121 - 200 MILLION	$443 - 522 MILLION	3.2 - 5.3
	CHARLESTOWN	$33 - 62 MILLION	$201 - 229 MILLION	4.3 - 7.9
TOTAL		**$154 - 262 MILLION**	**$644 - 751 MILLION**	**3.5 - 5.9**

PLANNING CONTEXT

Climate Ready Boston is implementing the *Greenovate Boston 2014 Climate Action Plan Update* strategy of integrating climate preparedness into all aspects of city planning, review, and regulation. *Imagine Boston 2030*, the first city-wide comprehensive plan in 50 years, has as one of its overarching goals to "promote a healthy environment and adapt to climate change." Climate preparedness is also a leading component in GoBoston 2030 and Resilient Boston.

The *Climate Ready Boston* report, released in 2016, updated climate projections, assessed Boston's vulnerabilities to climate change, and developed city-wide strategies and initiatives for reducing vulnerability to sea-level rise and coastal flooding, more extreme heat, and more intense precipitation. The report identified East Boston and Charlestown as two of the most vulnerable neighborhoods to sea level rise (SLR) and coastal flooding.

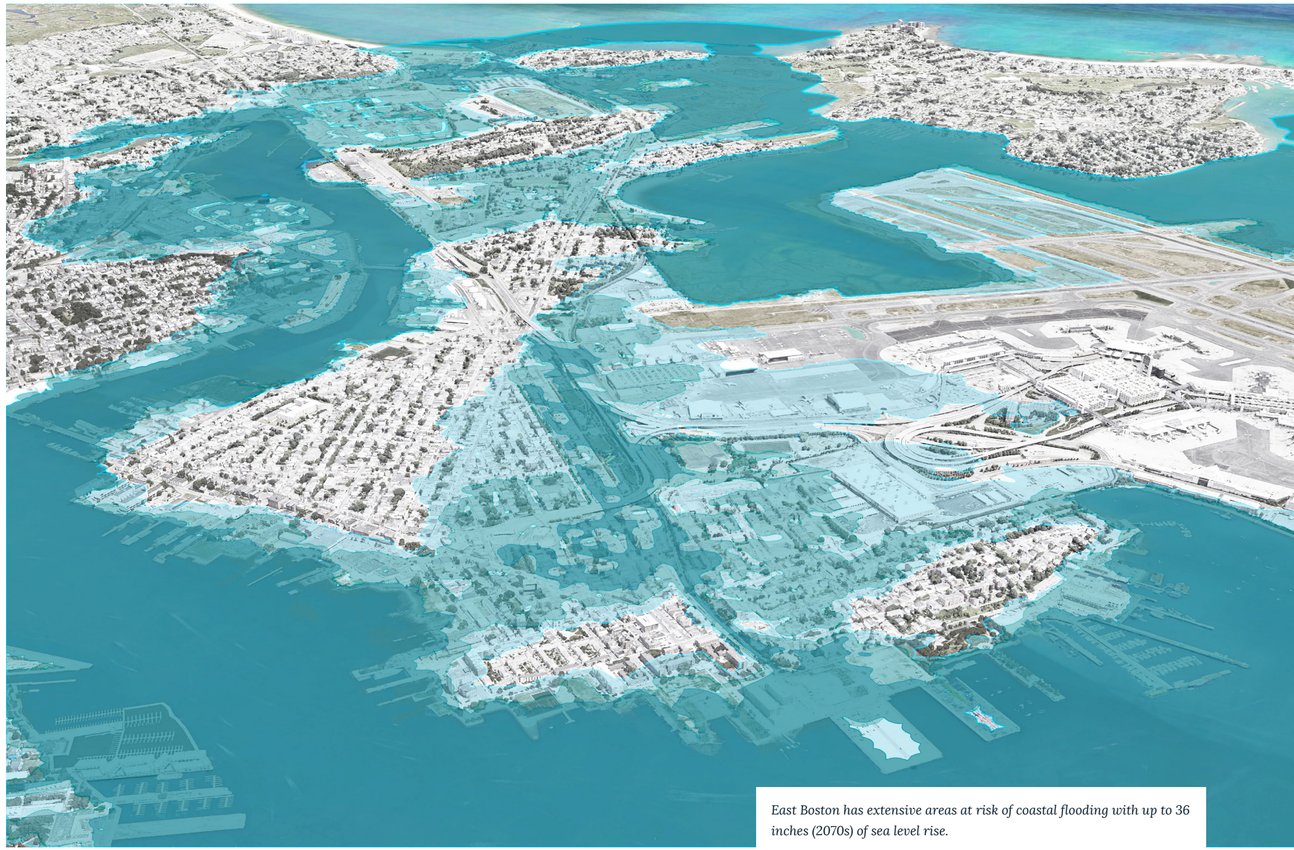
Coastal Resilience Solutions for East Boston and Charlestown is a direct response to recommendations in the report that the City "prioritize and study the feasibility of district-scale flood protection" (Initiative 5.3), and "develop local climate resilience plans in vulnerable areas to support district-scale climate adaptation" (Initiative 4.1).

STUDY AREAS

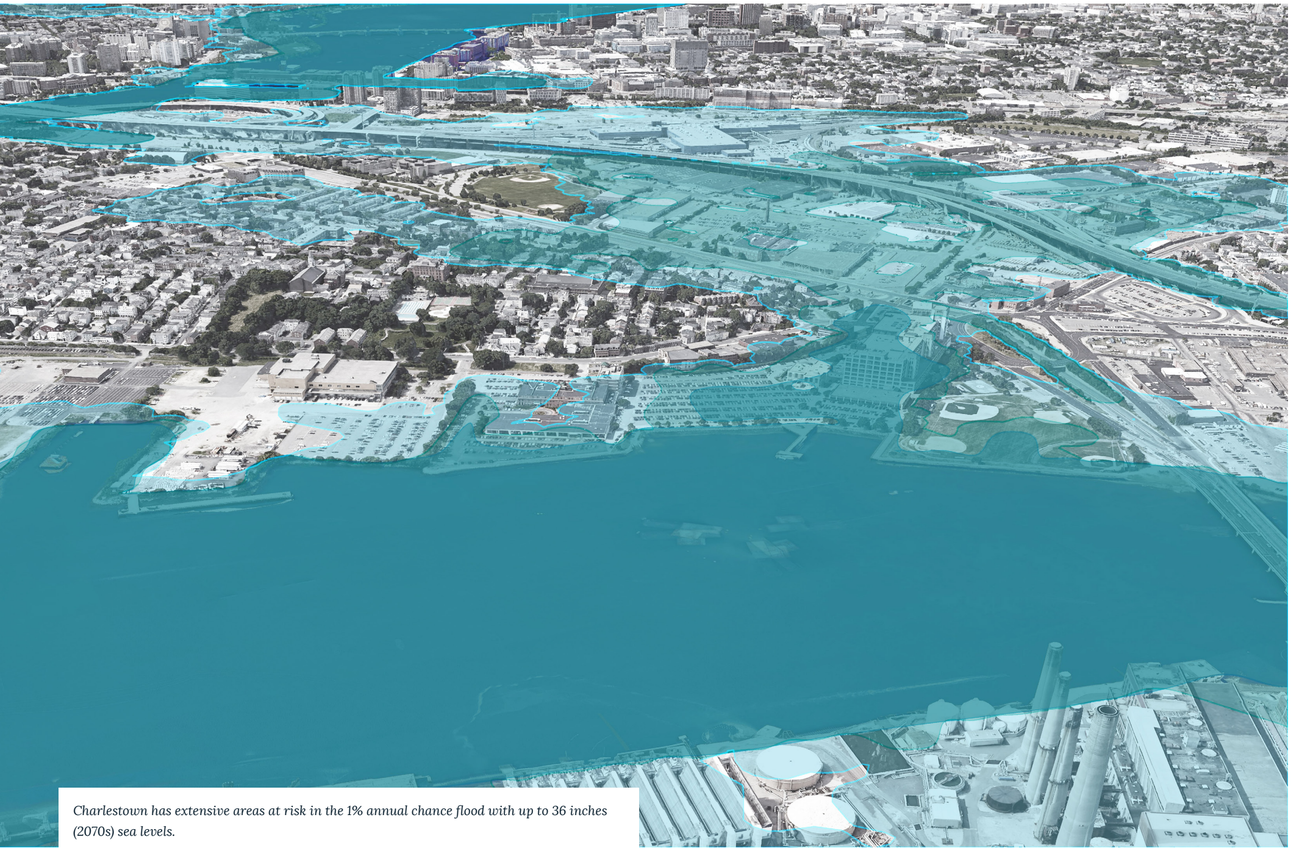
This project focused on two vulnerable areas:

- East Boston's Jeffries Point, Maverick, Central Square, and Lower Eagle Hill; and
- Charlestown's Sullivan Square, the Neck, and Rutherford Avenue, plus areas of Somerville and Cambridge.

The City of Boston is addressing these study areas first, because they are currently at risk from the 1% annual chance coastal flooding, have high concentrations of vulnerable residents and critical infrastructure, and have relatively narrow and well-defined flood pathways. Future Climate Ready Boston initiatives will cover other vulnerable areas.



East Boston has extensive areas at risk of coastal flooding with up to 36 inches (2070s) of sea level rise.



Charlestown has extensive areas at risk in the 1% annual chance flood with up to 36 inches (2070s) sea levels.

COASTAL FLOODING RISKS

Climate Ready Boston projections indicate that Boston's sea level could rise (from 2000 levels) by at least nine inches by 2030, 21 inches by as soon as 2050, and 36 inches by as soon as 2070. Nine inches may seem small, but it will make the current 1% annual chance flood in the East Boston and Charlestown study areas four to five times more likely than it is today. With 36 inches of sea level rise, floods that are now "1% annual chance" may occur monthly at the highest tides.

Both study areas are at risk of flooding through low-lying pathways that originate at the waterfront. Flood pathways in East Boston and Charlestown were identified using the Boston Harbor Flood Risk Model developed by the Massachusetts Department of Transportation (the basis of the *Climate Ready Boston* analysis), and then analyzed at a higher resolution down to the property and street level.

While the depth and extent of flooding increase over time, the flood pathways remain relatively narrow and well-defined. This means that targeted solutions at these locations can prevent coastal flooding in large portions of the study areas.

SEA LEVEL RISE SCENARIOS

Climate Ready Boston selected three sea level rise scenarios (9 inches, 21 inches, and 36 inches) that are likely to occur within the century. The actual sea level rise Boston experiences will be driven by many factors, including global carbon emissions.

Climate models show that sea level rise in the near and intermediate term is largely locked in due to carbon emissions that have already occurred. At least nine inches of sea level rise are likely, even if there is a major reduction in emissions.

PERCENT ANNUAL CHANCE

A "1 percent annual chance flood" has a 1 in 100 chance of being equaled or exceeded in any given year and is the primary coastal flood hazard delineated in FEMA flood maps. Though the chance of occurrence each year may seem relatively low, a 1 percent annual chance event could occur multiple times in a given year, decade, or century. These events have close to a one in three chance of occurring at least once during a 30-year period.

Climate Ready Boston uses a 1 percent annual chance flood nomenclature rather than the "100-year" flood, in order to limit confusion related to the possible time horizon of an event occurring. The "100-year flood event" terminology is sometimes misinterpreted to imply that 100-year events will occur only once every 100 years, which is incorrect.

A "0.1 percent annual chance flood" has a 1 in 1,000 chance of occurring in any given year. It is also referred to as the "1,000-year flood." It is 10 time less likely to occur than a 1 percent annual chance flood.

COASTAL RESILIENCE SOLUTIONS

More than 400 East Boston and Charlestown residents participated in meetings, open houses, and surveys where they shared their priorities on coastal resilience solutions. In addition to the base goal of protecting their safety, property, and livelihoods from coastal flooding, many shared a strong desire for improvements in mobility, affordability, open space, and waterfront access.

Multiple priorities can be addressed by integrating coastal resilience solutions with new and existing waterfront open spaces. The measures proposed in this report include elevated waterfront parks, enhanced Harborwalks, improved connections to the waterfront, natural wetland buffers, increased tree canopy to combat higher temperatures, and site amenities such as hardscaped seating stairs and furnishings that serve both social and flood protection functions. They also reserve space for compatible, resilient, mixed-use redevelopment with smaller footprints and greater building heights and density that can help activate and finance the waterfront transformation.

Integrated solutions can provide multiple layers of protection from sea level rise and coastal floods, in concert with broader climate resilience measures such as stormwater management, urban heat island mitigation, adapted buildings and infrastructure, and community preparedness. They also have the potential to enhance the public realm, social equity, economic opportunity, waterfront access, and natural resources.

Residents placed particular importance on ensuring that solutions are effective over the long term. The flood protection measures proposed are designed to be effective for 50 years or longer. They would be high enough to protect up to the 1% annual chance flood level with 36 inches of sea level rise (2070s), plus 1 foot of freeboard. If sea levels rise by more than 36 inches, these measures could be elevated at least two feet higher by adding fill, integrating structural furniture that adds height and social capacity, or installing deployable flood walls. With this built-in adaptability, their effectiveness could be extended by an additional 20 years or more.

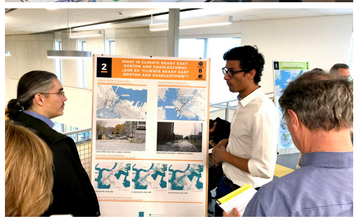
NEAR-TERM ACTIONS AND LONG-TERM ACTIONS

The near-term actions in this study address the main pathways for flooding with nine inches of sea level rise (2030s). The long-term actions are in locations that address the expansion of flood pathways and waterfront flood risks that develop as sea levels reach 21 inches (2050s). The measures are high enough to provide effective flood protection in these pathways from the 1% annual chance flood with 36 inches of sea level rise (2070s), but that amount of sea level rise will create additional flood pathways (e.g., Wood Island Bay in East Boston and the New Charles River Dam in Charlestown) that will affect the study areas.

IMPLEMENTATION ROADMAPS

Roadmaps were developed to guide the implementation of near-term actions in the East Boston and Charlestown study areas between now and 2030, and long-term actions through 2050 and beyond. They include high level phasing plans, cost estimates, and benefit-cost analyses. Near-term actions are described in more detail, with recommendations on design, policies, partnerships, and funding. The roadmaps also take into account foreseeable cycles of development and redevelopment and the time necessary for completing different actions.

Costs are based on construction estimates per acre for typical waterfront parks, berms, and shoreline protection features with the height necessary to achieve a desired flood protection level. The benefits of fully implementing the identified coastal resilience solutions extend well beyond flood protection to include social, ecological, and economic factors, although many of these benefits cannot be easily quantified. The directly quantifiable benefits of flood protection, or "avoided loss," are calculated using the *Climate Ready Boston* framework and data. Losses include damages to buildings and their contents, displacement costs, impacts to productivity, and mental stress. Both costs and phasing plans are estimates and recommendations only, and should not be used for detailed planning.



East Boston residents attended two public open houses where the project team shared ideas and received feedback on their preferences and concerns.

EAST BOSTON

COASTAL FLOODING RISKS

The East Boston study area includes much of Jeffries Point, Maverick, Central Square, and Lower Eagle Hill. The two most critical flood pathways to the study area originate at the Marginal Street and Border Street waterfronts.

In the current 1% annual chance flood, water would cross the Marginal Street waterfront, flow into the entrance of the East Boston Greenway, fill the Greenway, and then spread across a large low-lying area between the Greenway, Meridian Street, and Bennington Street.

Under current sea levels, flooding along Border Street would remain localized at the waterfront. With 9 inches of sea level rise (2030s), the 1% annual chance flood would cross the waterfront at low-lying industrial and commercial sites on Border Street and then spread across the same area affected by flooding from the Greenway.

Other flood pathways to the study area could develop in the 1% annual chance flood with greater sea level rise, through:

- Roadways east of the Greenway (21 inches, 2050s),
- Porzio Park and Massport Harborwalk Park (21 inches, 2050s), and
- Wood Island Bay (36 inches, 2070s).

The table below highlights the 1% annual chance flood depths at the East Boston Greenway entrance with current, plus nine inches (2030s), and plus 36 inches (2070s) of sea level rise. It shows that flood depths at the Greenway entrance would be about 1.1 feet deep if a 1% annual chance flood hit Boston today. Flood depths would increase to 2.5 feet by the 2030s, and 4.9 feet by the 2070s.

'WHAT CONCERNS YOU MOST?'
Residents attending the first of two East Boston Open House events said;

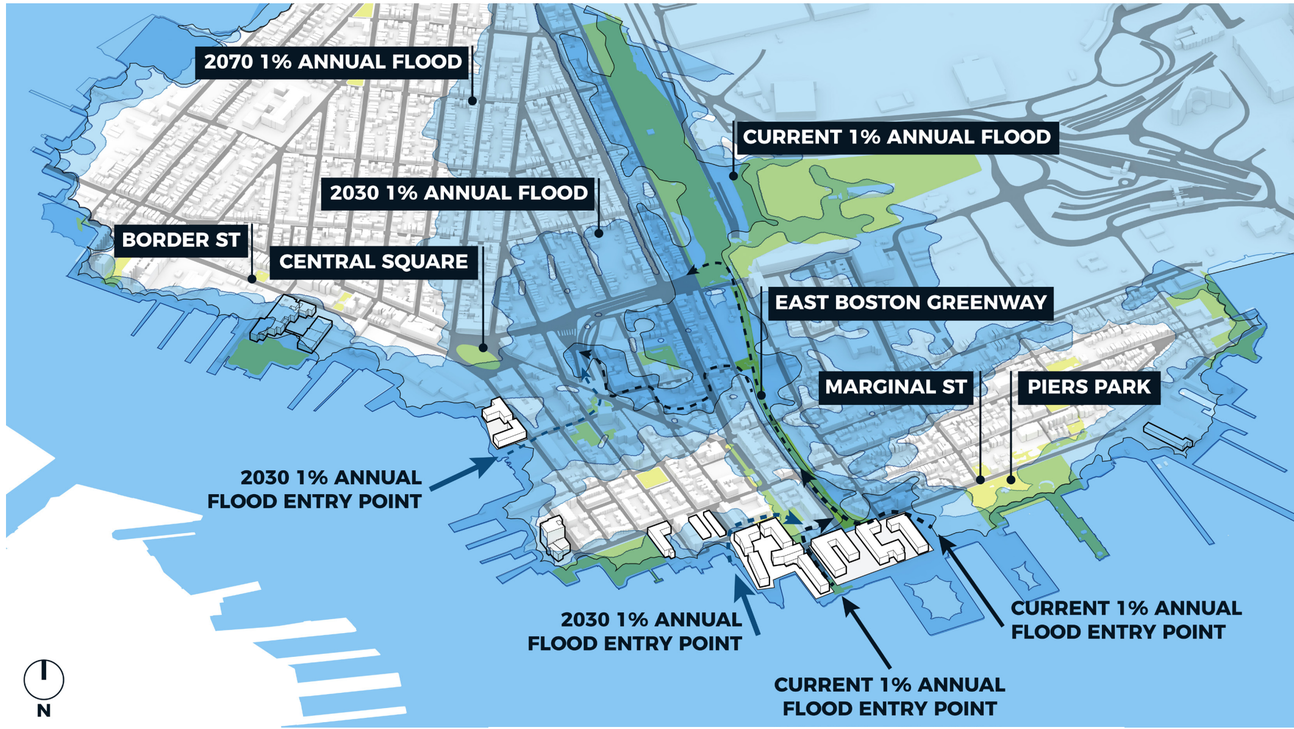
"Access to waterfront + smart development to mitigate flooding."

"That this study and all of the others that support it result in action now. Mistakes are inevitable, but progress has to start so we can build on it."

"Infrastructure underinvestment."

"Flooding and access to tunnels and bridges leading out of East Boston."

"Heat, flooding, clean air + water!"



The gradations of blue in the map show how the 1% annual chance flood extent changes as sea levels rise. The colors do not indicate depth of flooding. The arrows show the flood entry points and pathways with current sea levels, 9 inches of sea level rise (2030s) and 36 inches of sea level rise (2070s).

Annual Chance Flood Depths At The Greenway Entrance

Data source: Boston Harbor Flood Risk Model.

FEMA uses the 1% annual chance as a standard to assess flood risks and solutions. This table highlights how the 1% annual chance flood depth will increase with 9 inches and 36 inches of SLR.

		FLOOD DEPTH (FEET ABOVE EXISTING GROUND)		
ANNUAL CHANCE (%)	ANNUAL ODDS	CURRENT (2000S)	+9 INCHES SLR (2030S)	+36 INCHES SLR (2070S)
0.1	1 in 1,000	1.8	2.8	6.1
0.2	1 in 500	1.7	2.7	6.0
0.5	1 in 200	1.3	2.6	5.5
1	1 in 100	1.1	2.5	4.9
2	1 in 50	0.7	2.1	4.5
5	1 in 20	0.2	1.4	4.2
10	1 in 10	dry	1.0	3.7
20	1 in 5	dry	0.3	3.1
25	1 in 4	dry	dry	2.9
30	1 in 3	dry	dry	2.7
50	1 in 2	dry	dry	2.2
100	1 in 1	dry	dry	1.7

IMPLEMENTATION ROADMAP

The near-term actions in East Boston's implementation roadmap address the Marginal Street and Border Street pathways for flooding with nine inches of sea level rise (2030s). The long-term actions address the expansion of flood pathways and waterfront flood risks with 21 inches of sea level rise (2050s). Measures are designed to be high enough to provide effective flood protection from the 1% annual chance flood with 36 inches of sea level rise (2070s). However, with 36 inches of sea level rise (2070s), additional flood pathways (e.g., Wood Island Bay) will develop that need to be addressed in future planning and design work.

NEAR-TERM ACTIONS

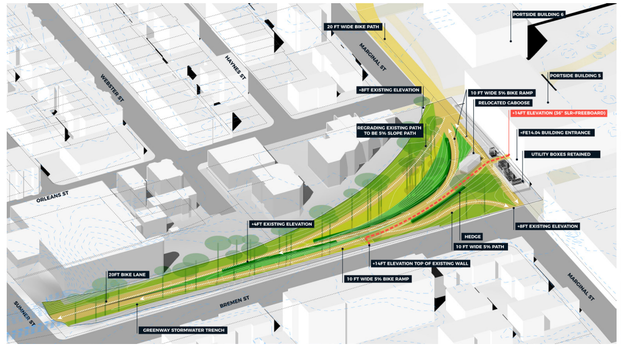
In East Boston, implementation begins with the Marginal Street flood pathway, which is at risk of flooding today, with measures that include a deployable flood wall in the East Boston Greenway, new elevated open spaces at the Greenway entrance and Piers Park II, and adaptations to ongoing development projects.

Greenway Floodwall: Installation of a seven-foot high deployable flood wall across the Greenway under Sumner Street would block the current 1% annual chance flood, with one foot of freeboard. The project would provide immediate protection to almost 4,300 residents, at least 70 businesses, and critical infrastructure for an estimated cost for design and construction of $100,000. Implementation includes an operational plan for deploying the flood wall in advance of a flood. The East Boston Greenway is owned by the City of Boston and maintained by the Parks and Recreation Department.

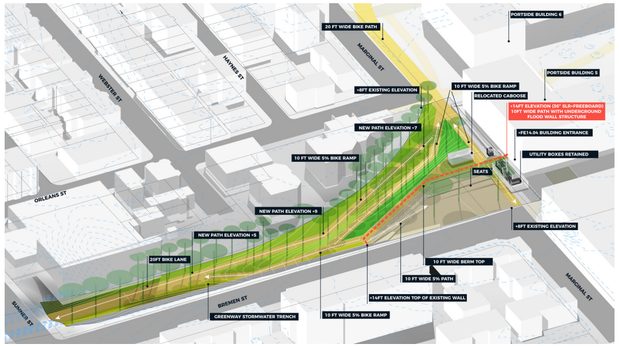
Greenway Entrance and Piers Park II: Elevating the Greenway entrance (owned by the City) and Piers Park II (owned by Massport) would provide long-term protection against the Marginal Street flood pathway. Community stakeholders at the East Boston Open House were supportive of incorporating waterfront views, stormwater gardens, social spaces, and wayfinding information in the redesigned Greenway entrance. All available techniques for prevention of flooding should be considered in the design of Piers Park II.

Deployable flood walls, such as the type shown in these renderings of the Greenway under Sumner Street, are installed only when a flood is anticipated. They are otherwise kept in storage.

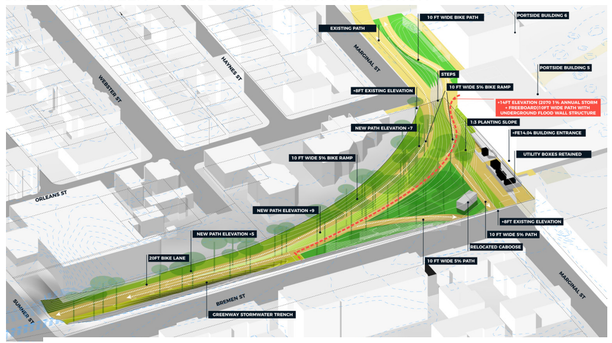
GREENWAY 'GREEN'



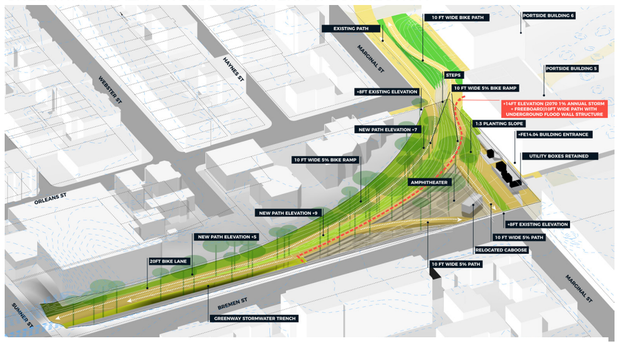
GREENWAY 'PLAZA'



GREENWAY 'GREEN' - ROSELAND INTERIOR CONNECTION



GREENWAY 'PLAZA' - ROSELAND INTERIOR CONNECTION



Four options for elevating and redesigning the Greenway entrance differ slightly in their form and function. Two options allow for a large lawn or 'green' while the other two offer a large hardscape plaza. The alternatives then differ in the connection they make to the new Roseland development, however all designs are raised to an Elevation of +14 (NAVD88) to protect from future flooding that could occur with 36 inches of sea level rise (2070).

One version of a new elevated entrance to the East Boston Greenway provides flood protection as well as social space and shade while retaining pedestrian and cycling access between the neighborhood and the Greenway.

NEAR-TERM ACTIONS CONTINUED

In the near term, elevating the Greenway entrance and incorporating flood protection in Piers Park II would reinforce and extend the level of protection provided by the Greenway flood wall to 300 additional residents and the fire station in Jeffries Point. Once actions in the Border Street Priority Area, described below, are implemented, an additional 6,200 residents and 180 businesses would be protected up to the 1% annual chance flood with nine inches of sea level rise (2030s), plus 1 foot of freeboard.

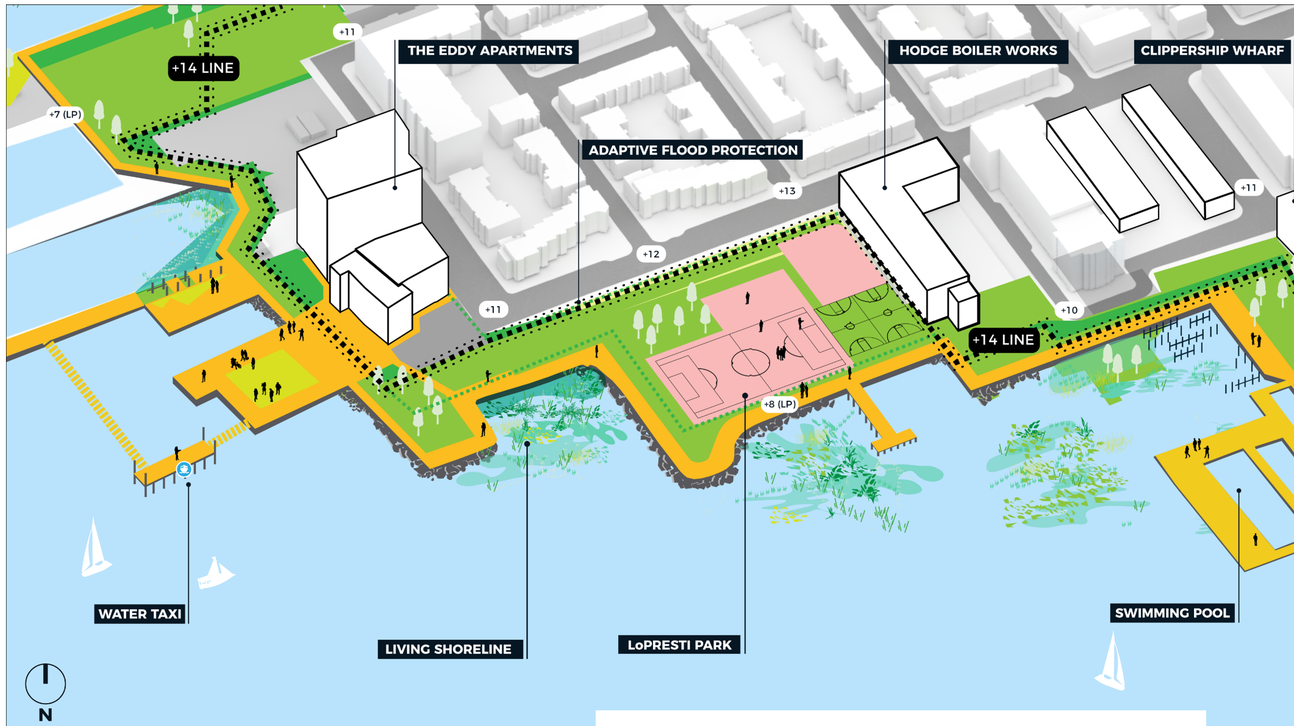
The estimated cost for design and construction of the Greenway entrance is $3.1-5.3 million. This range accounts for unknown characteristics of the site (e.g., soil quality) and final design (e.g., utilities and landscaping).

Clippership-Hodge Berm: Elevating the Harborwalk between Clippership Wharf, Clipper Ship Apartments, and 99 Sumner Street (Hodge Boiler Works), in combination with a deployable flood wall across Lewis Street, would protect residents in these buildings and nearby affordable housing, and the MBTA Maverick Station entrance from flooding damage and disruption. The estimated cost for design and construction is $500,000 to $900,000 for the berm and less than $150,000 for the deployable flood wall.

Border Street Priority Area:: To address the Border Street flood pathway, which is at risk of flooding with 9 inches of sea level rise (2030s), upfront planning and regulatory measures-including potential changes to designated port areas, the municipal harbor plan, and zoning--may be needed to ensure the integration of public investment and future private waterfront redevelopment into a unified coastal resilience solution.

With these planning and regulatory measures in place, a system of elevated parks, Harborwalks, docks, and nature-based features on the Border Street waterfront could then provide coastal flood protection with sea level rise while addressing community objectives for open space, mobility, and waterfront access. Top priority sites in this area are between Mario Umana Academy and Wigglesworth where the flood pathway would form in the 1% annual chance flood with 9 inches of sea level rise (2030s).

East Boston residents chose their own tools for protecting Border Street at the second East Boston Open House. Using 'money' provided, residents purchased open space, walls, berms and new development as methods to prevent flooding and build social and ecological value on the waterfront.



The stretch of proposed Harborwalk between Clippership Wharf and 99 Summer St. (Hodge Boiler Works) could be elevated to + 14 (NAVD88) as part of planned and ongoing construction. The numbers shown in white ovals indicate the approximate existing ground elevation in feet NAVD88.

Estimated Costs and Benefits of Near-Term Actions in East Boston

ESTIMATED COST	$48-80 million
NET PROJECT BENEFIT	$29-69 million
BENEFIT-COST RATIO	1.4 - 2.7

Measures could include an elevated open space at the Boston East DPA site and a waterfront park at Central Square with elevated Harborwalks extending in both directions. Raised roadways or a system of permanent flood walls would be effective alternatives, but would only serve flood protection purposes.

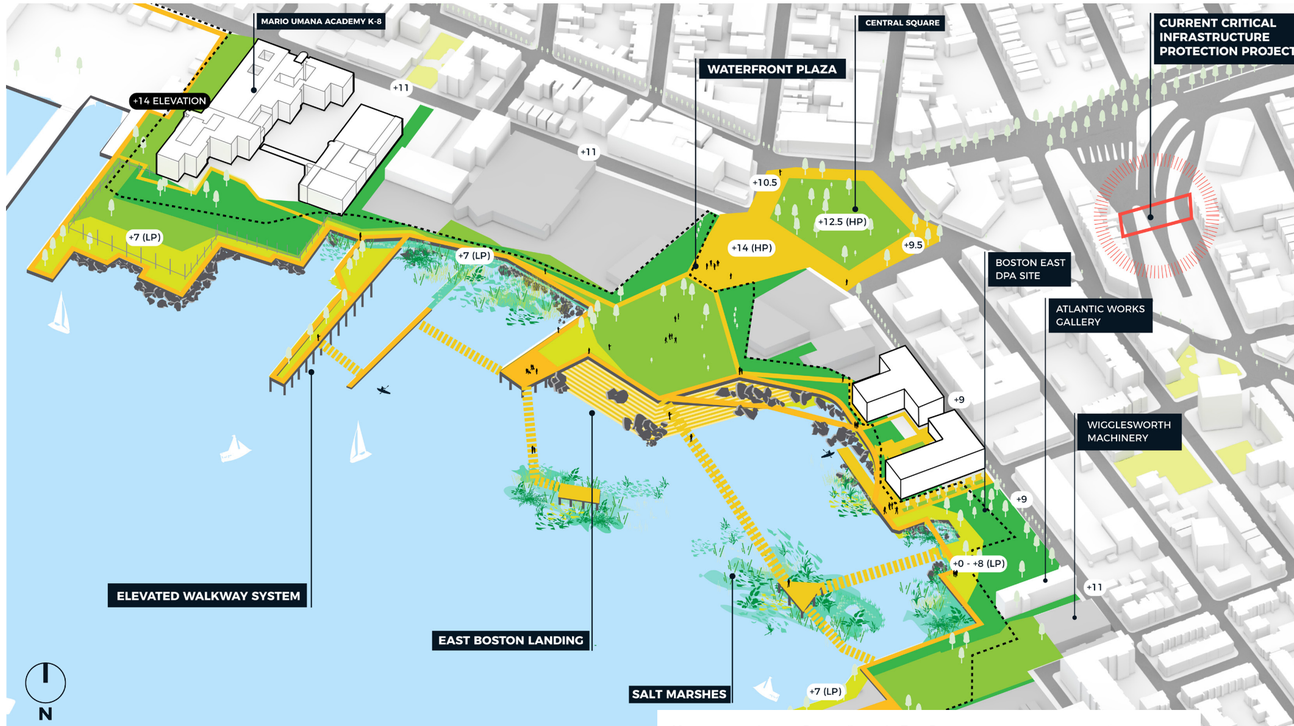
The estimated cost of designing and constructing priority flood protection projects on Border Street by 2030 is $24-39 million. These projects could be implemented by a single public owner, or by a combination of public and private entities.

Successful implementation will require that performance standards be embedded in formal planning documents, in particular, the Municipal Harbor Plan and the zoning code. Pairing these and potential changes to development controls with value capture and district improvement financing strategies may create opportunities to share implementation costs with the private sector. By furthering *Climate Ready Boston* Action 5.1, to "establish Flood Protection Overlay Districts and require potential integration with flood protection systems," and Action 9.5, to "incorporate future climate conditions into area plans," these efforts will provide an important testing ground for approaches that could be applied elsewhere in Boston.

Implementing all near-term actions would protect over 10,800 residents, at least 250 businesses, and critical infrastructure, such as transportation tunnels, first responder facilities, and the East Boston Neighborhood Health Center, up to the 1% annual chance flood with 9 inches of sea level rise (2030s), plus 1 foot of freeboard. At this level of protection, from a single event these measures would prevent an estimated $620 million in losses.

The reach of these flood protection measures would initially be limited to the flood pathways in the 1% annual chance flood with nine inches of sea level rise (2030s), plus one foot of freeboard. With additional flood protection measures in other parts of the neighborhood, their height would be sufficient to protect up to the 1% annual chance flood with 36 inches of sea level rise (2070s), plus one foot of freeboard.

Residual risks from localized flooding at properties on the waterfront, such as Mario Umana Academy, various maritime industrial facilities, and residences near Porzio Park, would remain until the long-term actions are implemented.



Near-term actions on Border Street in East Boston would create a coastal flood protection system, integrated in a new network of open spaces, which could be extended over time as sea levels rise. The numbers shown in white ovals indicate the approximate existing ground elevation in feet NAVD88. The dotted black line indicates the +14ft (NAVD88) elevation.

Estimated Costs and Benefits of Long-Term Actions in East Boston

ESTIMATED COST	$121-200 million
NET PROJECT BENEFIT	$443-522 million
BENEFIT-COST RATIO	3.2 - 5.3

LONG-TERM ACTIONS

The next tier of measures would expand the reach of coastal resilience solutions along the study area waterfront to independently address risks from the 1% annual chance flood with 21 inches of sea level rise (2050s), plus 1 foot of freeboard. With additional flood protection measures in other parts of the neighborhood, their heights would protect up to the 1% annual chance flood with 36 inches of sea level rise (2070s), plus one foot of freeboard.

Elevated parks and pathways at Mario Umana and Shore Plaza would protect critical facilities and vulnerable affordable housing residents. Porzio Park and Massport Harborwalk Park would be elevated to address the flood pathway that could develop through this area with 21 inches of SLR (2050s). As existing parks and buildings reach the age where renewal investments are needed, they would incorporate waterfront flood protection measures that tie into the broader system.

Full implementation of near and long-term measures would protect over 13,200 residents, at least 310 businesses, and many critical facilities up to the 1% annual chance flood with 21 inches of sea level rise (2050s), plus one foot of freeboard. At this level of protection, from a single event these measures would prevent an estimated $1.3 billion in losses.

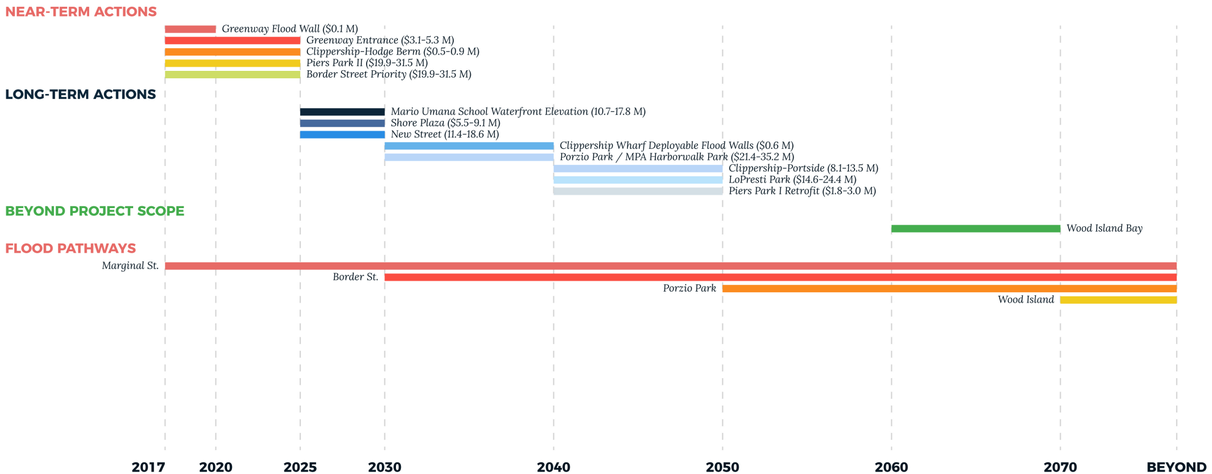
As sea level rise continues, additional measures will be needed to address the potential flood pathway through Wood Island Bay (36 inches, 2070s) that will also affect this area. In addition, earlier measures can be re-evaluated to determine whether and how they should be adapted to provide protection for sea level rise beyond 36 inches. Their original designs should accommodate at least two feet of additional flood protection height to extend their effective life by 20 years or more.

Near and long-term coastal resilience solutions in the East Boston study area.

Estimated costs for coastal resilience solutions in the East Boston study area.

RECOMMENDED TIMELINE: EAST BOSTON

Recommended phasing plan for coastal resilience solutions in the East Boston study area.
Costs and phasing are high level estimates and recommendations only and should not be used for detailed planning.



CHARLESTOWN

COASTAL FLOODING RISKS

The Charlestown study area includes much of Sullivan Square, the Neck, Rutherford Avenue, and areas of Somerville and Cambridge. The most critical flood pathway in the Charlestown study area leads from the Sullivan Square waterfront on the Lower Mystic River.

In the current 1% annual chance flood, water would first cross the waterfront at Schrafft's Center and Ryan Playground, fill the Schrafft's Center parking lot, and then flow onto Main Street. Flooding would remain localized around Main Street and Mishawum Street.

With nine inches of sea level rise (2030s), the 1% annual chance flood would spread to Rutherford Avenue and across various residential, industrial, and commercial areas.

Other flood entry points could develop in the 1% annual chance flood as sea level rise continues:

- The New Charles River Dam could be flanked directly south of the dam (21 inches, 2050s) or overtopped (36 inches, 2070s), sending flood waters north to Sullivan Square through Cambridge, Charlestown, and Somerville.
- Flooding from Ryan Playground and the MBTA's bus maintenance facility could flow over Alford Street and into the underpass (36 inches, 2070s).

The table below highlights the 1% annual chance flood depths at the Schrafft's Center parking lot with current, plus nine inches (2030s), and plus 36 inches (2070s) of sea level rise. It shows that flood depths at the parking lot would be about 0.7 feet deep if a 1% annual chance flood hit Boston today. Flood depths would increase to 2.0 feet by the 2030s, and 4.4 feet by the 2070s.

'WHAT CONCERNS YOU MOST?'
Residents attending the Charlestown Open House event said;

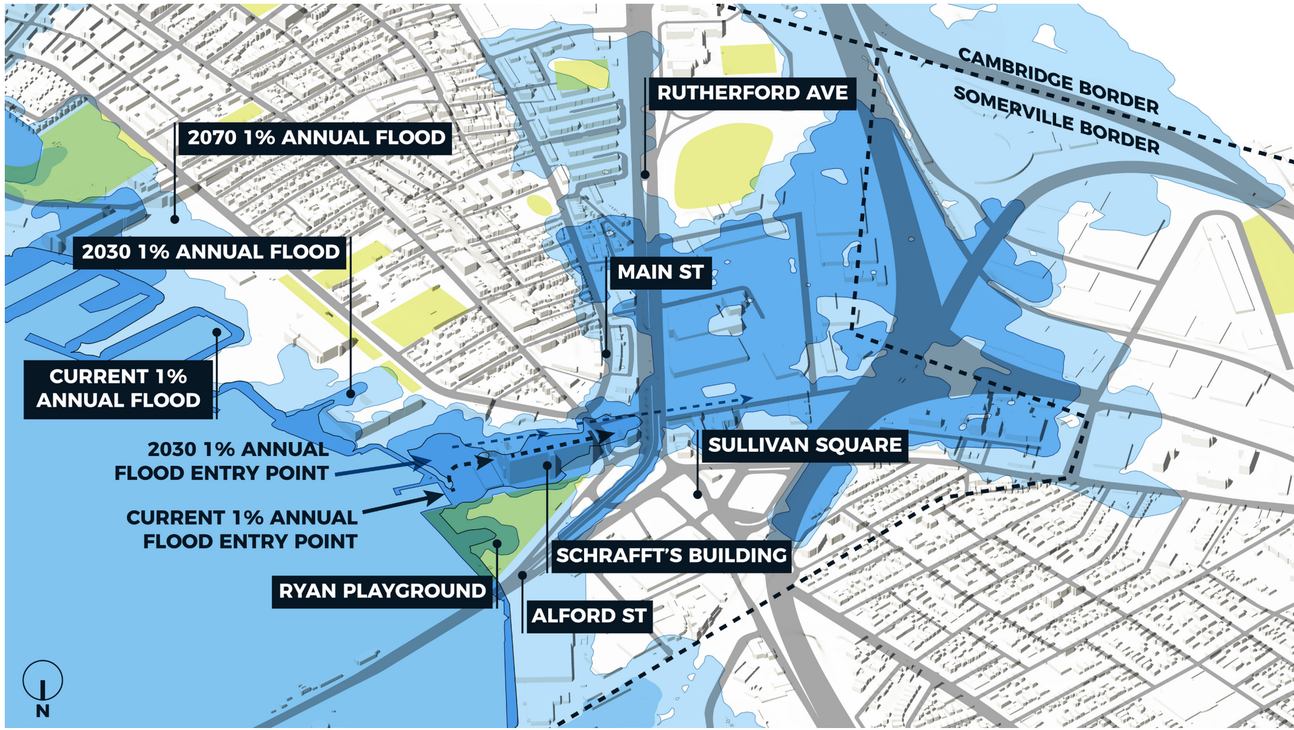
"Extreme heat waves and flooding."

"Flooding of roadways."

"Better connectivity from the neighborhood to the waterfront."

"Failing infrastructure, ESPECIALLY public transportation connecting Charlestown to the rest of the city."

"Climate change associated heat."



The gradations of blue in the map show how the 1% annual chance flood extent changes as sea levels rise. The colors do not indicate depth of flooding. The arrows show the flood entry points and pathways with current sea levels, 9 inches of sea level rise (2030s) and 36 inches of sea level rise (2070s).

Annual Chance Flood Depths At The Schrafft's Parking Lot

Data source: Boston Harbor Flood Risk Model.

FEMA uses the 1% annual chance as a standard to assess flood risks and solutions. This table highlights how the 1% annual chance flood depth will increase with 9 inches and 36 inches of SLR.

		FLOOD DEPTH (ABOVE EXISTING GROUND)		
ANNUAL CHANCE (%)	ANNUAL ODDS	CURRENT (2000S)	+9 INCHES SLR (2030S)	+36 INCHES SLR (2070S)
0.1	1 in 1,000	16.5	17.4	20.6
0.2	1 in 500	1.4	2.3	5.5
0.5	1 in 200	1.0	2.1	5.0
1	1 in 100	0.7	2.0	4.4
2	1 in 50	0.3	1.7	4.0
5	1 in 20	dry	1.0	3.7
10	1 in 10	dry	0.5	3.2
20	1 in 5	dry	0.1	2.5
25	1 in 4	dry	dry	2.3
30	1 in 3	dry	dry	2.1
50	1 in 2	dry	dry	1.7
100	1 in 1	dry	dry	1.2

IMPLEMENTATION ROADMAP

The near-term actions in Charlestown's implementation roadmap address the Sullivan Square flood pathway for flooding with nine inches of sea level rise (2030s). The long-term actions address the Ryan Playground flood pathway, which may form with 36 inches of sea level rise (2070s). Measures are designed high enough to provide effective flood protection from the 1% annual chance flood with 36 inches of sea level rise (2070s). However, with 21 inches (2050s) or more of sea level rise, additional flood pathways (i.e., New Charles River Dam) will develop that need to be addressed in future planning and design work.

NEAR-TERM ACTIONS

In Charlestown, the implementation roadmap is less complex, because the one critical flood pathway can be addressed by a small number of near-term actions and owners. Proposed near-term actions integrate coastal resilience solutions in existing City of Boston capital projects and create a new waterfront open space and flood protection system through private redevelopment.

A small section of Main Street, in front of the Schrafft's Center, would be elevated as part of the Rutherford Avenue and Sullivan Square redesign project. This project, led by the Boston Transportation Department in partnership with the Massachusetts Department of Transportation, is currently in design and scheduled to begin construction in 2021.

In addition, low-lying areas of the Ryan Playground waterfront would be elevated as part of the park's next scheduled renovation. Additional long-term actions could further elevate the waterfront to prevent the park from becoming a flood pathway in higher sea level rise conditions. Ryan Playground is owned by the City of Boston and managed by the Parks and Recreation Department.

The more critical and complex action is to create a new system of elevated parks and pathways along the Schrafft's Center waterfront, combined with private redevelopment. In addition to flood protection, it would provide new open space and waterfront access for the Sullivan Square community. The minimum elevation along the crest of these new waterfront open spaces would be high enough to protect up to the 1% annual chance flood with 36 inches of sea level rise (2070s), plus 1 foot of freeboard (14ft NAVD88).

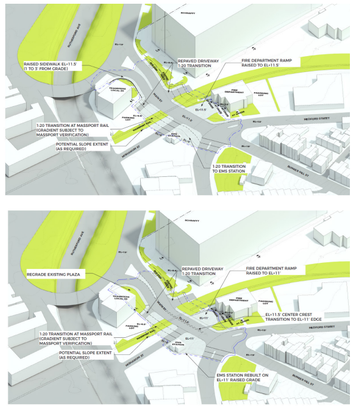
Charlestown residents provide feedback at the Charlestown Open House.

NEAR-TERM ACTIONS CONTINUED

Main Street Elevation: Elevating Main Street by an average of two feet in front of the Schrafft's Center driveway would block the main flood pathway through Charlestown up to a 1% annual chance flood with nine inches of sea level rise (2030s), plus 1 foot of freeboard. Achieving a higher flood protection level would not be feasible unless the existing fire station at the intersection of Medford Street and Main Street were redesigned or relocated.

This would protect over 250 residents, at least 60 businesses, first responder facilities, and the Rutherford Avenue underpass. The estimated cost for design and construction is $2-3 million. The roadway elevation could be integrated in the ongoing Rutherford Avenue and Sullivan Square redesign project, currently in design and scheduled to begin construction in 2021.

Ryan Playground: Ryan Playground's low-lying waterfront playing fields, seating, dugouts, and lighting systems would be vulnerable to damage in the 1% annual chance flood with nine inches of sea level rise (2030s). Raising these low areas to meet the surrounding grade would prevent damages in the near-term and make it easier and less costly to further elevate in the future. Additional long-term measures along the park's waterfront would prevent the park from becoming a flood pathway in a 1% annual chance flood with 36 inches of sea level rise (2070s). The estimated cost for design and construction is $300,000-500,000. This solution could be included as part of the park's next scheduled renovation, likely by 2025.



One option is to raise Main Street so that the centerline meets the target flood protection elevation. Two methods for achieving this are shown. Version 1 (top) employs a uniform raised roadway. Version 2 (bottom) employs a raised crested roadway with additional grading.

Ryan Playground short-term and long-term solutions together with redevelopment of the Schrafft's Center waterfront create a newly revitalized park with elevated pathways, plazas and beaches.

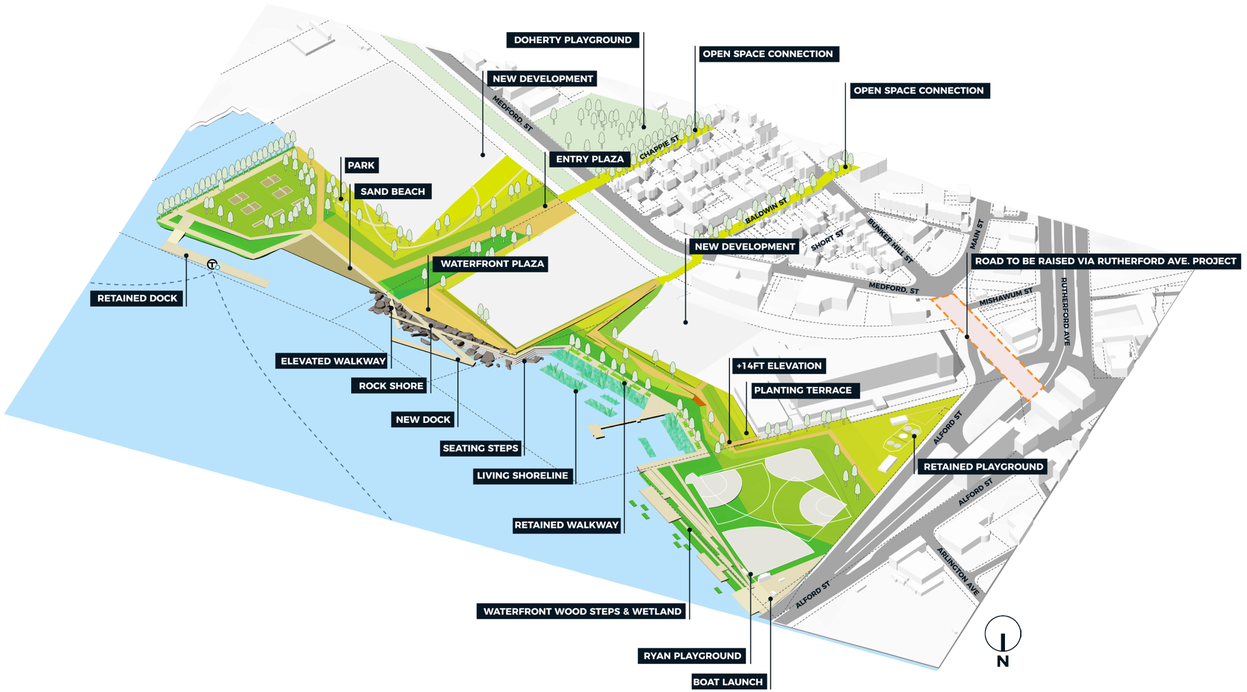
Schrafft's Center Waterfront: Redevelopment of the Schrafft's Center waterfront with elevated parks, nature-based features, and mixed-use buildings could bring value to residents, providing new opportunities for recreation, social activities, mobility, and commerce, while also restoring natural resources in the Harbor.

It would also reinforce and extend flood protection provided by elevating Main Street, protecting about 330 residents, at least 60 businesses, drainage and combined sewer systems, first responder facilities, and critical transportation infrastructure, such as Rutherford Avenue and its underpass, from the 1% annual chance coastal flood with nine inches of sea level rise (2030s), plus one foot of freeboard. At this level of protection, from a single event these measures would prevent an estimated $390 million in losses, including over $100 million from Schrafft's Center itself. The estimated cost for design and construction across the three properties is $28-53 million.

Planning and other regulatory efforts can facilitate implementation of the measures on the Schrafft's Center waterfront. For example, zoning that includes coastal resilience design guidelines and open space requirements would allow a broader mix of acceptable uses. Pairing these changes with value capture and district improvement financing strategies may create opportunities to share implementation costs with the private sector.

In combination with long-term actions at Ryan Playground, the Schrafft's Center waterfront solutions would block flood pathways from the Lower Mystic River in the 1% annual chance flood with 36 inches of sea level rise (2070s), plus one foot of freeboard.

Residents and stakeholders check out the 'augmented reality sandbox' demonstration of flooding in Boston at the Charlestown Open House.



Near and long-term coastal resilience solutions in the Charlestown study area.

Estimated Costs and Benefits of Near and Long-Term Actions in Charlestown

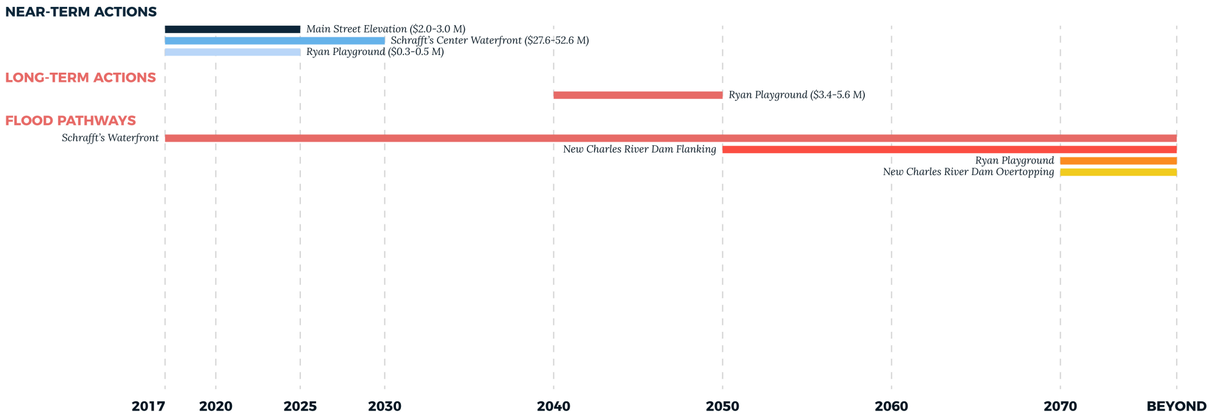
ESTIMATED COST	$33-62 million
NET PROJECT BENEFIT	$201 - 229 million
BENEFIT-COST RATIO	4.3 - 7.9

LONG-TERM ACTIONS

Ryan Playground: The long-term actions for Ryan Playground would raise the park's edge to the 1% annual chance flood level with 36 inches of sea level rise (2070s), plus 1 foot of freeboard. This elevation would be met at the top of a raised pathway with vistas of the Lower Mystic River and integrated seating for viewing the playing fields. In areas where space is constrained by lighting and dugouts, the pathway would transition to a seating bench that doubles as a flood wall. The existing seawall at the water's edge could be redesigned to provide a more naturalized shoreline, such as a terraced retaining wall planted with wetland species. The shallow mud flats could be restored to marsh, expanding the habitat created in the shallow areas of the Schrafft's Center waterfront. The estimated cost for design and construction is $3.7-6.1 million.

Full implementation of near- and long-term measures would protect about 1,000 residents, at least 100 businesses, drainage and combined sewer systems, critical transportation infrastructure, and first responder facilities up to the 1% annual chance flood with 21 inches of sea level rise (2050s), plus one foot of freeboard. At this level of protection, from a single event these measures would prevent an estimated $591 million in losses.

Additional measures would be needed to address the potential flanking (21 inches, 2050s) and overtopping (36 inches, 2070s) of the New Charles River Dam to extend the effectiveness of coastal resilience solutions. In addition, earlier measures can be evaluated to determine whether and how they should be adapted for sea level rise beyond 36 inches. Their original designs should accommodate at least two feet of additional flood protection height to extend their effective life by about 20 years.

RECOMMENDED TIMELINE: CHARLESTOWN

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