

Downtown

The Downtown focus area comprises several neighborhoods that lie in the northern part of Boston, including the West End, the North End, the Financial District, Chinatown, and the Leather District.

The West End lies across the Charles River from Cambridge, between the Longfellow Bridge and the Charlestown Bridge. The North End sits at the northernmost corner of the Boston mainland, surrounded on two sides by the Boston Harbor, across from East Boston. Prior to the 2000s, the North End was cut off from the rest of the mainland by the elevated Central Artery (I-93), placed underground during the “Big Dig.” The Financial District lies between the West End and North End and covers the largest extent of the focus area. Chinatown sits on the southern edge of Downtown, and the Leather District occupies nine blocks east of Chinatown.

Over the last three centuries, the Downtown focus area has been dramatically expanded through fill, as more land was needed to support population and industrial growth. The Downtown focus area was heavily impacted by urban renewal in the 1950s to 1970s, as evidenced by the construction of the Central Artery and clearing of sections of the West End.

Today, the Downtown focus area hosts a broad range of uses, reflecting the diverse neighborhoods that sit within it. The West End is currently in the

process of a development boom that is revitalizing the residential and commercial components of the neighborhood. The neighborhood will look very different over the next ten years. In addition, this area has a strong institutional presence due to Massachusetts General Hospital and affiliated facilities. The North End is a vibrant mixed-use neighborhood, with historic brick apartments intermingled with infill, and main commercial corridors along Hanover and Salem Streets. The Financial District is a commercial center, with a number of high-rise buildings; a retail and recreational hub, with shopping at Downtown Crossing and the Theater District; and Government Center. Chinatown is a densely populated mixed-use district, with Tufts Medical Center located at its southern edge. The Leather District contains residential and commercial tenants attracted to historic brick warehouses that offer “loft” space.

Reflecting its status as a center of commerce, government, and recreation, Downtown is home to extensive transportation infrastructure, a significant part of which is underground. This infrastructure is critical for residents of the entire region to access jobs and essential services. It is anchored by South Station and adjacent to Fort Point Channel and North Station.

Downtown is highly exposed to sea level rise (SLR) impacts due to its extensive low-lying coastline, with multiple paths for inundation, and its exposure to flooding from the Charles River, Boston Harbor, and Fort Point Channel. Downtown is challenging for flood protection because activities on the waterfront are highly related to, and economically dependent on, direct visual and physical access to the waterfront.

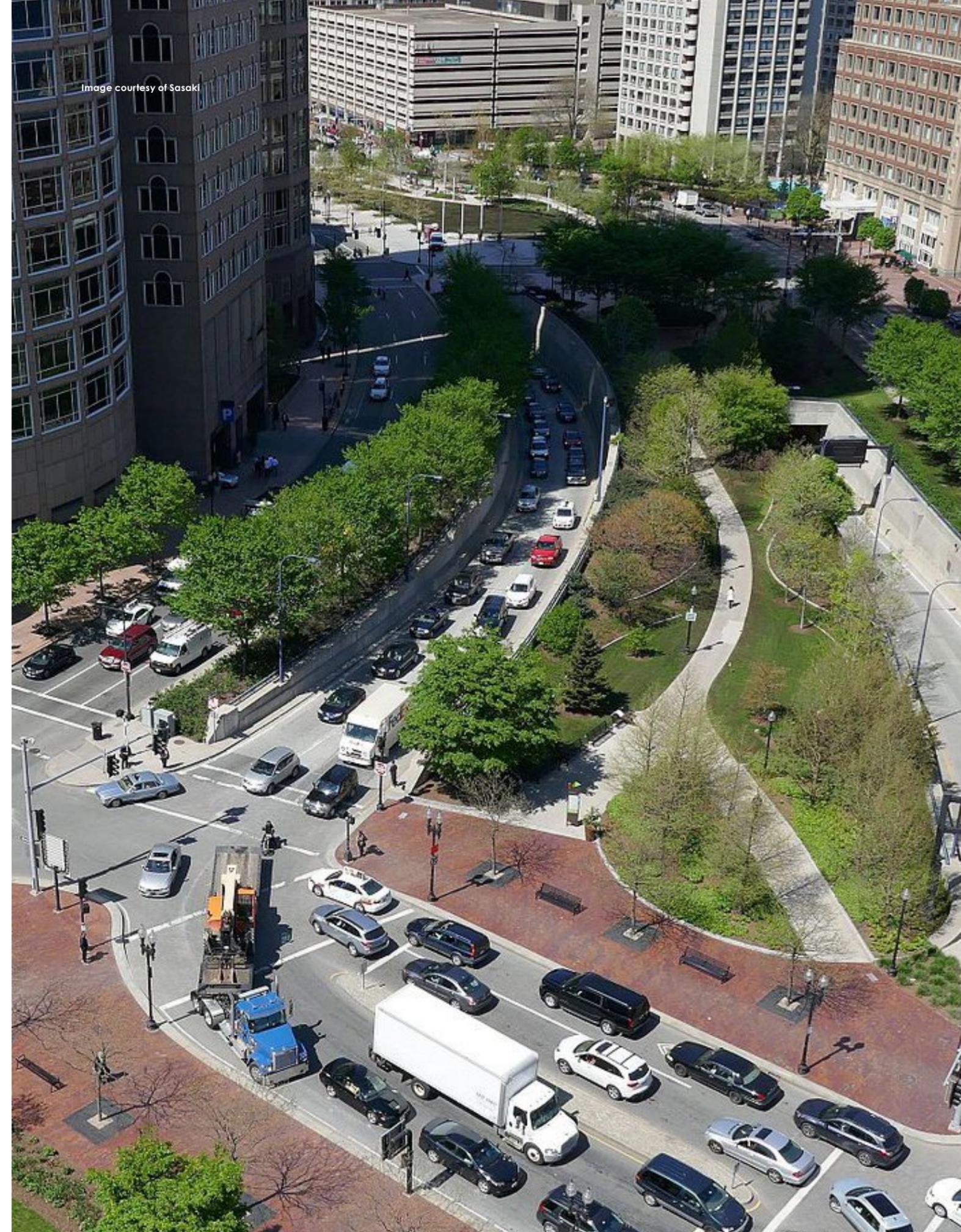


Image courtesy of Sasaki

FLOOD PROGRESSION

DEFINITIONS

Near term: Beginning 2030s, assumes 9 inches of sea level rise

Midterm: Beginning 2050s, assumes 21 inches of sea level rise

Long term: Beginning 2070s or later, assumes 36 inches of sea level rise

Exposure: Can refer to people, buildings, infrastructure, and other resources within areas likely to experience hazard impacts. Does not consider conditions that may prevent or limit impacts.

Vulnerability: Refers to how and why people or assets can be affected by a hazard. Requires site-specific information.

Consequence: Illustrates to what extent people or assets can be expected to be affected by a hazard, as a result of vulnerability and exposure. Consequences can often be communicated in terms of economic losses.

Annualized losses: The sum of the probability-weighted losses for all four flood frequencies analyzed for each sea level rise scenario. Probability-weighted losses are the losses for a single event times the probability of that event occurring in a given year.

*For a full list of definitions, refer to the Glossary in the Appendix.

Downtown is exposed to climate change impacts including heat, increased precipitation and stormwater flooding, sea level rise, and coastal and riverine flooding. Exposure to heat and stormwater flooding are addressed in the Citywide Vulnerability Assessment, while exposure and consequences to coastal and riverine flood risk are further discussed in this section.

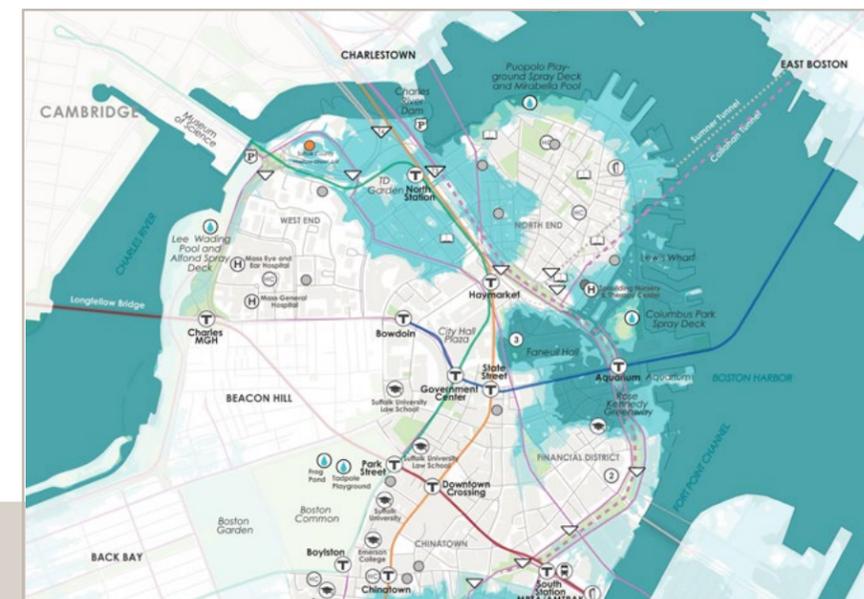
In the near term, low-lying waterfront areas between the Summer Tunnel, which carries traffic across Boston Harbor from Route 1A in East Boston; the Financial District; and areas near the Charles River Dam are most at risk. The lowest-lying areas are near the New England Aquarium and are exposed to high-probability storm events (10 percent annual chance) in the near term.



9 INCHES SEA LEVEL RISE



21 INCHES SEA LEVEL RISE



36 INCHES SEA LEVEL RISE

LEGEND

- Highest Monthly High Tide
- 10% Storm Flooding
- 1% Storm Flooding
- Roads
- Major Roads
- Major Tunnels
- Evacuation Route
- Evacuation Route Tunnels
- MBTA Blue Line
- Parks
- T MBTA Silver Line Station
- T MBTA Station
- U College or University
- V Tunnel Entrance
- S School
- P Police Station
- F Fire Station
- H Hospital
- HC Health Care Facility
- Other Essential Facilities and Shelters
- 1 Nozzaro Community Center
- 2 Ambulance 1
- 3 Station 8
- BHA BHA Public Housing
- SH Senior Housing
- LCCF Longterm Care Facility
- P Prison
- DCR DCR Spray Deck or Pool

Much of the Downtown waterfront will be exposed to coastal flooding by the end of the century. High tides are expected to impact inland areas near Faneuil Hall and the New England Aquarium. In addition, other parts of the waterfront that are out of the 1 percent annual chance floodplain earlier in the century are expected to be at risk by the end of the century.

Though Downtown's total land area at risk from coastal and riverine flooding is small compared to some focus areas, the land areas that are exposed are densely developed, likely leading to significant impacts in terms of structural damage and economic losses.

The topography of the Downtown focus area is shaped both by natural landforms and areas that were filled in the early and mid-1800s. The North End, for example, is largely naturally occurring high ground. On the other hand, the Mill Pond area, at the northern edge of the West End, was filled in the early 1800s, while the fill areas east and south of the North End were separately filled in the early to mid-1800s. These fill areas generally make

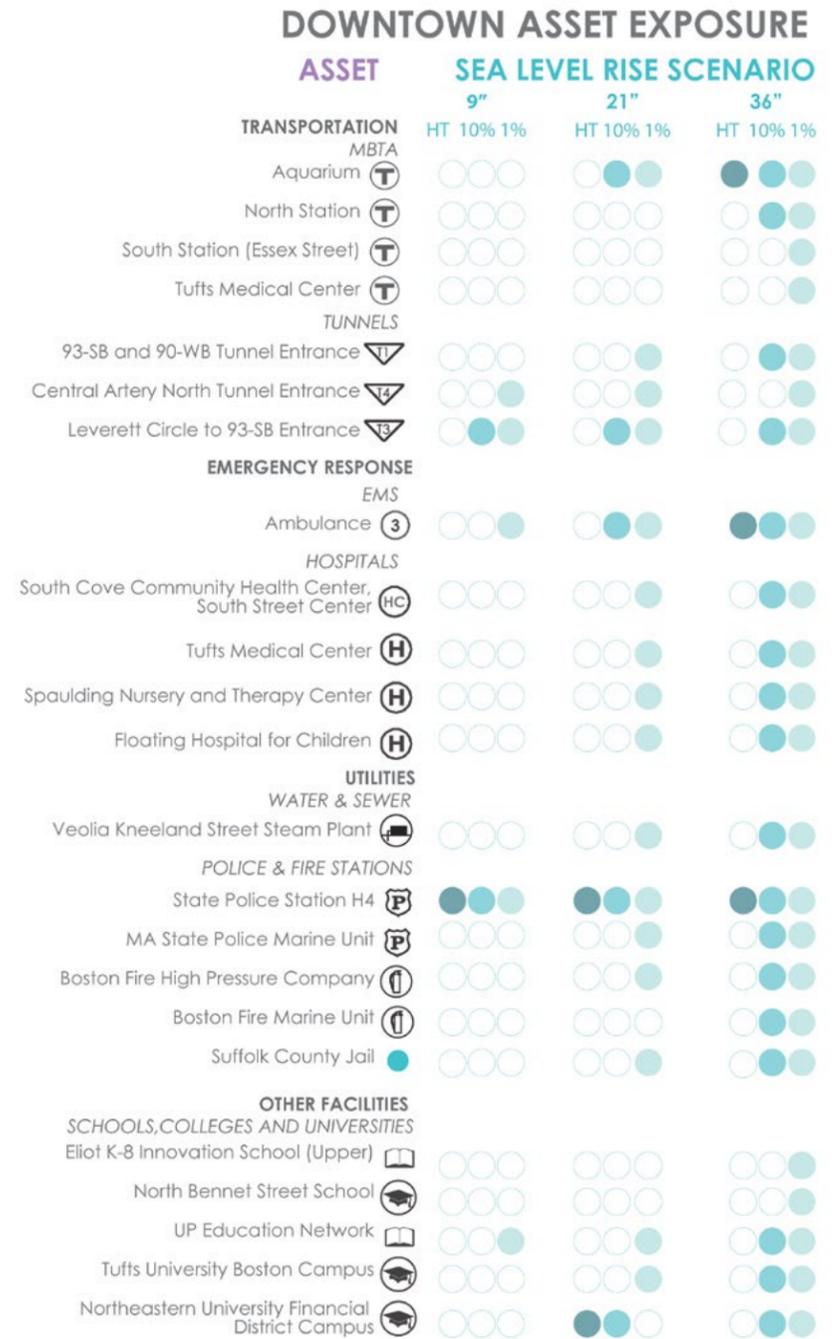
up the lowest lying and most vulnerable areas to coastal and riverine flooding within Downtown.

In the near term, low-lying waterfront areas near the Charles River Dam and the New England Aquarium are the source of the most significant flood risk Downtown. The land near the aquarium is the lowest-lying in all of Downtown, leading to the greatest exposure to high-probability coastal floods in the near term. Expected exposure to the 10 percent annual chance storm events in the near term extends as far inland as Faneuil Hall.

In the second half of the century, large areas near the aquarium and Faneuil Hall are expected to be exposed to flooding under high-probability storm events. In addition, the floodplain is expected to expand toward the West End and along the waterfront edge between the Sumner Tunnel and Charles River Dam.

Areas exposed to flooding only under low-probability events (1 percent annual chance or greater) in the near term are expected to be exposed to flooding during monthly high tides later in the century. This includes the aquarium and Faneuil Hall. Furthermore, most waterfront edges will be exposed to high-probability storm events (10 percent annual chance) by the end of the century, exposing densely developed areas during relatively frequently occurring storms.

Waterfront areas near the Charles River Dam and the New England Aquarium require resilience planning in the near term. Sections of the North End and Financial District require planning to mitigate loss before the end of the century.



EXPOSURE

POPULATION & INFRASTRUCTURE

POPULATION AND SOCIAL VULNERABILITY

Residents of Downtown comprise about 5 percent of Boston's overall population, or about 30,000 people. Compared to the citywide average, Downtown has a smaller share of children, adults with low to no income, people with disability, and people of color, although one-third of the Downtown population still consists of people of color. The population has a larger share of older adults and a significantly larger share of renters and people without vehicles, as is typical of a downtown area. For this reason, the population residing within this area could be disproportionately affected by any disruptions

in public transportation service, as well as loss of electricity and other utilities, particularly during summer or winter months, when climate regulation indoors is necessary for resident well-being.

In the near term, 630 people are expected to be exposed to flooding during monthly high tide, the highest of any focus area. In addition, approximately 2,190 people live in areas expected to be flooded by a high-probability flood event (10 percent annual chance), and 4,680 people live in areas expected to be flooded by a low-probability flood event (1 percent annual chance), making Downtown the second-most-exposed focus area (in terms of people) after East Boston for these events in the near term. The Austonia Public Housing development, with approximately 100 units for the elderly, is expected to be exposed to near-term, low-probability flood events (1 percent annual chance event) and more frequent storms throughout the century.

Throughout the mid- to late century, for both high- and low-probability events, Downtown can consistently expect to have the second- or third-highest population affected by flooding of any Boston focus area, behind East Boston and South End, depending upon the coastal storm condition and sea level rise scenario. Later in the century, Downtown shelter needs are expected to be around 1,000 individuals under the low-probability flood event (1 percent annual chance event). Since there are no emergency shelters located Downtown, those needing shelter will have to travel to other neighborhoods. This is especially critical for Downtown's concentrations of older people and those without vehicles. The Charles

River neighborhoods, the South End, East Boston, and South Boston may have viable sheltering options for Downtown residents, though these neighborhoods are all expected to require more shelter space for their populations, and there may be access challenges associated with reaching them.¹

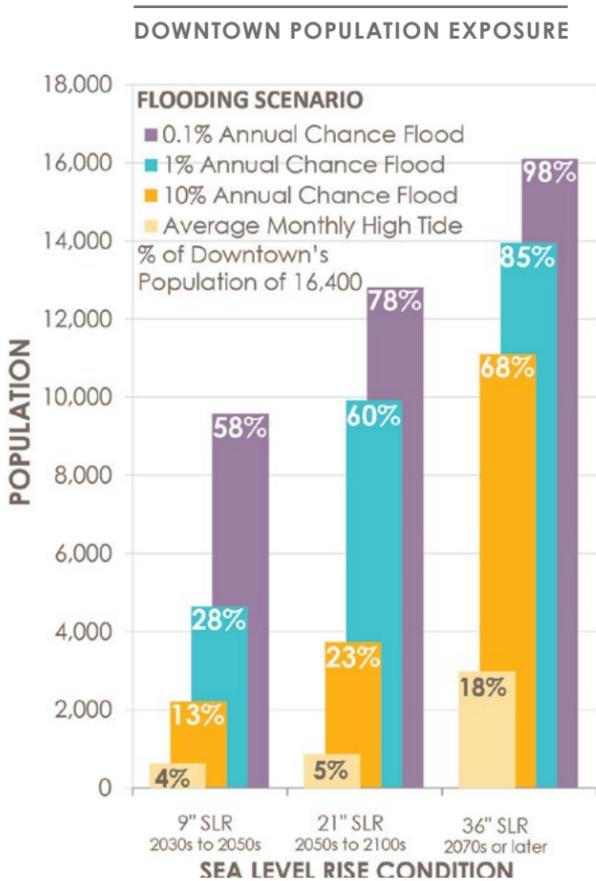
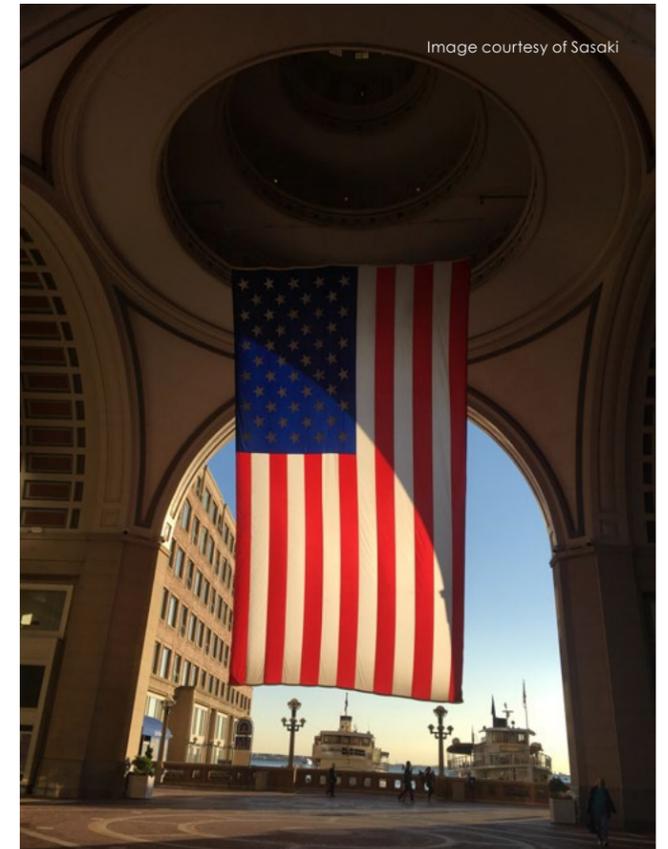
INFRASTRUCTURE

Various transportation connections from Downtown to Charlestown, East Boston, and South Boston across waterways may be exposed to flood impacts at some time this century.

Tunnels and bridges that lead out of Downtown may be exposed to near-term sea level rise and coastal storms, particularly the I-93 North corridor that connects Downtown and Charlestown. Other evacuation route tunnels and bridges expected to be exposed in the near term include the North Washington Bridge entrance next to Lovejoy Wharf that connects the North End and Charlestown, I-90/Ted Williams Tunnel entrances near Fort Point Channel (Seaport District exposure in the near term may impact bridge travel), and Sumner/Callahan Tunnel entrances in the northern end of Downtown. Two stormwater pumps that protect the I-90 portals are also exposed to mid-century flooding from low-probability storm events (1 percent annual chance), although site-specific evaluations should be conducted to assess true vulnerability and consequences of impact.

Two of the three MBTA stations that support connectivity from Downtown to East Boston and

¹ Vehicle ownership is not a factor considered in shelter-need calculations and, as such, the estimate may be conservatively low. A resident without a personal vehicle may find it more difficult to evacuate and find access to a shelter than a resident with a personal vehicle.



Charlestown may be exposed to flooding from sea level rise and coastal storms within this century. In particular, the Blue Line's Aquarium Station may be exposed to high-probability flood events (10 percent annual chance) in the near term. If the Downtown Aquarium Station and East Boston's exposed MBTA stations lose service due to flood impacts, Blue Line service could be interrupted from Downtown through Revere. This situation could lead to approximately 18,500 riders in need of alternative transportation options, leading to strains on other public transportation systems and affecting traffic patterns on a large scale. In addition, late-century storms and sea level rise may also impact Orange Line service between Charlestown and Downtown. The two stations (Community College and North Station) that connect these neighborhoods are exposed to the low-probability flood event (1 percent annual chance). North Station is a major hub for Amtrak and MTBA, and exposure to low-probability flood events and sea level rise in the late century may cause large scale impacts to transportation systems in Downtown, Charlestown, and East Boston.

MBTA's Red Line also services the Downtown area and connects Cambridge to South Boston. Portions of the Red Line that run through Downtown remain largely unexposed to flood impacts until later in the century; sections of the line proximate to the Charles River and the Charles/MGH Stations are exposed to the 1 percent chance event.

Planned expansion of MBTA's South Station must consider effects of sea level rise and coastal storm flooding while choosing the location of a train yard.

The South Station Intermodal Transportation Center is expected to be exposed to low-probability coastal and riverine flooding later in the century. Redevelopment of the station and location of a new train yard must consider sea level rise and coastal flood impacts to ensure that investments are protected in the long term. One-third of Downtown's emergency response services may be exposed to late-century flood impacts.

In the near term, State Police Station H-4, which has within its jurisdiction the Museum of Science, the Esplanade and Hatch Shell, and some of Boston's major hospitals,² is expected to be exposed to monthly high tides. While site-specific review is required to assess vulnerabilities to sea level rise, access interruption can be expected at the least. In addition, one of the three EMS stations located Downtown may experience exposure to low-probability (1 percent annual chance) storm events in the near term.

In the second half of the century, one of two Boston Fire Department facilities located Downtown may be exposed to low-probability storm events. Both facilities are exposed to high-probability storm events later in the century (10 percent annual chance). Exposure of emergency services such as fire, police, and medical may hinder Downtown's internal emergency-response capacity.

In addition, in the second half of the century, the Suffolk County Jail could be exposed to low-probability storm events. The facility has 650 beds. Evacuation and relocation of inmates in the case of a forecasted coastal storm could result in overcrowding at other facilities. Site-

specific evaluation of this facility is necessary to understand vulnerabilities and consequences of impacts.

Heating and cooling of Downtown office buildings may be compromised by low-probability mid-century storms and sea level rise. Low-probability late-century storms are expected to render Boston's steam system inoperable.³

The Veolia Kneeland Street steam plant provides Downtown office buildings with heat and hot water in the winter and air conditioning and cold water in warmer months. If substantial flooding is experienced at the facility in the near term, it may be rendered inoperable. Steam will then have to be exported from the Kendall Station in Cambridge and the Scotia plant in Fenway/Kenmore, reducing Boston's steam capacity by at least 50 percent. Though the distribution system is expected to return to normal operation shortly after flood levels recede, customers within the flood extent will likely experience temporary curtailments or isolations in their steam supply, in addition to select customers south of Kneeland Street, Northwest Boston, Quincy Market area, and Long Wharf area. Late-century flooding at Kneeland, Kendall, and Scotia Stations are expected to result in system failure, which will not be normalized until steam supply points can be repaired.

Loss of heating and cooling services in Downtown commercial buildings could potentially affect work productivity. Employees that work in facilities without heat capabilities may choose to stay home on extremely cold days. Alternatively, air conditioning is often necessary to keep computer systems, data centers, and other electrical

equipment cool. Loss of air conditioning may cause such assets to overheat and shut down, resulting in lost work productivity. Loss of heating and cooling capacity across the city could have detrimental impacts to residents, particularly if storm events coincide with heat waves or cold weather.

Tufts Medical Center campus, including the Floating Hospital, Dental Center, and Rehabilitation Center, could be exposed to low-probability mid-century coastal storms.

Portions of the Tufts campus may be exposed to the low-probability (1 percent annual chance) storm event in the second half of the century.⁴ The frequency of Tuft's exposure to coastal storms can be expected to increase with sea level rise and could potentially affect the facility's emergency center. Any full or partial service interruption at Tufts will likely have an effect on Massachusetts General Hospital, also located Downtown. Though Massachusetts General Hospital is not likely to be exposed to flood impacts during this century, potential overcrowding at the facility can lead to swift resource depletion and a delay in necessary emergency care post-event.

²Source: "Station H-4, SP Boston." The Massachusetts Executive Office of Public Safety and Security. <http://www.mass.gov/eopss/law-enforce-and-cj/law-enforce/msp-troops/troop-h/station-h-4-sp-boston.html>.

³Flood impacts are based on existing conditions of Veolia facilities. Near-term flood impacts may be managed through the potential upcoming replacement of Kneeland Station.

⁴Site-specific review of Tufts Medical Center assets is necessary.

EXPOSURE AND CONSEQUENCES

BUILDINGS AND ECONOMY

RISK TO BUILDINGS

In the near term, Downtown is expected to have approximately 60 structures exposed to flooding during monthly high tides—the largest number of exposed structures, ahead of Charlestown and East Boston. Downtown has more than double the current real estate market value exposed to monthly high-tide flooding compared to any other focus area in Boston. However, Downtown’s near-term high-tide exposure is concentrated in a relatively small area—17 acres, compared to 90 acres in Dorchester. Mixed-use and residential uses together account for approximately 70 percent of the real estate market value exposed.

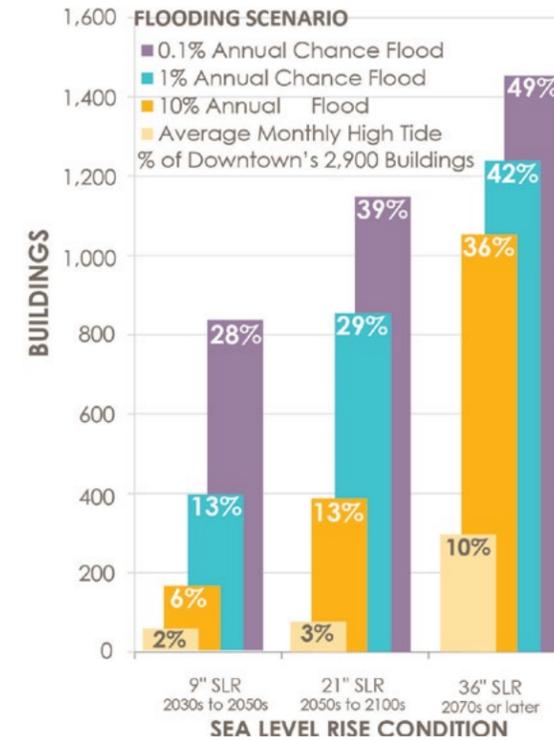
Additionally, low-probability coastal flood events in the near term lead to an exposed market value in Downtown that is roughly half of that for

Expected annualized losses for Downtown make up about one-third of all those expected citywide in the near term and over 20 percent of all expected citywide losses toward the end of the century.

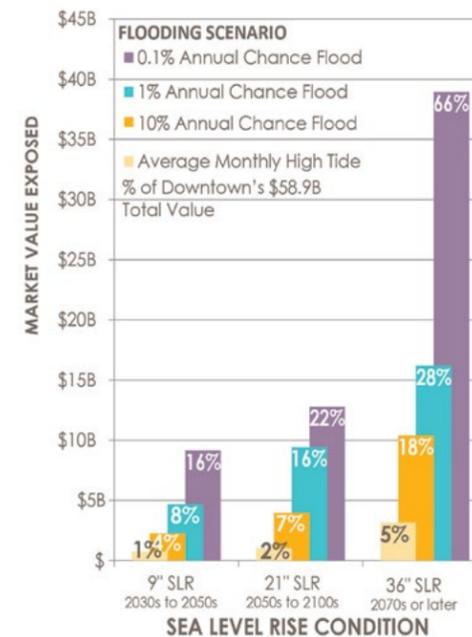
South Boston for the same event. Downtown has 390 structures exposed to flooding during a low-probability flood event (1 percent annual chance), behind only East Boston and South Boston.

In the late century, Downtown is expected to have 300 structures exposed during monthly high tides, five times as many as in the near term, and 1,240 structures exposed to flooding during a low-probability flood event (1 percent annual chance), more than 35 times as many as in the near term. Roughly 25 percent of the structures exposed to the 1 percent annual chance event are commercial, roughly 35 percent are mixed-use, and roughly 30 percent are residential. Land acreage exposed in Downtown is relatively low when compared to other high-exposure neighborhoods under all flood scenarios. For example, the Downtown land area exposed to high-tide flooding late in the century is roughly 20 percent of acres exposed in South Boston and only 15 percent the exposed area in East Boston. This speaks to the high concentration of structures in Downtown Boston. A detailed evaluation would need to be conducted to determine whether waterfront shoreline protections or building-level adaptations would have a greater effect on reducing loss in this area over the near and long term.

DOWNTOWN BUILDING EXPOSURE



DOWNTOWN MARKET VALUE EXPOSURE



RISK TO THE ECONOMY

As of 2014, there are over 12,200 jobs in Charlestown, and associated industries contribute over \$2.5 billion of output (sales and revenues) into the city's economy annually. The Charlestown economy is well balanced, as no single industry comprises more than an 8 percent share of employment or output within the neighborhood.

Charlestown's economy is most vulnerable in medium- and long-term climate scenarios. Based on the neighborhood's current economy and building stock conditions, \$8 million in annualized output loss and approximately 50 positions in annualized employment loss are expected toward the end of the century. Scientific research and development, accounting, and insurance-related services rank among top industries expected to be impacted. Losses have been calculated strictly based on expected flooding to structures, as opposed to egress and utility lines, and cascading loss of function impacts are not considered in the analysis.⁶ In the second half of the century, the site of a current martial arts training center is expected to be heavily impacted by floodwaters and joins top industries expected to be affected by coastal storm events.

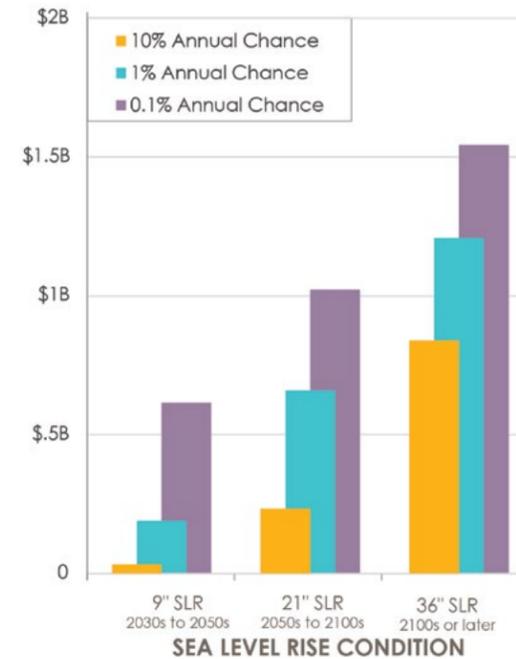
⁶More-detailed analysis would be required to quantify expected loss of function impacts to utilities and transportation outside of economic loss derived from direct physical damage to structures.

ECONOMIC RISK ASSUMPTIONS

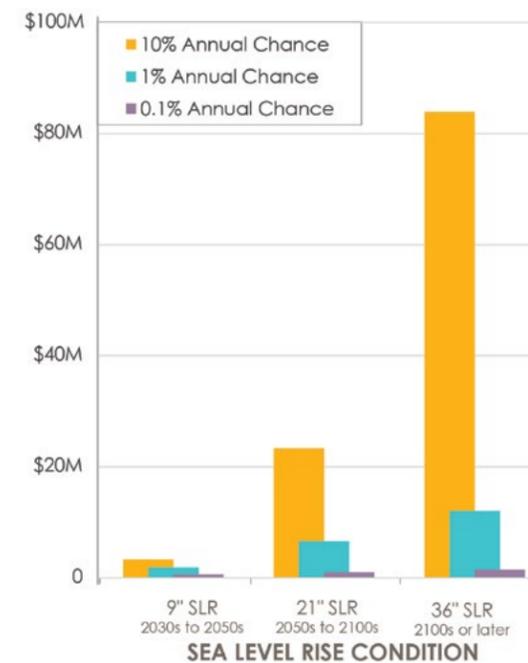
Job and output loss include direct, indirect, and induced consequences of flood impacts. Direct results are impacts felt within a neighborhood, while indirect and induced results are those expected to be felt throughout Suffolk County as a result of changes in spending patterns. Results for both job and output losses are the sum of annualized values for the four flood frequencies analyzed for each sea level rise scenario. This represents a lower-bound estimate for several reasons. First, not all probabilistic events are considered. Second, the analysis assumes that all impacted businesses eventually reopen, though FEMA estimates that almost 40 percent of small businesses—and up to 25 percent of all businesses—never reopen after experiencing flood impacts. Third, only building areas directly impacted by floodwater are assumed to experience business interruption. This does not consider interruptions of businesses due to loss of power or utility functions. Finally, the analysis only considers existing populations, businesses, and buildings and does not include projections for future growth. Refer to the Appendix for a more detailed explanation of the exposure and consequence analysis.

INDUSTRY	ANNUALIZED LOSS OF ECONOMIC OUTPUT
Restaurants	\$15,400,000
Hospitals and Other Medical Services	\$8,600,000
Retail	\$4,200,000
Real Estate	\$5,200,000
All Other Industries	\$34,900,000
Total	\$68,300,000

DOWNTOWN ECONOMIC LOSSES



DOWNTOWN ANNUALIZED LOSSES



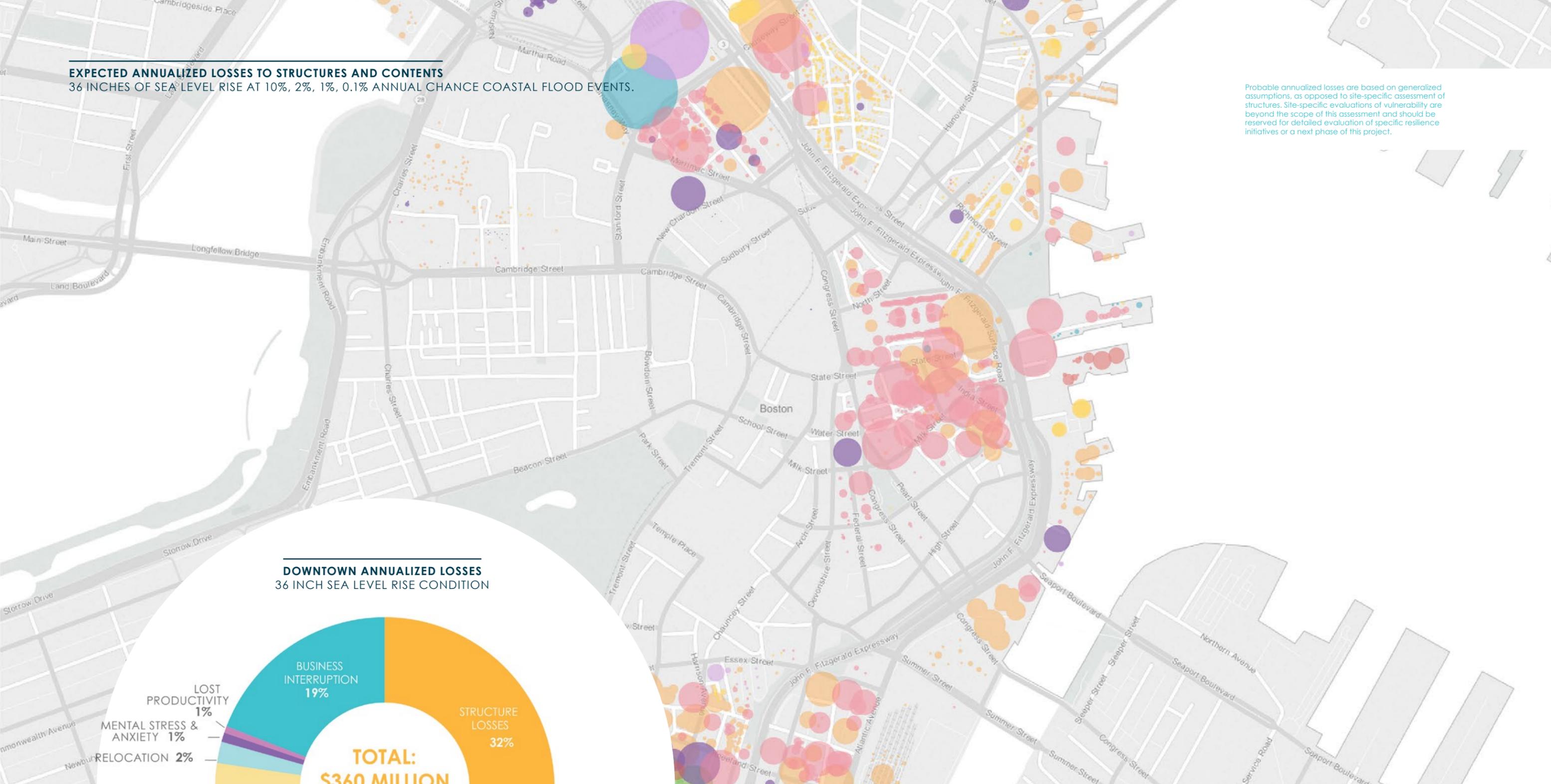
Over \$700 million in current real estate market value is exposed to high-tide flooding in the near term, the highest amount of any neighborhood.

Projected losses Downtown are concentrated in a smaller area than other neighborhoods expected to experience comparable direct damage impacts through the century.

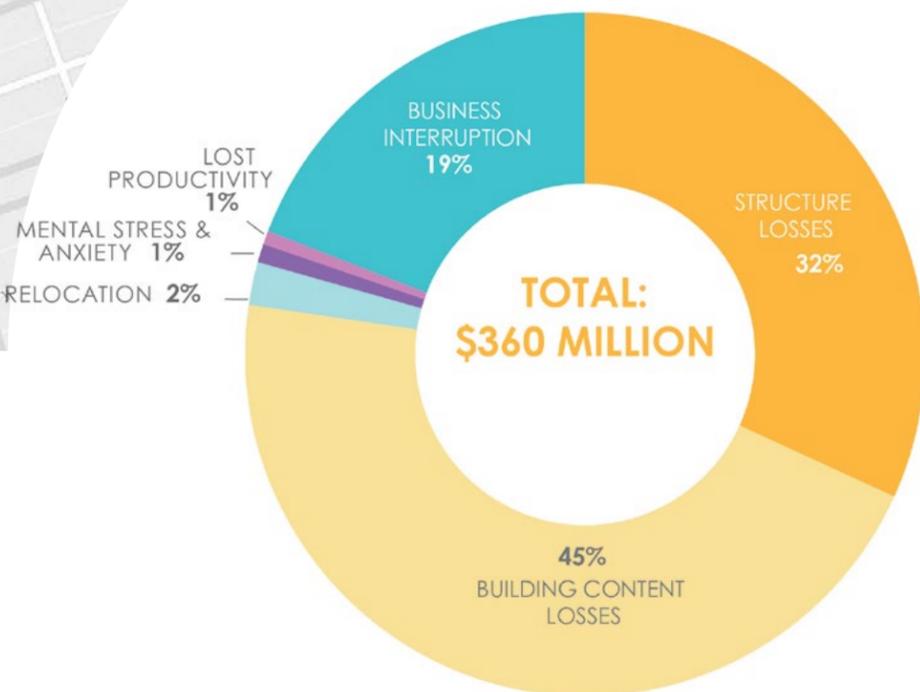
Restaurant and retail industries will be particularly hard hit by flood impacts due to inherent impediments to temporary relocation for such businesses, as well as their roles in supporting the area. As these industries are known to support low- to moderate-income employees, special planning considerations will be needed to mitigate loss to vulnerable populations.

EXPECTED ANNUALIZED LOSSES TO STRUCTURES AND CONTENTS
 36 INCHES OF SEA LEVEL RISE AT 10%, 2%, 1%, 0.1% ANNUAL CHANCE COASTAL FLOOD EVENTS.

Probable annualized losses are based on generalized assumptions, as opposed to site-specific assessment of structures. Site-specific evaluations of vulnerability are beyond the scope of this assessment and should be reserved for detailed evaluation of specific resilience initiatives or a next phase of this project.



DOWNTOWN ANNUALIZED LOSSES
 36 INCH SEA LEVEL RISE CONDITION



- Commercial (\$99.2M)
- Cultural/Religious, Edu, Rec (\$49.3M)
- Essential Services (\$22.2.0M)
- General Government (\$10.1M)
- Industrial/Transportation(\$2.4M)
- Mixed Use (\$92.4M)
- Residential (\$13.1M)
- Total (\$289M)**



Each circle represents annualized losses suffered by an individual building. Larger circle size indicates higher contents and structures losses. Annualized losses take into consideration the annual probability of an event occurring, as well as the projected impacts of such an event.

DOWNTOWN

APPLICATION OF RESILIENCE INITIATIVES

PROTECTED SHORES

DEVELOP LOCAL CLIMATE RESILIENCE PLANS TO SUPPORT DISTRICT-SCALE CLIMATE ADAPTATION

The City should develop a local climate resilience plan for Downtown to support district-scale climate adaptation.

The plan should include the following:

- **Community engagement** through a local climate resilience committee, leveraging existing local organizations and efforts.
- **Land-use planning for future flood protection systems**, including Flood Protection Overlay Districts in strategically important “flood breach points” identified below (see Potential Flood Protection Locations).
- **Flood protection feasibility studies**, evaluating district-scale flood protection, including at locations identified below (see Potential Flood Protection Locations).
- **Infrastructure adaptation planning** through the Infrastructure Coordination Committee. For Downtown, the Massachusetts Department of Conservation and Recreation is a key partner, as it controls the New Charles River Dam.
- **Coordination with other plans**, including Imagine Boston 2030, GoBoston 2030, Special Planning Areas, the Downtown Waterfront Municipal Harbor Plan, and any future Municipal Harbor Plan processes.
- **Development of financing strategies and governance structures** to support district-scale adaptation.

ESTABLISH FLOOD PROTECTION OVERLAY DISTRICTS AND REQUIRE POTENTIAL INTEGRATION WITH FLOOD PROTECTION

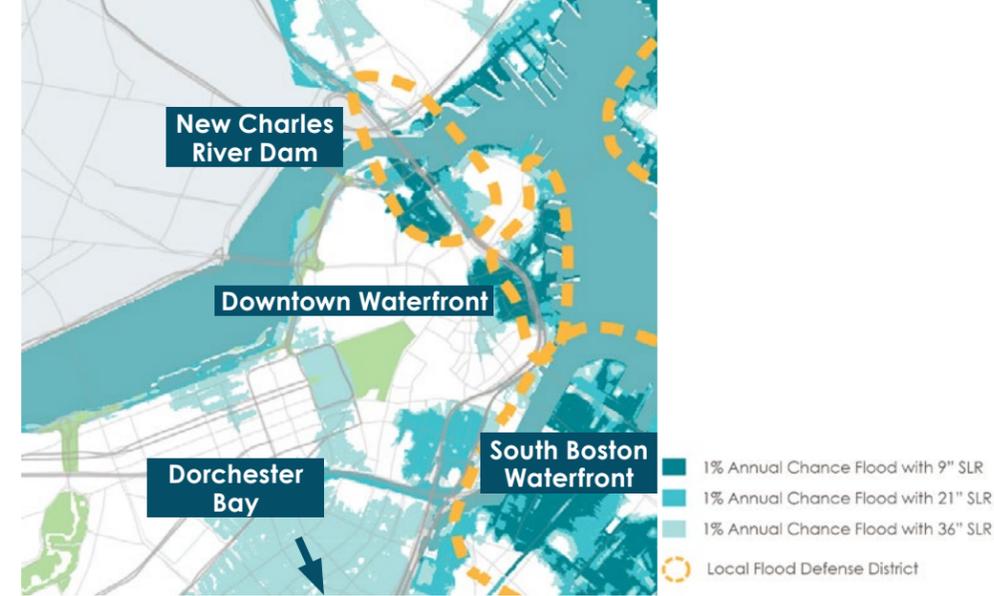
The Boston Planning and Development Agency (BPDA) should petition the Boston Zoning Commission to create new Flood Protection Overlay Districts in areas that are strategically important for potential future flood protection infrastructure (see Potential Flood Protection Locations below). Within a Flood Protection Overlay District, a developer would be required to submit a study of how a proposed project could be integrated into a future flood protection system; options may include raising and reinforcing the development site or providing room for a future easement across the site.

PRIORITIZE AND STUDY THE FEASIBILITY OF DISTRICT-SCALE FLOOD PROTECTION

To reduce the risk of coastal flooding at major inundation points, the City should study the feasibility of constructing district-scale flood protection at the primary flood entry points Downtown (see Potential Flood Protection Locations below for a preliminary identification of locations and potential benefits).

These feasibility studies should take place in the context of local climate resilience plans, featuring engagement with local community stakeholders, coordination with infrastructure adaptation, and considerations of how flood protection would impact or be impacted by neighborhood character and growth. Examples of prioritization criteria include the timing of flood risk, consequences for people and the economy, social equity, financial feasibility, and potential for additional benefits beyond flood risk reduction.

SLR SCENARIO	DISTRICT SCALE FLOOD PROTECTION FOR 1% ANNUAL CHANCE FLOOD ⁷
9" SLR (2030s–2050s)	Downtown Waterfront and the New Charles River Dam
21" SLR (2050s–2100s)	Downtown Waterfront and the New Charles River Dam
36" SLR (2070s or later)	Downtown Waterfront, the New Charles River Dam, South Boston Waterfront, and Dorchester Bay locations combined



POTENTIAL DISTRICT-SCALE FLOOD PROTECTION LOCATIONS⁶

See District-Scale Flood Protection Systems Overview section (page Y) for a citywide perspective on district-scale flood protection. District-scale flood protection is only one piece of a multilayered solution that includes prepared and connected communities, resilient infrastructure, and adapted buildings.

In the near term, flood protection at two locations is critical:

- **The Downtown Waterfront**, addressing flood entry points along the low-lying eastern edge of Downtown; and
- **The New Charles River Dam**, addressing potential overtopping or flanking of the dam, which would inundate areas around North Station and the West End.

While flood protection at the waterfront would stay independently effective through the end of the century, protection at the dam would eventually need to be combined with interventions addressing flood risk from South Boston and Dorchester Bay in order to provide flood risk reduction to Boston's interior neighborhoods.

LOCATIONS

- **The Downtown Waterfront Location** is focused on flood entry points along the low-lying eastern edge of Downtown, starting in the North End and extending to the mouth of Fort Point Channel. Flood protection solutions could include a series of barriers, potentially encompassing floodwalls, greenways, or berms. Potential alignments include along the path of the Rose Kennedy Greenway, connecting high ground near Hanover Street in the north with high ground near Oliver Street in the south, or closer to the waterfront, with potential integration with Christopher Columbus Park.
- **The New Charles River Dam Location**, also described in the Charlestown focus area, is focused on flood pathways by the Zakim Bridge / New Charles River Dam, which would inundate the northern section of Downtown. Potential flood protection solutions could

⁶These preliminary coastal flood protection concepts are based on a high-level analysis of existing topography, rights-of-way, and urban and environmental conditions. Important additional factors, including existing drainage systems, underground transportation and utility structures, soil conditions, and zoning, as well as any potential external impacts as a result of the project have not been studied in detail. As described in Initiatives 5-2 and 5-3, detailed feasibility studies, including appropriate public and stakeholder engagement, are required in order to better understand the costs and benefits of flood protection in each location.

⁷Additional flood protection may be required for flood events more severe than the 1 percent annual chance flood. See Appendix for more detailed information on expected effectiveness of flood protection systems, including analysis of additional flood protection locations and flood frequencies.

include a tide barrier across the mouth of Miller's River, a tide gate and connecting flood protection system just west of Littoral Way, or a deployable barrier across the railroad right-of-way connecting Charlestown and North Station.

- **The South Boston Waterfront Location**, described in the South Boston focus area, is focused on flooding from Fort Point Channel that would affect the southern areas of Downtown such as Chinatown and the Leather District.
- **The Dorchester Bay Location**, described in the Dorchester focus area, is focused on flooding from Dorchester Bay, which could reach parts of Downtown if not addressed.

DETAILED CONSIDERATIONS

- **Independent protection at the Downtown Waterfront location throughout the century:** The flood pathway around the Downtown Waterfront location is relatively isolated from other flood pathways, so no additional alignments are necessary to protect this area.

- **Large number of waterfront commercial buildings protected at the Downtown Waterfront location:** The majority of buildings protected by flood protection at this location are commercial buildings.
- **Many neighborhoods benefit from dam flood protection:** Flood protection at the New Charles River Dam could simultaneously protect parts of northern Downtown, southern Downtown, Charlestown, the Charles River neighborhoods, and the South End and Roxbury.
- **Requirement for multiple protection locations in the late century:** Though flood protection at the New Charles River Dam is expected to be able to protect northern sections of Downtown throughout the century, additional interventions at the South Boston Waterfront and Dorchester Bay are necessary to protect southern portions of Downtown, the South End, South Boston, and portions of Roxbury and Dorchester from flooding later in the century.

PREPARED & CONNECTED COMMUNITIES

CONDUCT AN OUTREACH CAMPAIGN TO PRIVATE FACILITIES THAT SERVE VULNERABLE POPULATIONS TO ENSURE THAT THEY ENGAGE IN EMERGENCY PREPAREDNESS AND ADAPTATION PLANNING

The City should conduct outreach to managers of facilities in Downtown that serve significant concentrations of vulnerable populations and are not required to have operational preparedness and evacuation plans under current regulations. Targeted facilities will include affordable housing complexes, substance abuse treatment and rehabilitation centers, daycare facilities, food pantries, small nonprofit offices, and others. The City should also conduct outreach to hotel and tourism attraction operators, given the role that they play in serving transient populations. An illustrative example of the type of facilities to which the City might conduct outreach is the Kinder Care Learning Center.⁸ This facility is exposed to near-term damage from sea level rise and coastal flooding, in addition to access issues related to near-term stormwater flooding.

EXPAND BOSTON'S SMALL BUSINESS PREPAREDNESS PROGRAM

The City should reach out to small businesses in Downtown exposed to stormwater flooding in the near term or coastal flooding under a 1 percent annual chance event at 9 inches of SLR to help them develop business continuity plans, evaluate insurance coverage needs, and identify low-cost physical adaptations. Under a 1 percent annual chance event at 9 inches of SLR, 185 commercial buildings and 131 mixed-use buildings that could host small businesses are exposed to flood risk. Furthermore, the Chinatown Main Street District is expected to have isolated portions exposed to stormwater flooding in the near term and throughout the century. The Chinatown Main Street District also will be significantly exposed to coastal flood impacts by low-probability storms in the mid-century.

⁸The City did not review the extent of existing preparedness planning as part of this study.

RESILIENT INFRASTRUCTURE

ESTABLISH INFRASTRUCTURE COORDINATION COMMITTEE

The Infrastructure Coordination Committee (ICC) should support coordinated adaptation planning for Downtown's key infrastructure systems, including energy, transportation, water and sewer, and environmental assets. The City should support the MBTA in conducting a full asset-level vulnerability assessment of its system, including the Red Line. The MBTA is currently conducting a vulnerability assessment of the Blue Line. The Blue Line Aquarium Station will be exposed to flooding at 9 inches of SLR under a 1 percent annual chance event.

PROVIDE GUIDANCE ON PRIORITY EVACUATION AND SERVICE ROAD INFRASTRUCTURE TO THE ICC

The Office of Emergency Management should work with Boston Transportation Department, Department of Public Works, and private utilities to provide guidance on critical roads to prioritize for adaptation planning, including evacuation routes and roads required to restore or maintain critical services. With 9 inches of SLR, under a 1 percent annual chance flood event, Interstate 93, Atlantic Avenue, Summer Street, Congress Street, and Nashua Street are exposed to coastal flooding.

CONDUCT FEASIBILITY STUDIES FOR COMMUNITY ENERGY SOLUTIONS

The 2016 Boston Community Energy Study identified the North End as a potential location for an emergency microgrid, based on its concentration of critical facilities. The Environment Department should work with local stakeholders and utility providers to evaluate this site. The proposed location is expected to remain largely unexposed to both coastal and stormwater flooding throughout the century.

ADAPTED BUILDINGS

PROMOTE CLIMATE READINESS FOR PROJECTS IN THE DEVELOPMENT PIPELINE

Upon amending the Zoning Code to support climate readiness (see Initiative 9-2), the Boston Planning and Development Agency (BPDA) should immediately notify all developers with projects in the development pipeline in the future floodplain that they may alter their plans in a manner consistent with the zoning amendments (e.g., elevating their first-floor ceilings without violating building height limits), without needing to restart the BPDA permitting process. Currently, 39 residential and 18 commercial buildings are under construction or permitted Downtown, representing 3,067 additional housing units and six million square feet of new commercial space.

INCORPORATE FUTURE CLIMATE CONDITIONS INTO AREA PLANS AND ZONING AMENDMENTS

The Boston Planning and Development Agency should incorporate future climate considerations (long-term projections for extreme heat, stormwater flooding, and coastal and riverine flooding) into major planning efforts in Downtown. The City is currently drafting the Downtown Waterfront Municipal Harbor Plan. In addition, the State Department of Conservation and Recreation is evaluating options for Storrow Drive Tunnel repair or reconstruction.

ESTABLISH A CLIMATE READY BUILDINGS EDUCATION PROGRAM FOR PROPERTY OWNERS, SUPPORTED BY A RESILIENCE AUDIT PROGRAM

The City should develop and run a Climate Ready Buildings Education Program and a resilience audit program to inform property owners about their current and future climate risks and actions they can undertake to address these risks. To address the most immediate risks, the City should prioritize audits for buildings with at least a 1 percent annual chance of exposure to coastal and riverine flooding in the near term, under 9 inches of SLR. Downtown, this includes almost 400 structures, with 42 percent of these consisting of residential and mixed-use buildings that house residents. A resilience audit should help property owners identify cost-effective, building-specific improvements to reduce flood risk, such as installing backflow preventers, elevating critical equipment, and obtaining deployable flood barriers; promote interventions that address stormwater runoff or the urban heat island effect, such as green roofs or “cool roofs” that reflect heat; and encourage owners to develop operational preparedness plans and secure appropriate insurance coverage. The resilience audit program should include a combination of mandatory and voluntary, market-based, and subsidized elements.

PREPARE MUNICIPAL FACILITIES FOR CLIMATE CHANGE

The Office of Budget Management should work with City departments to prioritize upgrades to municipal buildings in Downtown exposed to stormwater flooding in the near term or to flooding at 9 inches of SLR under a 1 percent annual chance flood event. EMS Station Ambulance 8 will be exposed to coastal flooding at 9 inches of SLR under a 1 percent annual chance flood event. The South Postal Station on Atlantic Avenue will be exposed to stormwater flooding in the near term and coastal flooding from the 1 percent annual chance event in the second half of the century. To address extreme heat risks, the City should prioritize backup power installation at municipal facilities that demonstrate high levels of criticality, including specific Boston Centers for Youth and Family and Boston Public School facilities that serve as emergency shelters.