# BOSTON

## RESILIENT, HISTORIC BUILDINGS DESIGN GUIDE

*A comprehensive guide to retrofitting Boston's historic buildings to address climate change*

*Mayor Martin J. Walsh*

## A RESILIENT HISTORY

In order to maintain Boston's vibrant historic character, we must protect its historic properties from climate change risks. In doing so, we not only better protect ourselves and our neighbors from sea level rise, increased heat and precipitation, we also ensure that the building's that showcase Boston's legacy exist years from now.

## HOW TO USE THIS DESIGN GUIDE

The purpose of this design guide is to illustrate resilience strategies that can be incorporated into the preservation of historic properties.
**It will help you do the following:**

### 1) Familiarize yourself with key terms.
*Mitigation*, *Resilience*, *Adaptation*

### 2) Identify your property's risks.
Understand Boston's overall vulnerability to climate change risks, in addition to your own property's. In doing so, better prepare yourself to address these risks.

### 3) Understand strategies for implementation.

### 4) Visualize a resilient future for your district.
Case studies showcase Boston's historic districts highlight what mitigation, resilience, and adaptation strategies look like on a historic property.

This document was prepared by Bella Purdy.

**Boston Environment Department**
**August 2018**

*All images, drawings, and diagrams are by Bella Purdy, unless otherwise noted.*

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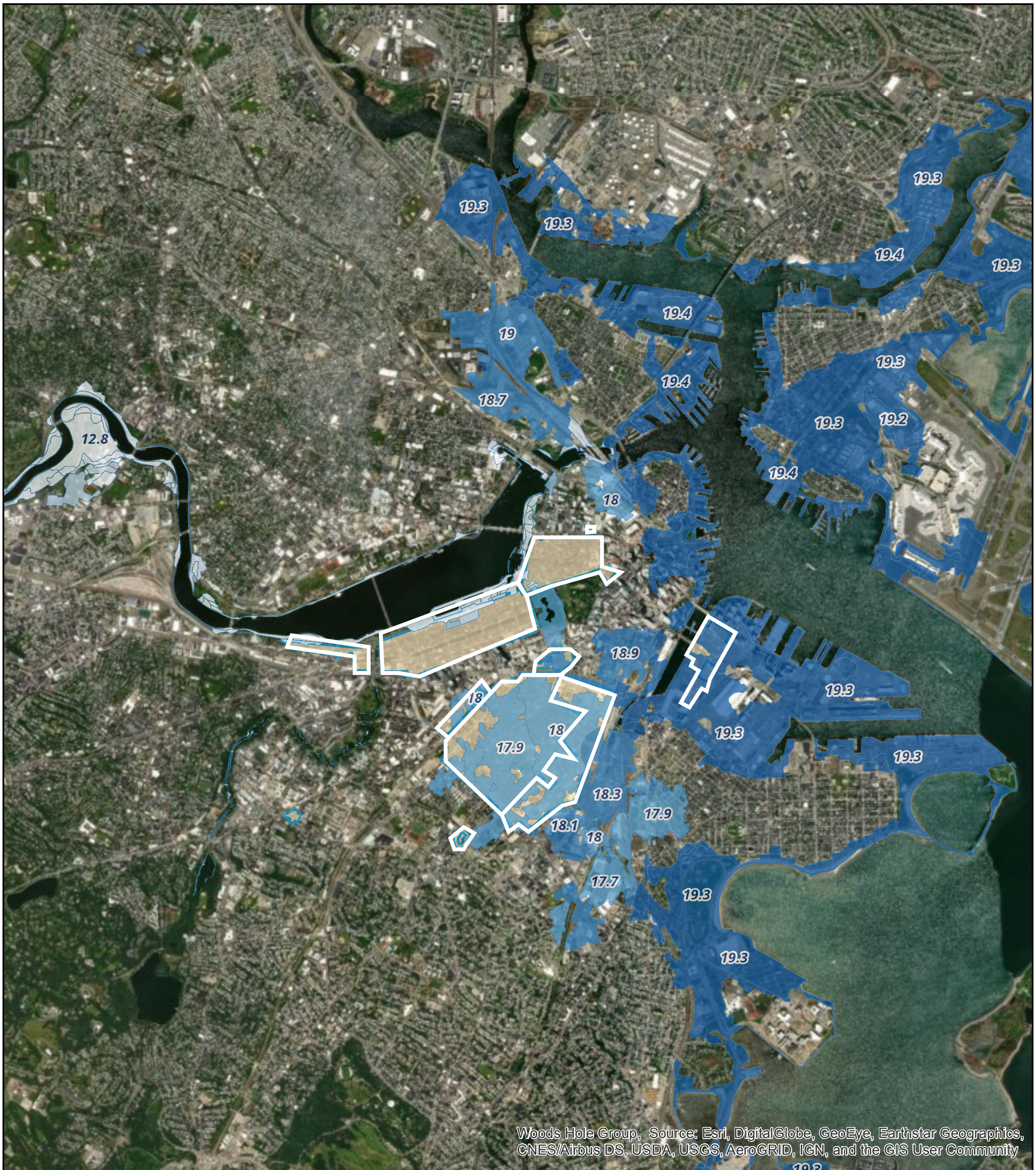
*Source: City of Boston, Boston Planning and Development Agency*




☐ Historic District

**Map shows 40" Sea Level Rise Scenario.**

*Please see the [Boston Planning and Development Agency map](#) to identify your parcel's risk.*

MAP FOR REFERENCE ONLY
NOT A LEGAL DOCUMENT

The Zoning information reported here may not reflect the most current legislation adopted by the Boston Zoning Commission. The signed Code Maps, enacted by the Boston Zoning Commission and available at the BRA, together with any amendments, remain the official Zoning documents. If discrepancies exist, the official signed Code Maps shall be considered correct.

0 | 2,800 | 5,600 | 8,400 | 11,200 Feet

Date: 8/6/2018

boston planning & development agency

# A PRESERVATION AND RESILIENCE

In the coming century, many natural hazards that Boston already faces – including coastal and riverine flooding, storm water flooding, and extreme heat – will be exacerbated by climate change. By 2070, almost 90,000 residents will face a one-percent chance of coastal and riverine flooding in any given year, affecting over $80 billion in building stock.

## Is your historic building at risk?

Resilience to climate change risks is fundamental to the City of Boston's preservation goals. In order to maintain the rich historic fabric of the City, historic buildings must be able to withstand sea level rise, increasing storm events and precipitation. Not only do these events threaten the structure and materials of historic buildings, they also threaten the safety of the occupants of historic buildings.

This reference guide outlines actions that historic property owners may take to adapt their buildings to mitigate these risks. For more information about Boston's risks please see:
[https://www.boston.gov/departments/environment/climate-ready-boston](https://www.boston.gov/departments/environment/climate-ready-boston)

**While there are challenges to adapting older buildings, there are many opportunities as well.**

**These opportunities are outlined in this document and can help you actively reduce energy consumption, create renewable energy, mitigate flood risks, contribute to the thermal comfort of occupants in relationship to rising annual temperatures, and adapt to future changing conditions.**

While design for climate change is a relatively new topic, many resilience strategies are common considerations in building practice. Many historic buildings already incorporate passive strategies to promote thermal comfort. In addition, preserving a historic building saves a significant amount of energy compared to new construction which is one of the predominant energy consuming industries in the United States.

**Thank you for maintaining your historic property to both contribute to the important Boston character as well as to adapt our City to address the growing risks of climate change!**

### One 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 time horizon.***

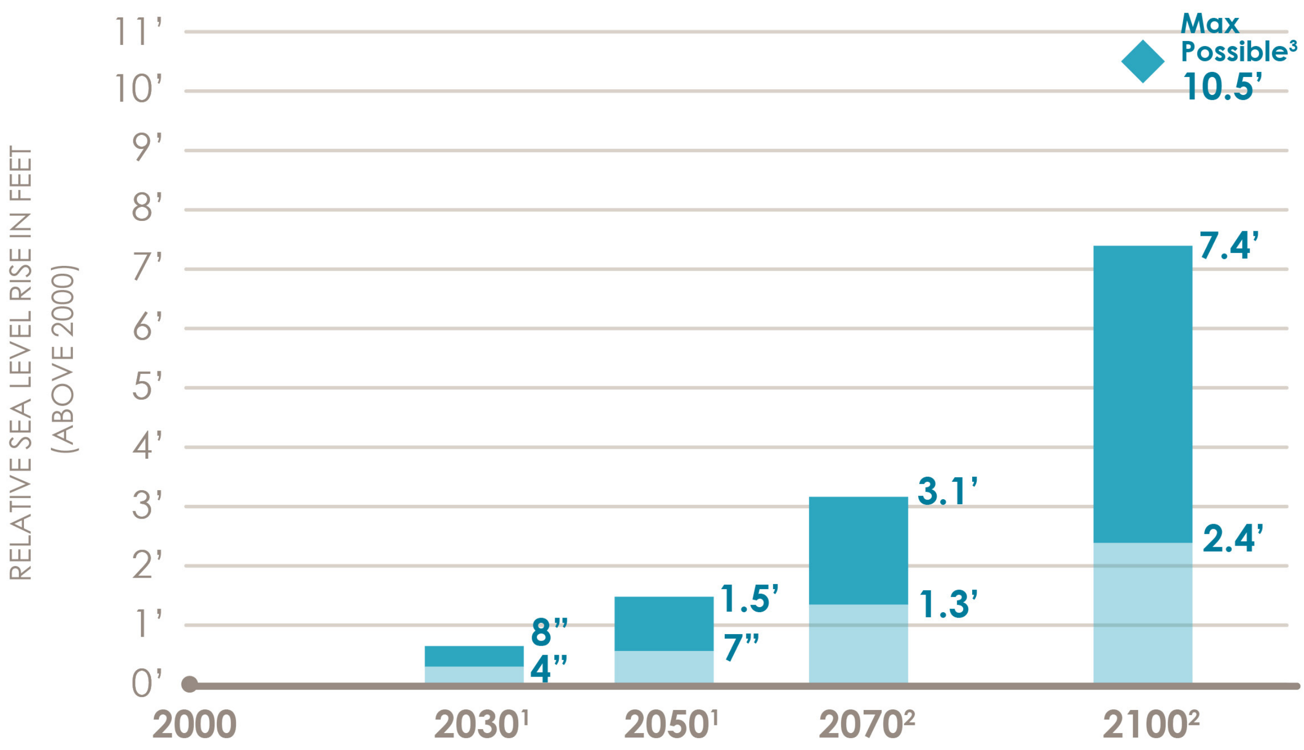
## MITIGATION

*Processes that can reduce the amount and speed of future climate change by reducing emissions of heat-trapping gases or removing them from the atmosphere.*

*(National Oceanic and Atmospheric Administration)*

Historic buildings are often naturally energy efficient because they were built before the prevalence of mechanical heating and cooling systems, and so use passive strategies to promote thermal comfort. Preserving a historic building saves energy that would be consumed during new construction due to the amount of new material needed, as well as the production and transportation of these materials.

The City recommends mitigation strategies that save energy or create renewable energy on site.




*1 - Likely under all emission scenarios*
*2 - Likely under moderate to high emission scenarios*
*3 - Low probability under high emission scenario*

## RESILIENCE

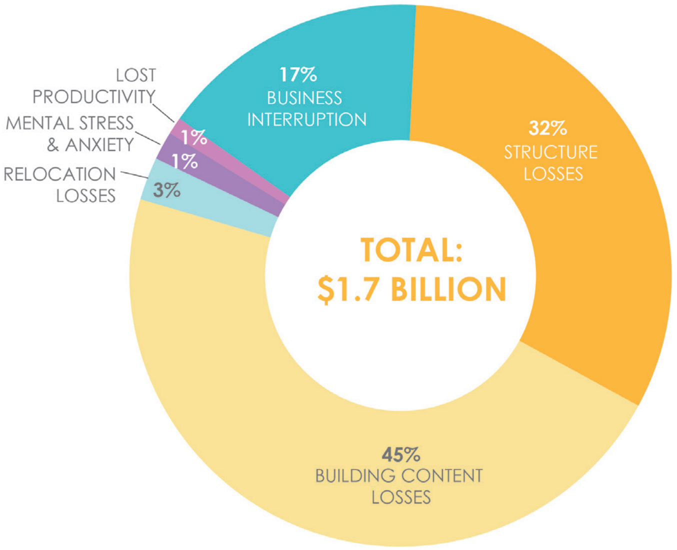
*Resilience is the ability to withstand, respond to, and recover from a flooding or storm event.*

*(National Oceanic and Atmospheric Administration)*

The City recommends considering resilience strategies as a component of protecting historic properties from flood damages. Resilience strategies facilitate a quick recovery after a storm event. For example, by making site improvements to handle increased precipitation loads, there is a reduced chance of damages to the property. **Resilience strategies are complimentary to preservation; the focus of both is to protect the structure and materials of the building and improve the quality of life for the occupants.**

**Resilience strategies can provide co-benefits to residents of the historic district. Such strategies may involve improving the landscape setting or public realm:**

- Passive storm water systems such as rain gardens, bioswales, retention ponds, streetscaping
- Pervious coverage
- Public space as flood buffer or catchment area
- Urban tree canopy to mitigate heat island effects




## ADAPTATION

*Adaptation is the process of adjusting to new (climate) conditions in order to reduce risks to valued assets.*

*(National Oceanic and Atmospheric Administration)*

The City recommends adapting properties in flood hazard zones to address flood risks. Adaptations should respond to risks while also causing minimal impacts to the historic character of the property. Adaptation may involve elevating certain parts of a historic building above the **Design Flood Elevation**. All adaptive alterations to historic buildings must be reviewed and approved by the district's Commission. The Commission will consider the potential flood risks of the property to aid in determining the appropriateness of the adaptation strategy.

### RESOURCES

**Climate Ready Boston**

Climate Ready Boston is an initiative to develop resilient solutions to prepare our City for climate change.

**Carbon Free Boston**

Carbon Free Boston is an initiative to analyze our options in the City's efforts to reach carbon neutrality by 2050

**Greenovate**

Greenovate Boston is Mayor Walsh's initiative to get all Bostonians involved in eliminating the pollution that causes global climate change, while continuing to make Boston a healthy, thriving, and innovative city.

## YOUR DISTRICT

*Use the Boston Planning and Development Agency Zoning Map to locate your historic district.*

The BPDA Zoning map not only includes the Sea Level Rise Flood Hazard Area (SLR-FHA) and FEMA Special Flood Hazard Area (SFHA) but also Boston's historic and landmark districts. To understand the flood risks for your district, turn on both the SLR-FHA and historic district layers.

## DEFINITIONS:

### Base Flood Elevation -

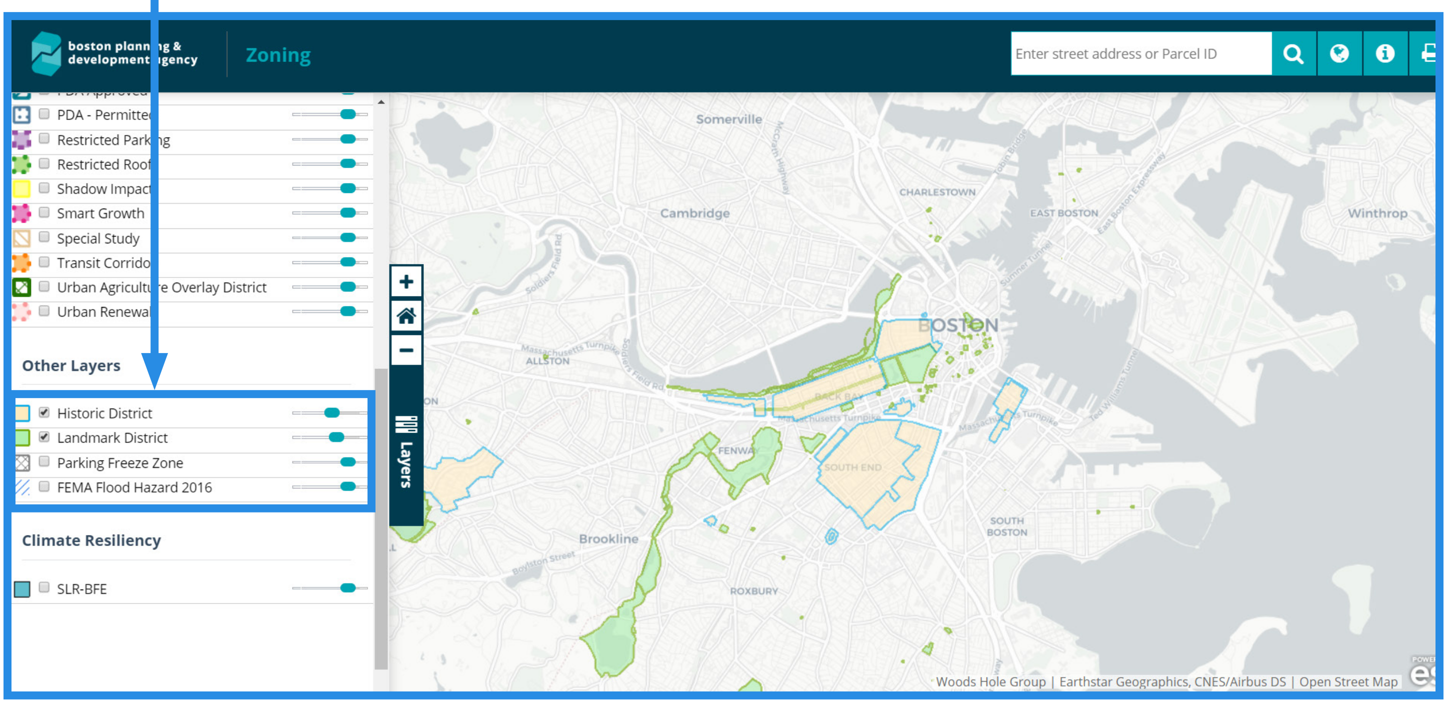
The height that floodwaters are projected to reach during a 100-year flood.

### Design Flood Elevation -

The height of the lowest occupiable floor (when wet floodproofing), or the height of the lowest structural member of an inhabitable floor(when elevating a building). Depending on building type and location, the DFE is usually separated from the Base Flood Elevation by one to two feet of freeboard.

### Freeboard -

The distance between the Base Flood Elevation (BFE) and the Design Flood Elevation (DFE). Freeboard provides a buffer between projected flood elevations and a building's lowest inhabitable floor. Refer to ASCE 24-14 for freeboard requirements.



## BOSTON'S RISKS

*Sea Level Rise, Increasing Precipitation and Storm Events May Affect Your Historic District and its Residents.*

### Please Note:

It is useful to understand the flood risks for your historic property in order to select an adaptation strategy that will protect critical spaces from the estimated flood level. Please see the BPDA's flood map to understand your parcel's potential flood risk.

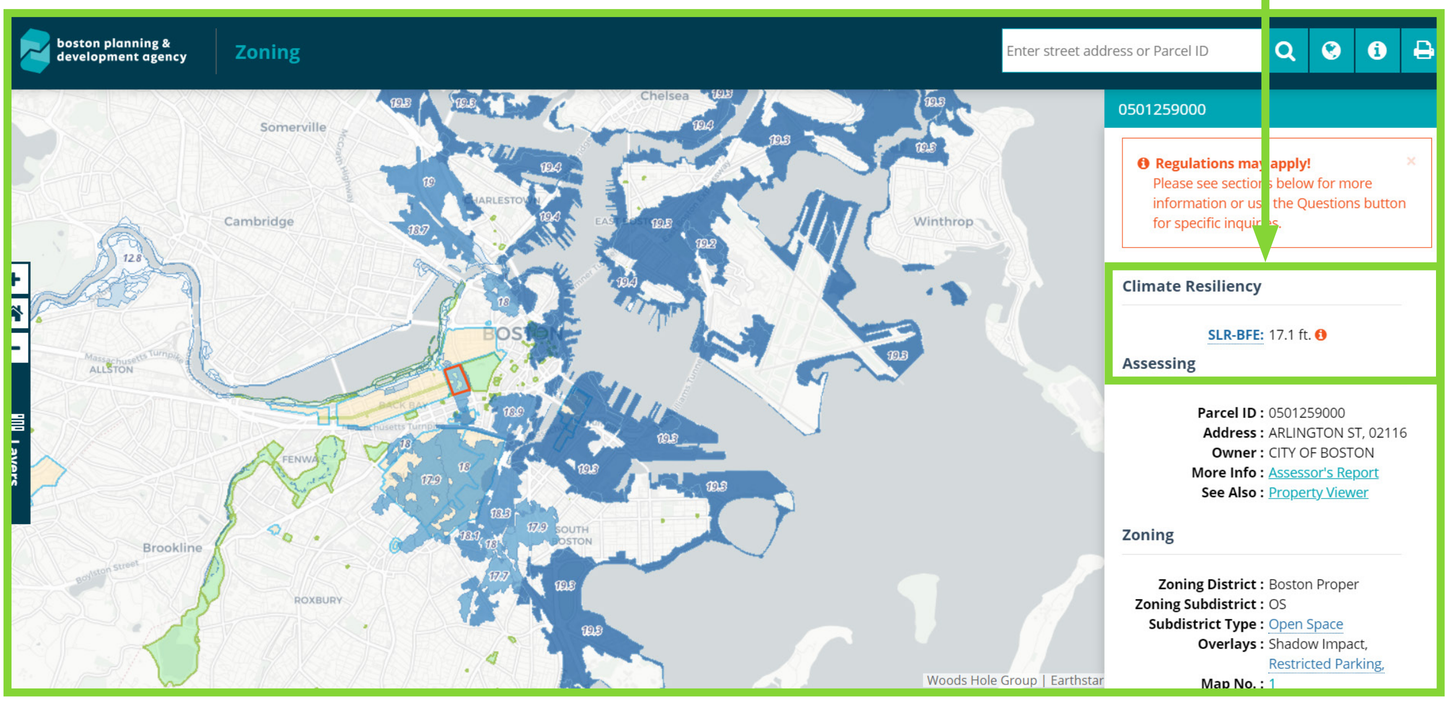
Property owners are encouraged to reference the BPDA Flood Hazard Area Map and evaluate their own tolerance for risk given the specifics of their project's site, location, uses and functional life to determine if additional flood hazard mitigation and prevention measures should be incorporated into their property. Historic guidelines do not mandate adaptation of historic properties, but the City recommends considering adaptation.

## UNDERSTANDING FLOOD RISKS

*Use the BPDA Zoning Map to find your flood risk.*

The BPDA Zoning map includes the Sea Level Rise Flood Hazard Area (SLR-FHA) and FEMA Special Flood Hazard Area (SFHA), and also Boston's historic and landmark districts. To understand the flood risks for your district, turn on both the SLR-FHA and historic district layers.

Once you locate your parcel, you will have a better understanding of how quickly you should adapt your property.



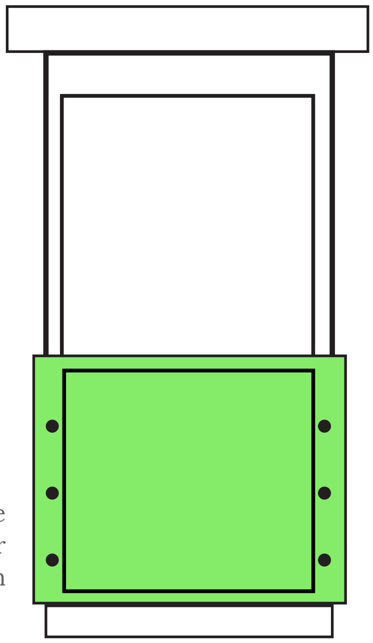
## HOW TO: DRY FLOODPROOF

*This page illustrates how retractable flood gates work and are installed.*

### Please Note:

While retractable flood gates that are used to cover openings and doors do not impede on the public right-of-way, other barrier types that are installed in front of a property may not block the public right of way. Please consult with the Boston Department of Public Works guidance for temporary barriers to ensure that your barrier is in accordance with these guidelines.

1

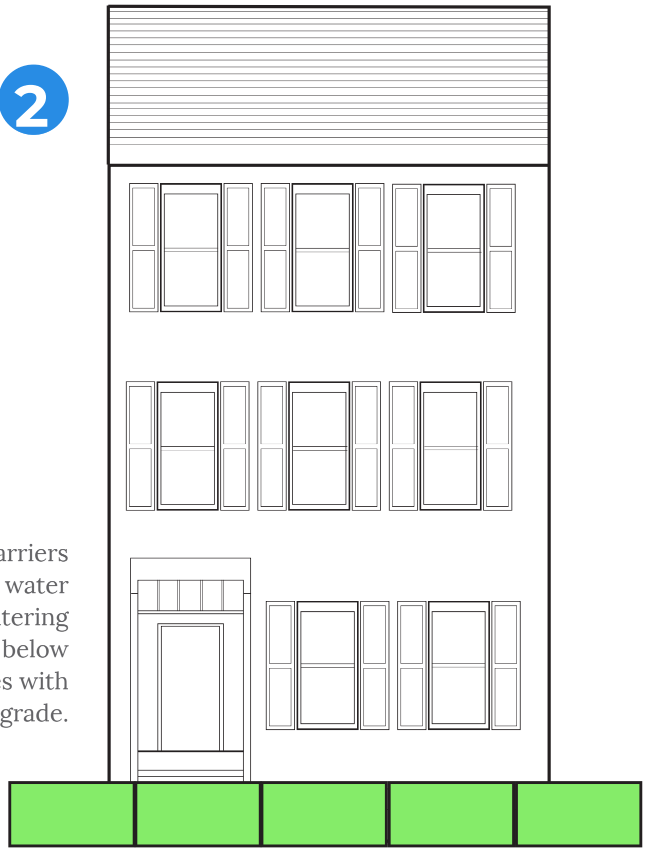


Hardware must be reviewed by your Commission

### 1) Openings - Flood Shield

Flood gates or shields for doors and windows can be installed in anticipation of a storm or flood event. It is recommended that hardware for these systems is installed prior to this type of event, so that a property owner is ready to deploy the shield during an emergency. An inspection of your property may be needed prior to installation. **Dry flood proofing can cause increased hydrostatic pressure on exterior walls that may result in structural damages. Please evaluate the condition of your property prior to installation.**

2



Temporary barriers can block water from entering entrances and below grade spaces with openings at grade.

### 2) Site - Barriers

Deployable barriers may be placed around a property in anticipation of a storm or flood event, however they must be within the boundaries of the property and cannot be placed in the public right-of-way, such as the sidewalk. It is dangerous for individuals to deploy this type of system without consulting best practices put forth by the Boston Department of Public Works.

## HOW TO: WET FLOODPROOF

*This page illustrates how to prepare your below grade spaces for flooding.*

### Please Note:

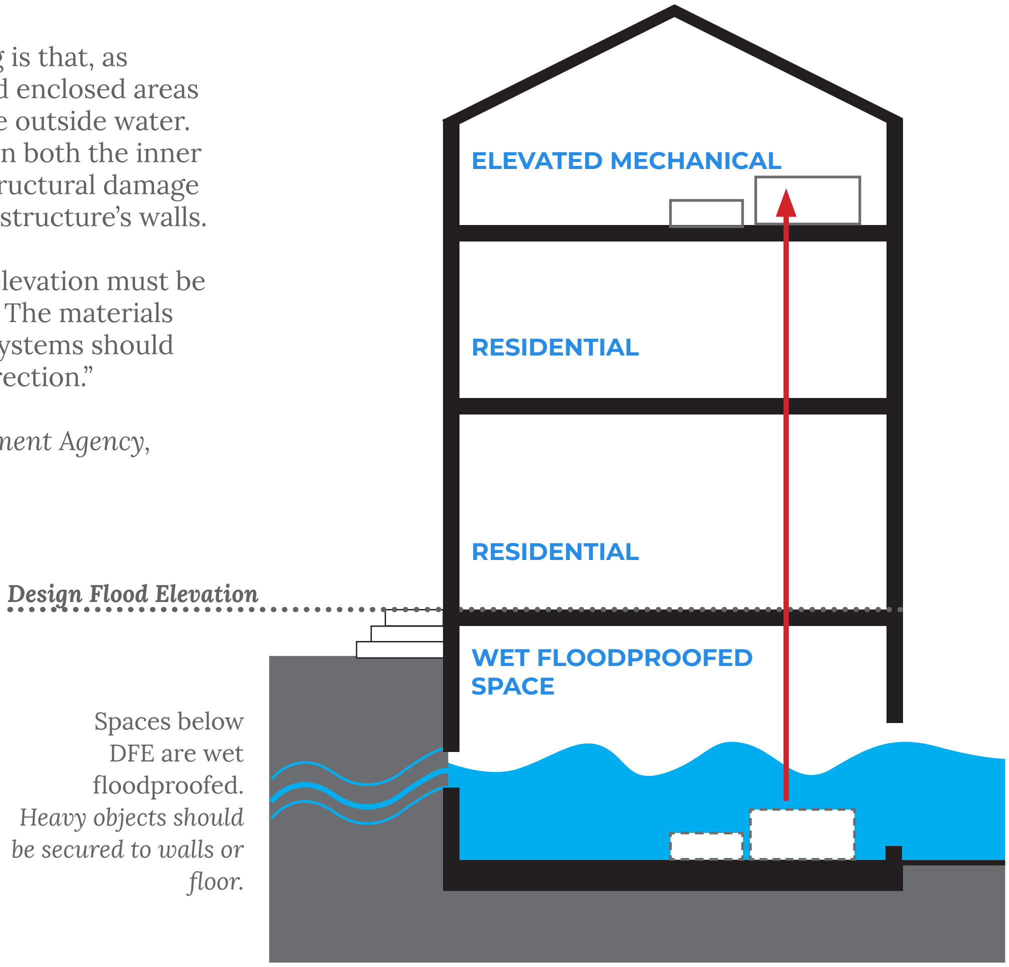
In order to utilize this method, critical systems such as mechanical systems, must be elevated above the Design Flood Elevation to avoid damages. This often involves moving these systems from a below grade, basement space to an upper level or to the roof of a historic property.

"**Wet Floodproofing** is a design method that allows water to move in the enclosed parts of a home's lower area, such as the crawlspace or an unoccupied area, and then out when water recedes. Materials and components used in these areas are selected for their ability to become wet, sustain minimal damage, dry, and be restored.

The advantage of wet floodproofing is that, as floodwaters come into the prepared enclosed areas they will reach the same level as the outside water. This equalizes the water pressure on both the inner and outer walls and may prevent structural damage caused by unequal pressure on the structure's walls.

All the materials below the design elevation must be resistant to flood or water damage. The materials and components of wall and floor systems should encourage drying in at least one direction."

*Source: Federal Emergency Management Agency, Homeowners' Guide to Retrofitting*




Spaces below DFE are wet floodproofed. *Heavy objects should be secured to walls or floor.*

## HOW TO: ELEVATE

*This page illustrates how you might elevate the first floor of your property to address flood risks*

### Please Note:

If you are planning on a major interior renovation of your historic property, it could be an ideal time to also consider elevating the first floor of your building to the Design Flood Elevation. Changes to address flood risks should still adhere with the character of the historic district.

Elevation of a historic property can happen in several forms. Methods that have minimal visual impacts on the front facing facade, or public way should be considered prior to those that visually impact the building and its settings.

### 1) Elevate Interior First Floor

*No alterations to the front facing facade*

This method involves elevating the first floor from the interior of the building. The first level can be elevated to the Design Flood Elevation if the floor to ceiling height is high enough to handle a height reduction, and if the original windows have a large enough sill height to accommodate the raised floor. This strategy requires interior stairs from the front entry to the elevated floor (*diagram 01*).

### 2) Elevated Interior First Floor and Entry

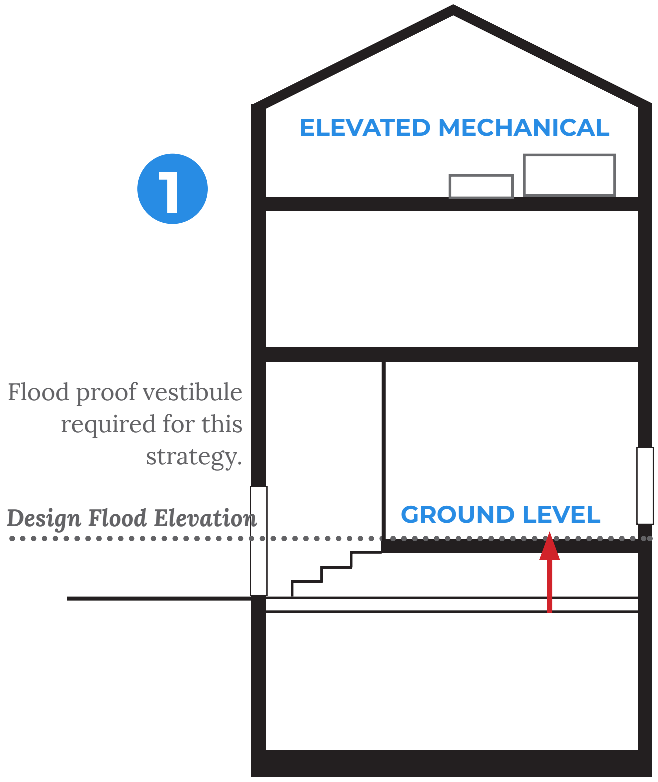
*Front facing facade altered, low visual impact required*

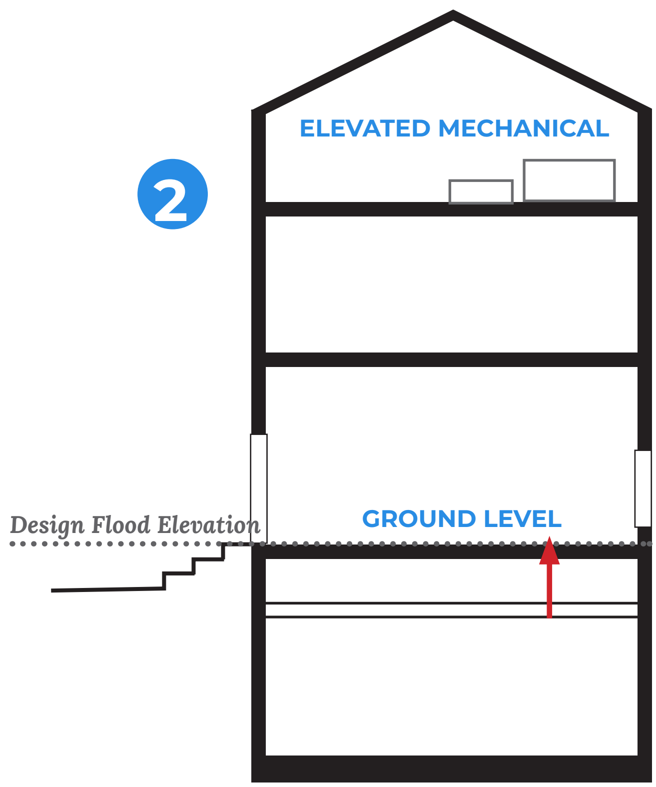
This method involves elevating the first floor and the exterior entry. The first level can be elevated to the Design Flood Elevation if the floor to ceiling height is high enough to handle a height reduction, and if the original windows have a large enough sill height to accommodate the raised floor. This strategy requires exterior stairs to the elevated front entry (*diagram 02*).

### 3) Elevated Entire Structure

*Front facing facade altered*

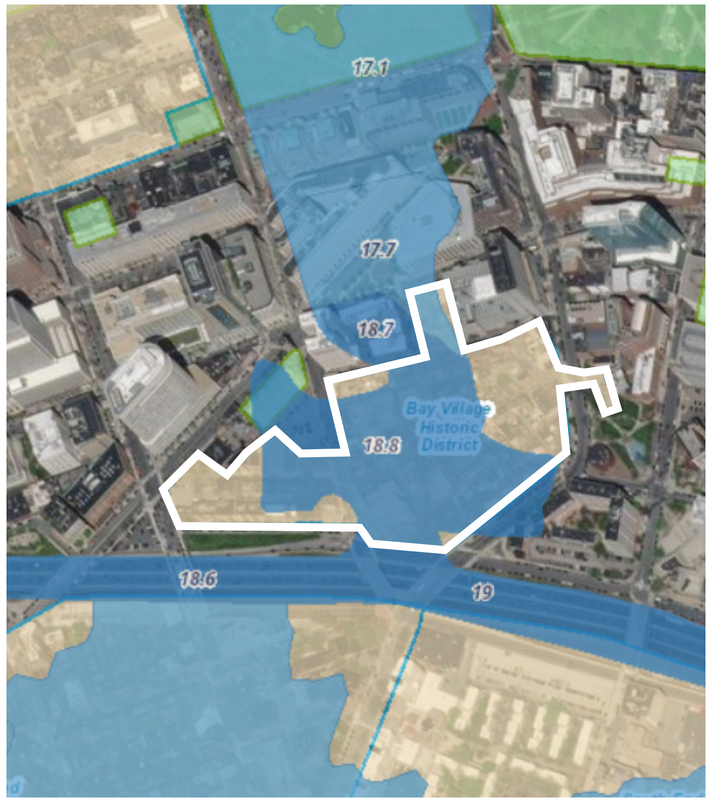
The most aggressive approach is to elevate the entire structure. If the surrounding site is raised as well to mask the visual impact, this may be an acceptable approach, but this approach is not encouraged due its visual impact on the historic character of the building and its setting (*no visual depiction*).



## BAY VILLAGE HISTORIC DISTRICT

Prior to 1825 the Bay Village area consisted of mudflats created by Back Bay tides. Once construction of a dam was authorized and the land drained, construction began almost immediately. Early deeds restricted height and construction materials, as a result, the major streets tend to be visually similar; red brick was the building material of choice, often with a granite foundation. Most Bay Village buildings were constructed between 1825 and 1899 and represent a variety of architectural styles, ranging from Federal to Greek Revival to Victorian.




### For more information on this district:

[https://www.boston.gov/historic-district/bay-village-historic-district](https://www.boston.gov/historic-district/bay-village-historic-district)

### Resilience benefits in this district:

Bay Village has many existing resilience benefits. For example, elevated entryways on many historic properties are a benefit during storm and flood events. In addition, the district has a thriving tree canopy that shades properties in the neighborhood. By preserving your historic property you are also helping to protect yourself and surrounding residents from the growing effects of climate change. Please see the following page for more recommendations on ways in which to adapt your property.

MITIGATION

RESILIENCE

ADAPTATION

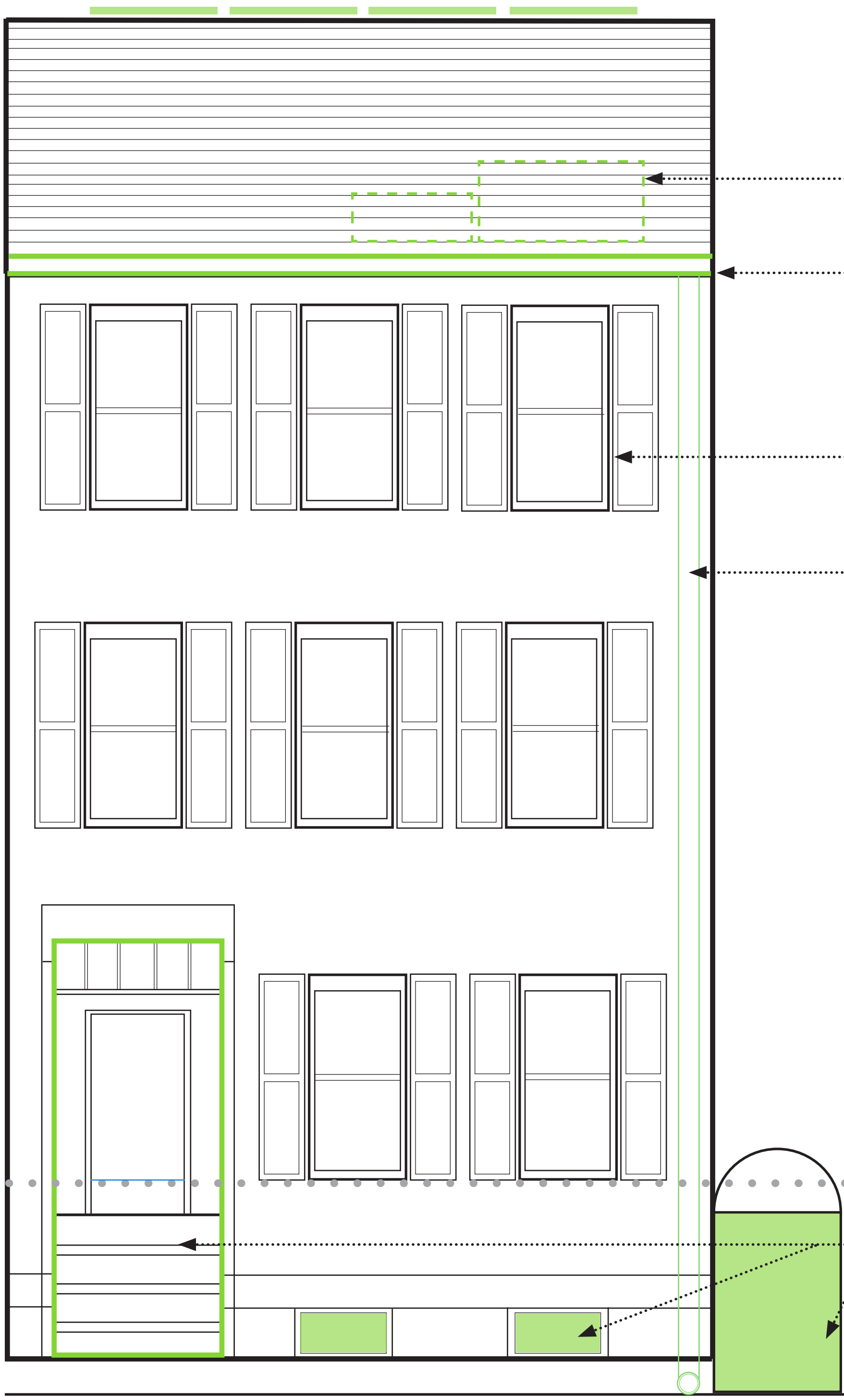
Install Solar Panels on flat roofs, 10' min from the front-facing facade
*Not visible from the public way*

At the interior, elevate critical mechanical systems

Install gutter heating plate to handle snow and ice loads and prevent ice dams

Restore shutters to be operable

Right -size downspouts to handle increasing precipitation loads. Many historic downspouts do not have a minimum load requirement.



## Please Note:

*Elevated Entryways*

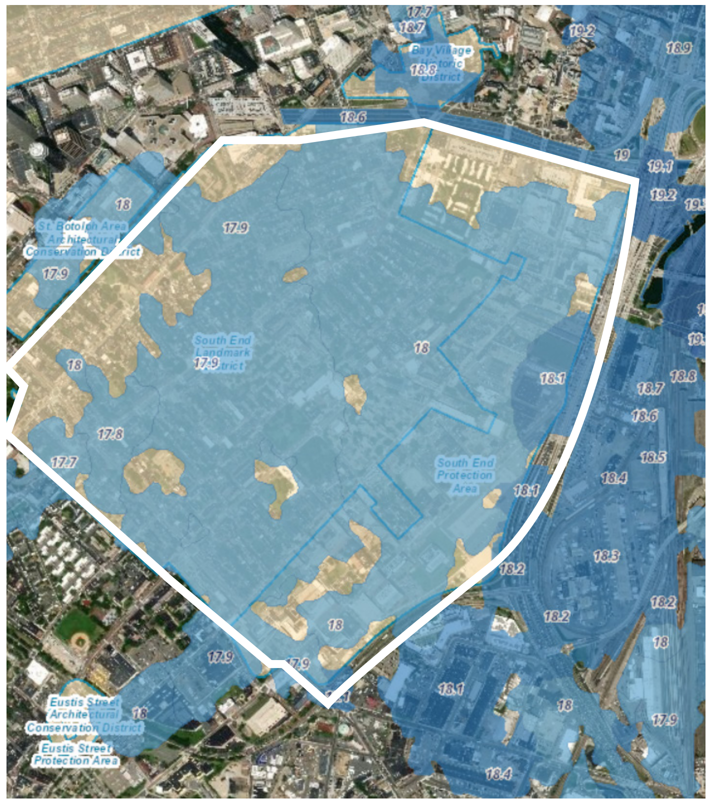
Many homes in Bay Village Historic District already have elevated entryways because portions of the neighborhood were raised in the 1800's due to issues with drainage and sewer. These elevated entries are a positive asset in terms of flood risk adaptations.

Elevate First floor to DFE.

Install hardware around openings at street level to accommodate retractable flood gates during storm events.

## SOUTH END LANDMARK DISTRICT

Originally marshland bisected by a narrow strip of land called The Neck (now Washington Street), the South End consists of historic residential blocks, parks, and main thoroughfares with commercial, industrial, and institutional buildings. After the marsh was filled, development began in 1850 by real estate speculators building fashionable, single-family row houses. Restrictions on building size and materials meant residential structures in long uniform rows, resulting in remarkable visual unity throughout the area. After the Financial Panic of 1873, the most wealthy Bostonians moved to the brand new Back Bay, and, by the turn of the century, lodging houses geared towards the working class were almost the only residential structures built. For further historical background please see South End Landmark District Study Report.




### For more information on this district:
[https://www.boston.gov/historic-district/south-end-landmark-district](https://www.boston.gov/historic-district/south-end-landmark-district)

### Resilience benefits in this district:
The South End Landmark District has many characteristics beneficial to mitigation and resilience strategies. For example, historic properties with flat roofs can accommodate photovoltaic panels, cool roofs, blue roofs, and green roofs. These roof installations can help reduce interior temperatures, reduce neighborhood wide heat island effects, manage storm water, and save energy. In addition, elevated residential entries on many of these properties is ideal during flood events. Please see the following page for more recommendations on ways in which to adapt your property.

MITIGATION

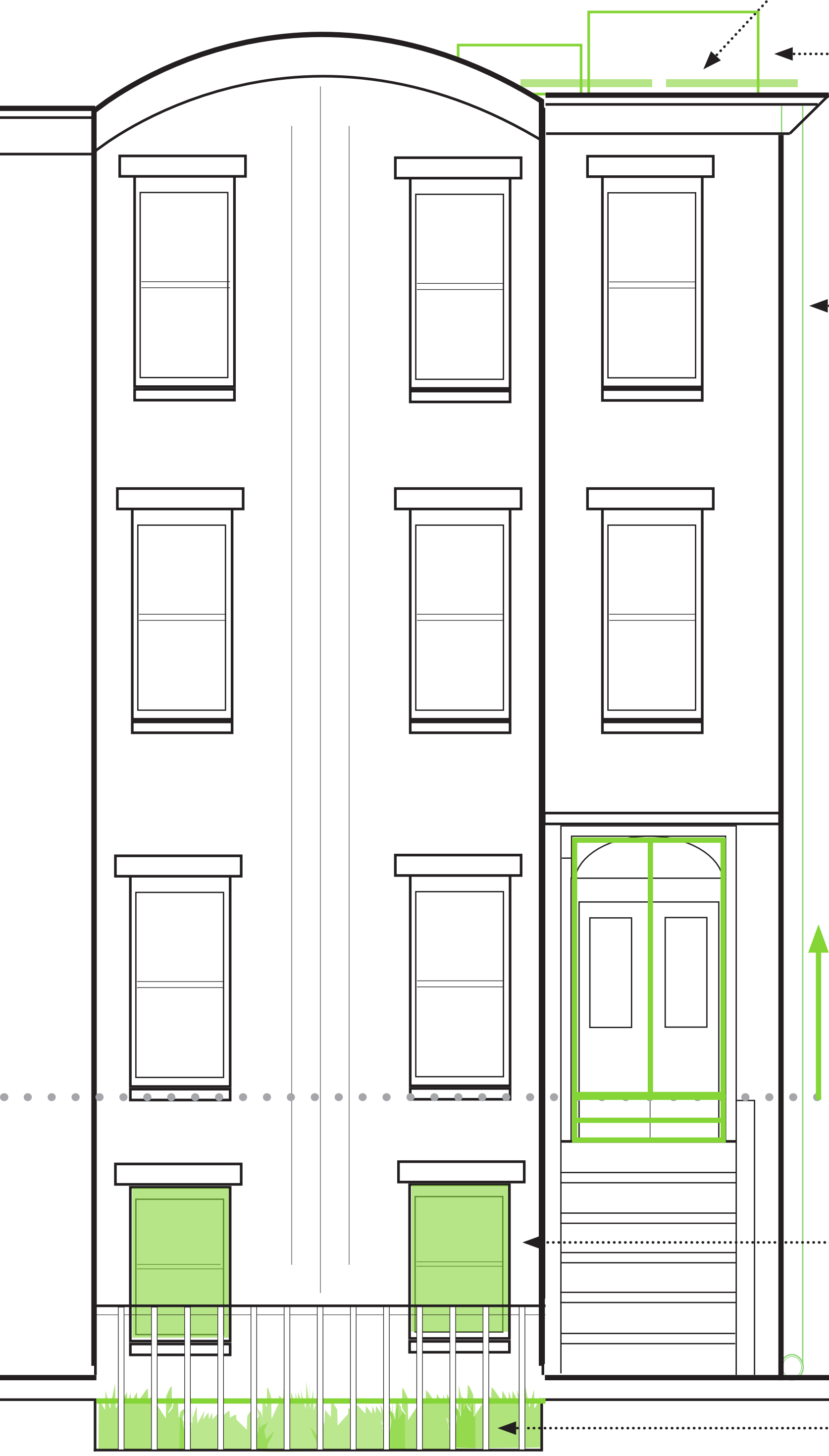
RESILIENCE

ADAPTATION

Install Solar Panels on flat roofs, 10’ min from the front-facing facade, cool roof or green roof

Elevate critical mechanical systems above Design Flood Elevation. Should not be visible from the public way.

Right -size downspouts and gutters to handle increasing precipitation loads. Many historic downspouts and gutter systems do not have a minimum load requirement.



**Please Note:**

*Sunken gardens*

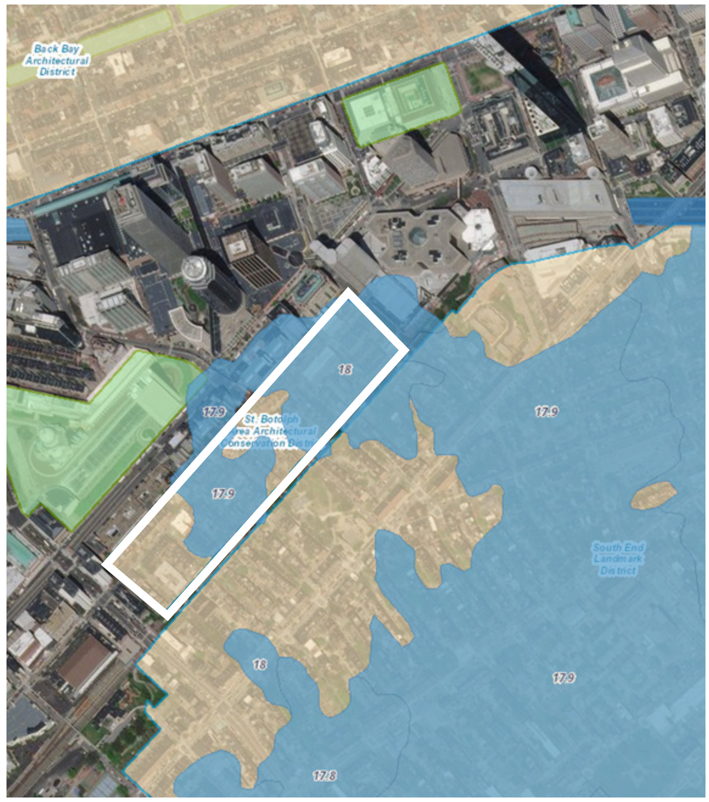
Many houses in the South End have sunken gardens that extend below the street elevation and have windows to basement spaces. To flood proof these day lit, basement spaces, consider either filling the garden with fill and adding plantings or wet proofing the basement space. Filling in the space my result in a loss of living area, but is a more aggressive approach to flooding.

Elevate First floor and front entry to DFE, floor to ceiling height permitting.

Install retractable flood gates

Add flood resistant landscaping and fill to sunken garden.

## ST. BOTOLPH AREA ARCHITECTURAL CONSERVATION DISTRICT




The St. Botolph area was created in 1857, when public health concerns and creating new space for Boston's growing population led to filling tidal lands. Development in St. Botolph began ca.1881 and by the end of the 1880s, about half of the St. Botolph area was developed with mostly single-family residences. The remainder of the area was developed in the 1890s with construction of multi-family structures. Although close to Back Bay and the South End, rapid development by speculators lends St. Botolph a visual cohesiveness not found in its larger neighbors.

### For more information on this district:

*https://www.boston.gov/historic-district/saint-botolph*


### Resilience benefits in this district:

St. Botolph Area Architectural Conservation District has many characteristics beneficial to mitigation and resilience strategies. For example, rows of condominium buildings with flat roofs can accommodate photovoltaic panels. With the cooperation of property owners, this energy can be shared across properties. These rows of flat roofs are also ideal for installation of cool roofs that can reduce heat island effects on the neighborhood. Please see the following page for more recommendations on ways in which to adapt your property.

MITIGATION

RESILIENCE

ADAPTATION

Install Solar Panels on flat roofs, 10' min from the front-facing facade, cool roof or green roof

Elevate critical mechanical systems to the roof above the Design Flood Elevation

Right -size downspouts and gutters to handle increasing precipitation loads. Many historic downspouts and gutter systems do not have a minimum load requirement.

**Please Note:**

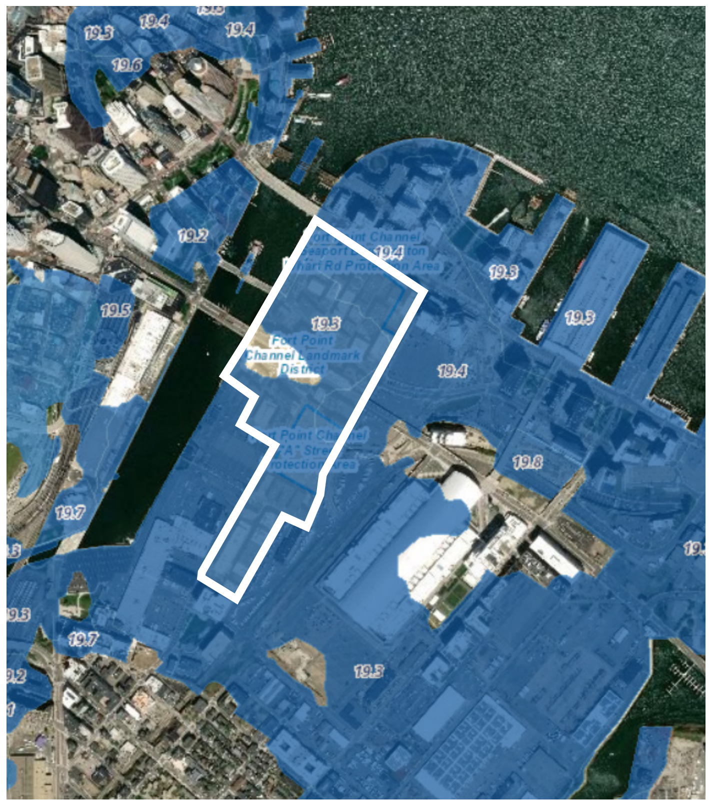
*Shared energy*

Condominium housing may be ideal for shared renewable energy strategies. Many multi-family buildings in the South End have flat roofs which can more easily be retrofitted to accommodate Photo Voltaic Panels and cool roofs.

Elevate First floor and front entry to DFE, floor to ceiling height permitting.

Add flood resistant landscaping

## FORT POINT CHANNEL




The Fort Point Channel Landmark District (FPCLD) encompasses roughly 55 acres across the Fort Point Channel from downtown Boston. Developed in the 1830s by the Boston Wharf Company and owned by the company until the early 2000s, the Fort Point Channel area is Boston's largest, most cohesive, and most significant collection of late 19th and early 20th century industrial loft buildings. Development of the Fort Point Channel area began in 1836 and continued until 1882. The Boston Wharf Company erected nearly all of the buildings in the FPCLD from the designs of their own staff architects.

### For more information on this district:

*https://www.boston.gov/historic-district/fort-point-channel*


### Resilience benefits in this district:

The Fort Point Channel Landmark District has many characteristics beneficial to mitigation and resilience strategies. The prototypical, brick warehouse buildings can commonly accommodate large-scale green and blue roofs that contribute to the management of storm water and reduce heat island effects. In addition, because they buildings have more available square footage, adaptation strategies that involve vacating the ground level can be made up for either on an upper level or with the addition of a penthouse. Tall floor to ceiling heights are also ideal for elevating the first floor.

**Fort Point Channel has the highest flood risk of all historic districts in Boston.**

**Please Note:**

*Alternate Adaptation*

If elevation of the interior first floor is not possible, the property owner may consider moving programmed spaces from the first level to the second level above the Design Flood Elevation (DFE). With permission from the commission, a penthouse addition can be added to make up for lost space.

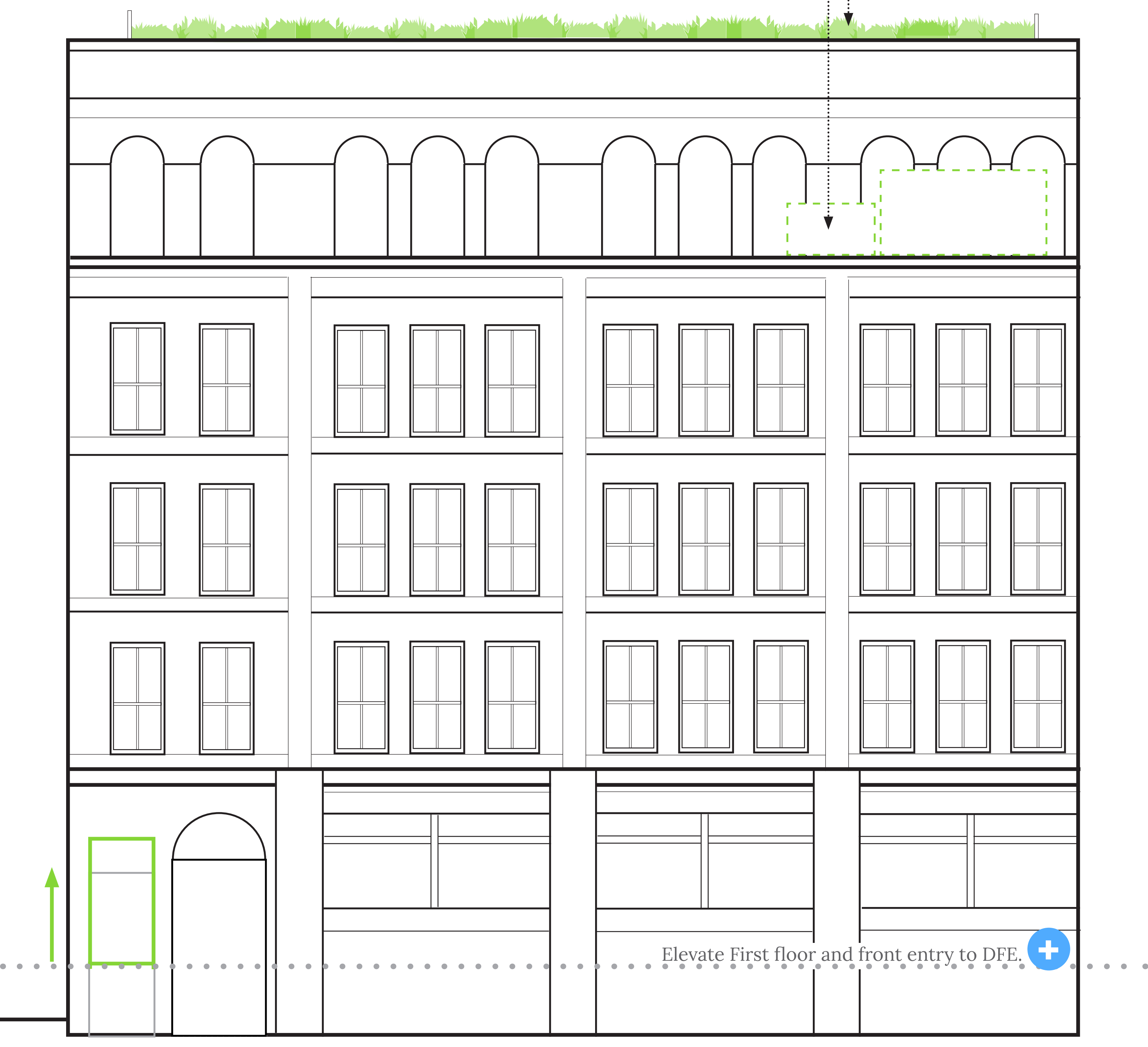
Green roof contributes to cooling and storm water management.
Co-benefit: public space for occupants

Mechanical system elevated to interior upper level or roof

MITIGATION

RESILIENCE

ADAPTATION



## BACK BAY ARCHITECTURAL DISTRICT

The Back Bay was originally a tidal body of water, used for mill operations. In the mid-19th century extensive landfilling began, resulting in over 450 acres of usable land by the 1880s. The Back Bay was an early planned fashionable residential district, based on Baron Haussmann's plans to remake Paris. As the tidal flats were slowly filled in, beginning at the edge of the Public Garden and extending westward, residential construction advanced on filled-in lots as they became available. As a result, Back Bay, when viewed in block sequence, illustrates the changing tastes and stylistic evolution of American architecture over the course of the mid- to late 19th and early 20th centuries. Commercial development started on Boylston Street around 1880, and on Newbury Street in the early 20th century, in some cases adapting existing row houses.


### For more information on this district:
[https://www.boston.gov/historic-district/back-bay-architectural-district](https://www.boston.gov/historic-district/back-bay-architectural-district)

### Resilience benefits in this district:
The Back Bay Architectural District has many characteristics beneficial to mitigation and resilience strategies. Many residences already have elevated entryways and first levels which protect the main living space from flood risks. In addition, Back Back has a substantive tree canopy, that residents can work to help protect.

MITIGATION

RESILIENCE

ADAPTATION

Install blue roof on flat roofs with parapet that render the roof invisible from the public way.

Elevate critical mechanical systems at interior or roof above the Design Flood Elevation at

Right -size downspouts to handle increasing precipitation loads. Many historic downspouts do not have a minimum load requirement.

**Please Note:**

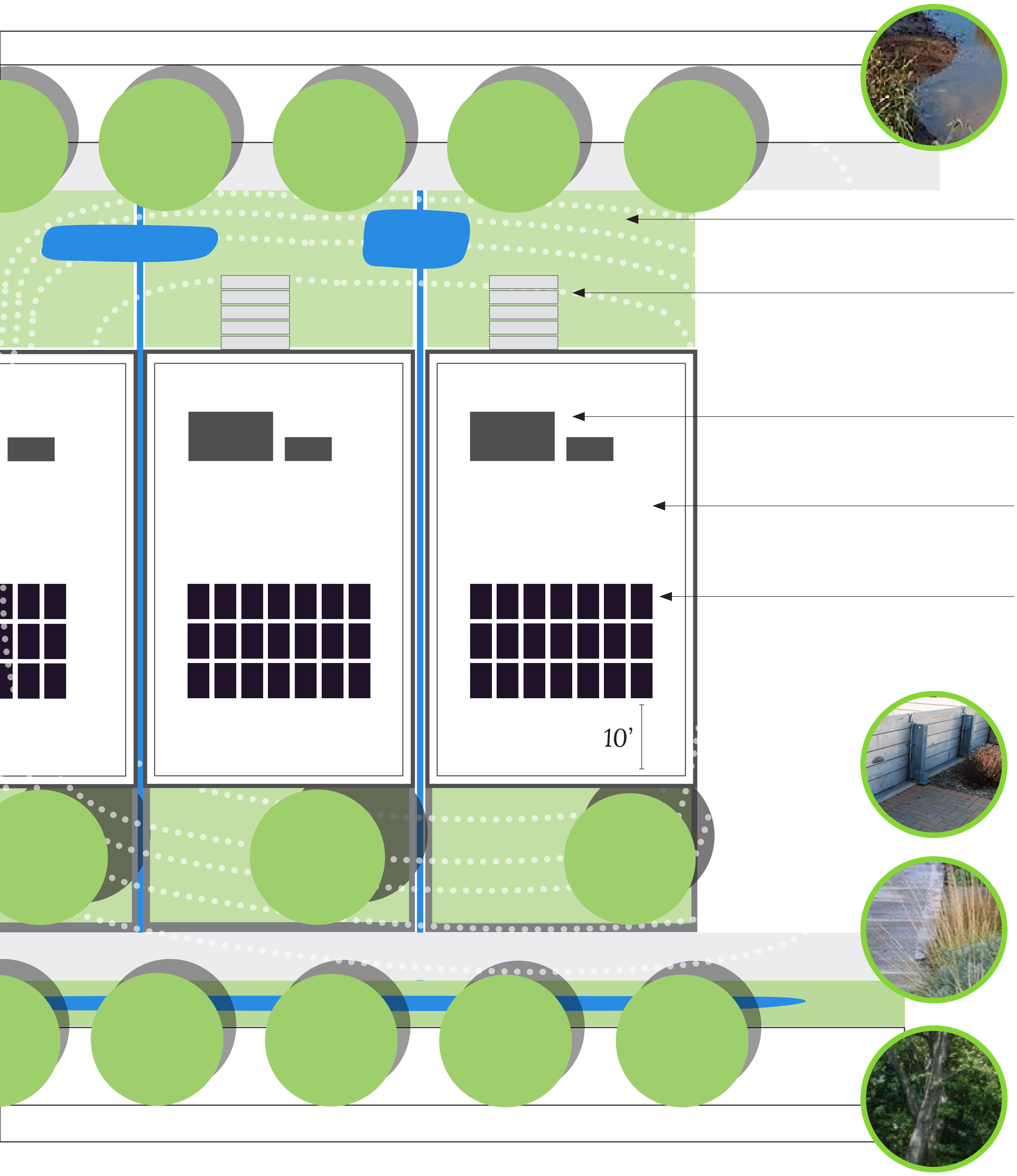
*Urban Tree Canopy*

Boston's urban tree canopy helps residents stay cool through shading of homes, creation of park space, and increased window and moisture flow. Back Bay has an exceptional canopy. With your help to maintain these trees, you can protect your neighbors from urban heat island effects.

Elevate First floor and front entry to DFE, floor to ceiling height permitting.

## SITE STRATEGIES

*Resilient Historic Buildings*



## ROOFS

### *Cool roofs*

Cool roofs may be appropriate on historic structures that have flat roofs and parapets, trim, or other ornamentation that render the roof invisible from the street front. Cool roofs can reduce the average interior temperature of a historic property by several degrees, as well as contribute to overall reduction of heat island effects in the neighborhood. **Review Required**.

**MORE INFORMATION:** [*https://www.energy.gov/energysaver/energy-efficient-home-design/cool-roofs*](https://www.energy.gov/energysaver/energy-efficient-home-design/cool-roofs)

### *Blue roofs*

Blue roofs are a type of roof that is designed to store rain water and slowly release it. As precipitation loads increase due to climate change, blue roofs can help manage these loads by reducing the amount of water handled by downspouts and aging infrastructure. Blue roof installation is subject to review by all historic commissions. **Review Required.**

*Please Note - Historic downspouts and gutter systems were not designed to a specific load amount and are often too small for present day precipitation events.*

### *Green roofs*

Green roofs are roofs designed to handle vegetation and soil loads. Green, vegetative roofs help reduce heat loads on a building, capture storm water, and can provide an outdoor amenity for residents. **Review Required.**

### *PV panels*

Photo-voltaic panels (solar panels) are an economical, clean, and efficient method of on-site energy production. Panels are acceptable on flat roofs, and must be invisible from the public way. **Review Required.**

**MORE INFORMATION:** [*https://www.energy.gov/eere/solar/homeowner-s-guide-going-solar*](https://www.energy.gov/eere/solar/homeowner-s-guide-going-solar)

### *Critical systems, mechanical systems*

The Boston Landmarks Commisison recommends that properties located in a Sea-Level Rise Flood Hazard Area (SLR-FHA) elevate their mechanical system to an attic space or to the roof during interior renovation projects. Consult the Boston Planning and Development Authority zoning map to understand your property's flood risk. **Review Required.**

## STORM WATER MANAGEMENT

### *Gutters and Downspouts*

Historic gutters and downspouts were not designed with precipitation load standards; therefore, they may not be suitable for increased precipitation loads. In some instances, it may be acceptable to install large downspouts and gutters to handle increasing precipitation loads. When replacing downspouts, the Commission encourages the property owner to consider installing downspouts with a cleanout at the bottom to enable the removal of debris.

Additional stormwater management systems on site should be considered but should not compromise the visual appearance of the facade. For example, a property owner may install rain barrels on the back facade or integrate flood mitigation strategies into the landscape if the strategy adheres to the historic guidelines.

The property owner should regularly maintain dry wells to ensure that they are functioning, not clogged or collapsed. Heating plates or strips can be installed on the interior of the gutter to mitigate ice damming.

**Review Required.**

## EXTERIOR SURFACES

### *Openings*
Your Historic District Commission may make an exception for the alteration of one opening to accommodate an elevated entryway in accordance with the consideration of the Base Flood Elevation. Alterations should be minimally impactful. The organization and appearance of windows should not be changed. When elevating the first floor, the floor to sill height of the window should be enough to accommodate the raised floor elevation without altering the window opening. The property owner should first consider altering the back facade to include a new entrance before considering alterations to the front facade. All interior alterations should be given preference over exterior alterations. **Review Required.**

### *Weatherization*
The Commission encourages weatherization of existing windows when applicable to reduce the energy consumption of the historic building. Installation of low-e glass that is similar in appearance/reflectiveness to existing glass, installation of storm window panes on the interior of the window, invisible films, caulking around the window frame are acceptable actions if they have minimal visual impact on the original appearance of the window. **Review Required.**

### *New Windows*
When the Commission allows window replacement, it encourages property owners to select windows that both adhere to the historic guidelines and also conserve energy. Insulated glass is encouraged by the Commission if the original muttin design can be maintained. **Review Required.**

### *Shutters*
The Commission encourages the restoration or installation of operable shutters. Operable shutters may be utilized as a passive cooling strategy. While the interiors of a historic property are not regulated, the Commission encourages the installation of interior shutters to contribute to passive thermal comfort. **Review Required.**

### *Temporary Flood Gates*
The Landmark Commission allows the installation of temporary, deployable barriers in anticipation of a storm event. No review of temporary, deployable barriers is required, however the use of deployable barriers should be in accordance with the Boston Department of Public Works guidelines for barrier systems. Barrier systems that require installation of permanent hardware must be reviewed by the Commission.

### *Entrance Areas*
Boston Historic Commissions may allow elevation of entryways in accordance with the Design Flood Elevation to mitigate the negative effects of flooding on the historic property. Alterations should be as minimal as possible. Property owners may considering expanding an existing opening such as a window to accommodate a doorway. If possible, the owner should make such alterations to the back facade rather than the facade visible from the public way. All changes must be reviewed by the historic district in which your property exists. **Review Required.**

− MITIGATION

= RESILIENCE

\+ ADAPTATION

## DESIGN STRATEGIES

*Extreme Precipitation Events, Storms, Sea Level Rise*

| STRATEGY | TYPE OF ACTION | DESCRIPTION |
|---|---|---|
| **Elevated site** | = + | An entire site can be elevated in anticipation of future flooding using cut and fill. |
| **Balanced cut and fill** | = | By keeping soils on site, this strategy can lead to cost savings, if existing soils are not contaminated. |
| **Permanent flood wall** | + | Flood walls can protect sites from storm surges and high tides, however the environmental impacts and potential for maladaptation should be considered. |
| **Levee** | + | While floodwalls are built with materials like brick or reinforced concrete, levees are typically made of compacted soil. |
| **Harbor barrier** | + | Harbor barriers can protect large areas from storm surges but may be overtopped by future sea level rise. |
| **Bio-swales** | = | Typically larger than rain gardens, bioswales facilitate on-site stormwater retention. |
| **Wave attenuation** | + | A built or natural formation that decreases a wave’s energy. |
| **Berm** | = + | A berm is a raised area of land that acts as a natural flood barrier. |
| **Water square** | + | An urban plaza designed to collect water and increase stormwater infiltration. These spaces are also designed for active public uses during clear weather. |
| **Permeable pavement** | = + − | Allows stormwater to move through paving to the soil beneath. |
| **Salt marsh** | = | Salt marshes protect shoreline areas from erosion, wave action, and flooding from extreme rain. They also provide habitat and improve water quality. |
| **Planting vegetation** | = − | Landscape strategies can help absorb flooding and increase stormwater infiltration. Saltwater tolerant plants should be chosen for areas exposed to coastal flooding. |
| **Elevated infrastructure** | + | Elevating roads, sidewalks, and seawalls can temporarily keep rising seas at bay. There are high costs associated with the elevation, maintenance, and the pumping stations installed in areas that cannot be elevated. |
| **Living shorelines** | = | A term used by NOAA to describe a natural bank stabilization technique that protects the area, creates habitat, and improves water quality. |
| **Temporary flood barriers** | = | Buildings can be designed with shield tracks that allow flood shields to slide into place, or temporary flood walls can be placed along the perimeter of a property. |
| **Dry flood proof critical facilities** | = | Mechanical equipment must be elevated above the BFE in FEMA Zone V. |

− **MITIGATION**

= **RESILIENCE**

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## DESIGN STRATEGIES

*Extreme Precipitation Events, Storms, Sea Level Rise*

| STRATEGY | TYPE OF ACTION | DESCRIPTION |
|---|---|---|
| **Dry flood proof ground level** | + | Hydrostatic and hydrodynamic pressure can cause structural damage. In post-FIRM buildings, dry floodproofing can only be used for non-residential spaces in A Zones. Not recommended for buildings with basements. |
| **Wet flood proofing** | + | Wet floodproofed spaces can only be used for parking, access, and storage. |
| **Rain garden** | = | Rain gardens, typically smaller than swales, can help increase stormwater infiltration and improve water quality. Cities can create rain garden programs as part of their educational outreach. |
| **Back flow prevention** | = + | Backflow prevention hardware helps protect potable water from contamination. |
| **Emergency power system** | = + | Renewable energy systems, including solar and wind, should be paired with energy storage to facilitate islanding. Buildings can also be equipped with emergency generators. |
| **Emergency drinking water and waste water provisions** | = | A disaster can impact the availability of clean, drinkable water. |
| **Rainwater harvesting** | = − | Rainwater harvesting can be used for irrigation. |
| **Blue roof** | + | Blue roofs are typically cool roofs that can also store rainwater. They are designed to release the water slowly. |
| **Sump pump** | = + | Sump pumps are a backup measure typically paired with dry flood proofing. These pumps help get rid of any water that makes it through a flood wall or flood shield. Sump pumps need electricity to operate, so buildings with pumps should also install an emergency power source. |
| **Securing large objects** | | May include securing an outdoor fuel tank, which could become debris and a source of contamination. |
| **Elevated mechanical systems** | = + | Elevating mechanical systems can allow for islanding. The best time to raise utilities above the DFE or SLR-DFE is when mechanical systems need to be updated. |
| **Elevated building** | + | Urban design strategies may be needed to connect an elevated building with the public realm. The only permanent uses allowed by NFIP below the lowest occupied floor of an elevated building are parking, storage, crawl space, and access. |
| **Low power occupancy mode** | = | This could include enough power for an elevator, water and waste water systems, some LED lighting, fridges, and a conditioned community room. |
| **Water damage resistant and saltwater damage resistant materials.** | = | Construction below the SLR-BFE should be resistant to damage from coastal flooding. In addition, NFIP requires that materials below the BFE be flood damage resistant. |

− MITIGATION

= RESILIENCE

\+ ADAPTATION

## DESIGN STRATEGIES

*Extreme Heat Events*

| STRATEGY | TYPE OF ACTION | DESCRIPTION |
|---|---|---|
| **Tree cover** | = − | Trees help lower temperature by providing shade. |
| **Planting vegetation** | = | Vegetation helps lower temperatures through evapotranspiration. |
| **Cool pavements** | = + | Cool pavements can help reduce heat islands by reflecting sunlight, enhancing evaporation, and staying cooler than conventional paving materials. |
| **High albedo materials** | = − | High albedo materials are surfaces that reflect sunlight rather than absorb sunlight. |
| **Green roof** | = + − | Green roofs can increase on-site storm water retention and help decrease urban heat island effects. |
| **Cool roofs** | = + − | Roofing system that is light in color and has high solar reflectance and thermal emittance. |
| **Green wall** | = − | Green walls can provide an additional layer of building insulation and help improve air quality. |
| **Exterior shading** | = − | Exterior shading can create thermal comfort in outdoor public spaces as well as help control the interior temperature of a building. |
| **Operable windows** | − | Operable windows function as a backup measure during power outages for temperature control and accessibility. |

## DESIGN STRATEGIES

*Greenhouse Gas Reduction and Net Zero Carbon Building Performance*

| STRATEGY | TYPE OF ACTION | DESCRIPTION |
|---|---|---|
| **Distributed energy** | − | Locally sited, small-scale energy sources. |
| **Renewable energy** | − | Strategies include solar, wind, biomass, and geothermal, among others. Solar panel arrays can also create shade. |
| **Efficiency measures** | − | A high performance building envelope facilitates islanding and efficient systems can help reduce demand on the grid during heat waves. |
| **Energy Storage** | − | A process that stores power for use during peak demands on the energy grid. |

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