Boston Coastal Resilient Design Guidelines & Zoning Overlay

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City's Strategy of Multiple Layers of Protection: Guidelines & Zoning

Climate Ready Charlestown:
Long-term flood protection systems for the Sullivan Square waterfront

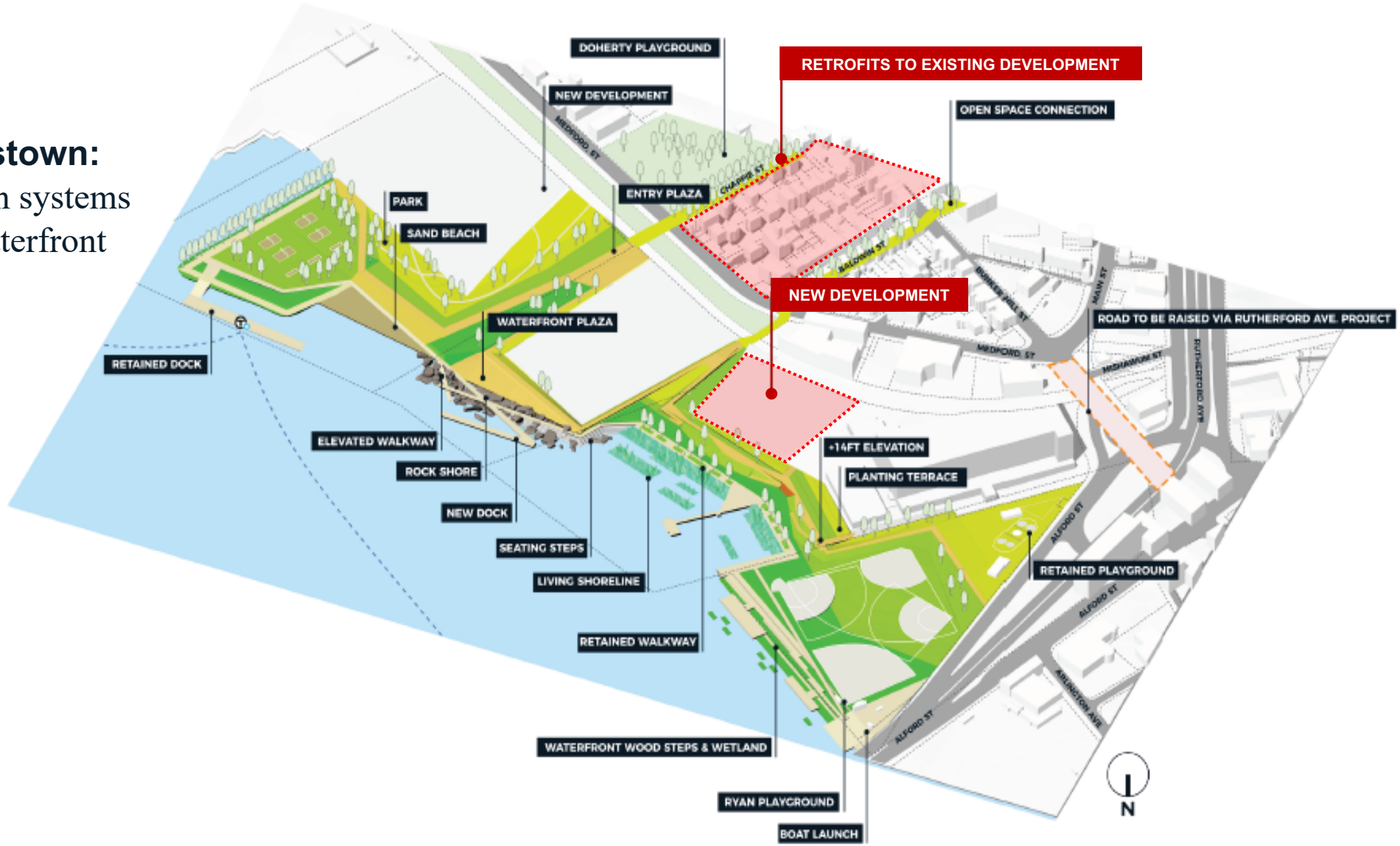


Image Source: Climate Ready Charlestown

Role of Zoning and Guidelines

Zoning

- Protect against risks to life safety and property damage, and conserve the value of land and buildings.
- Ensure existing zoning does not inhibit resilient design and upgrades.
- Specific zoning definitions, dimensional and use provisions to facilitate resilience.

Guidelines Document

- Provide specific design direction on implementing resilience measures for new construction and retrofits.
- Illustrate flood protection measures in Boston context.
- Guide development in Zoning Overlay

Coastal Resilience Design Guidelines & Zoning

I. Review of Best Practices

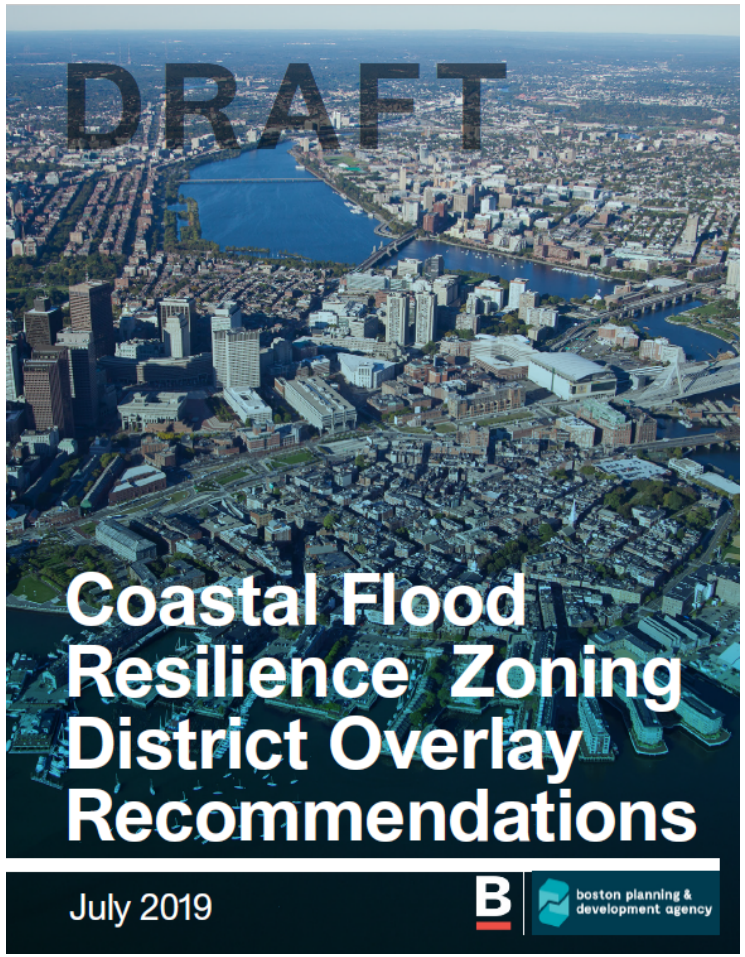
II. Review of Zoning Code, Overlays, State Regs

III. Internal Stakeholder Meetings

IV. Focus Groups

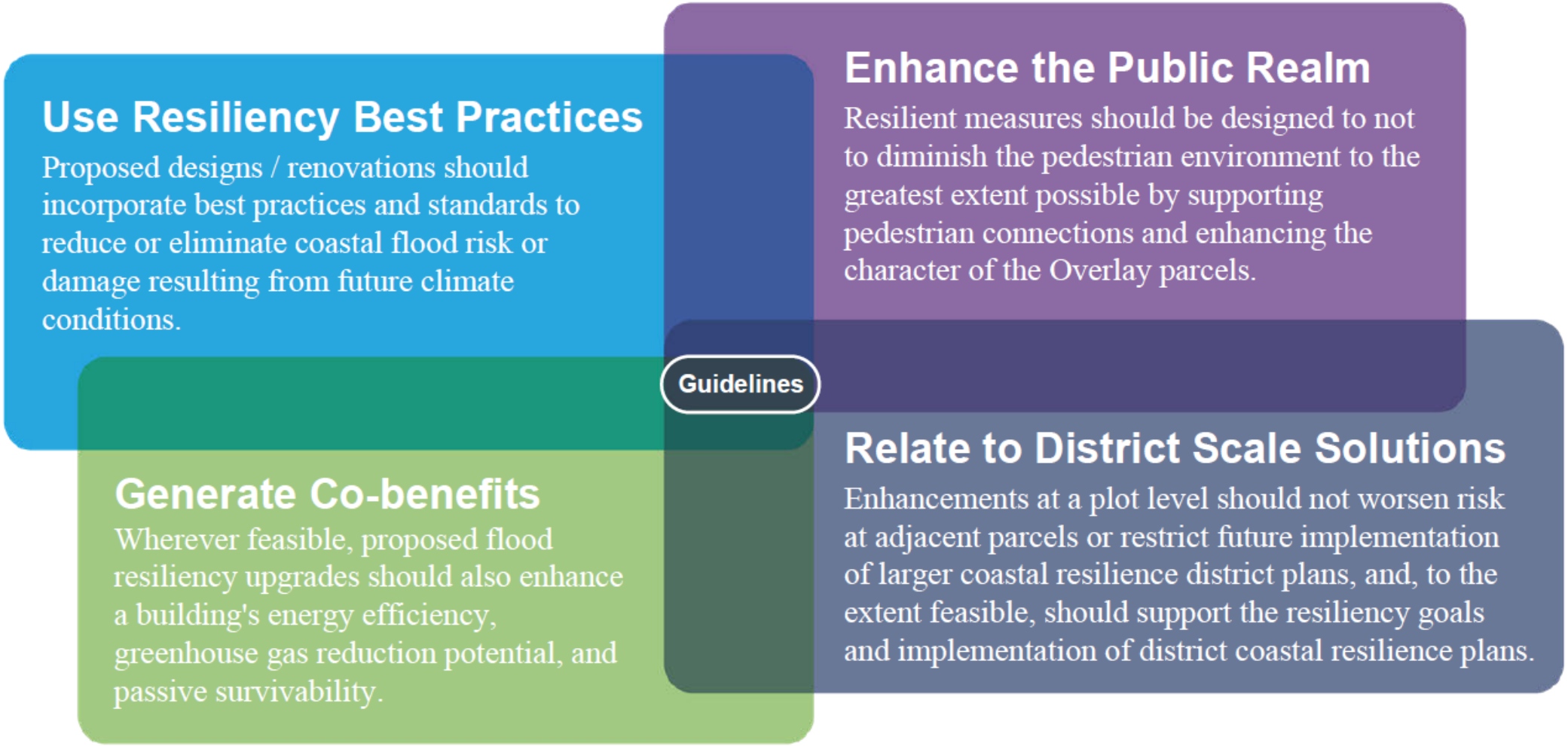
V. Public Engagement

VI. Draft Zoning Recommendations & Guidelines

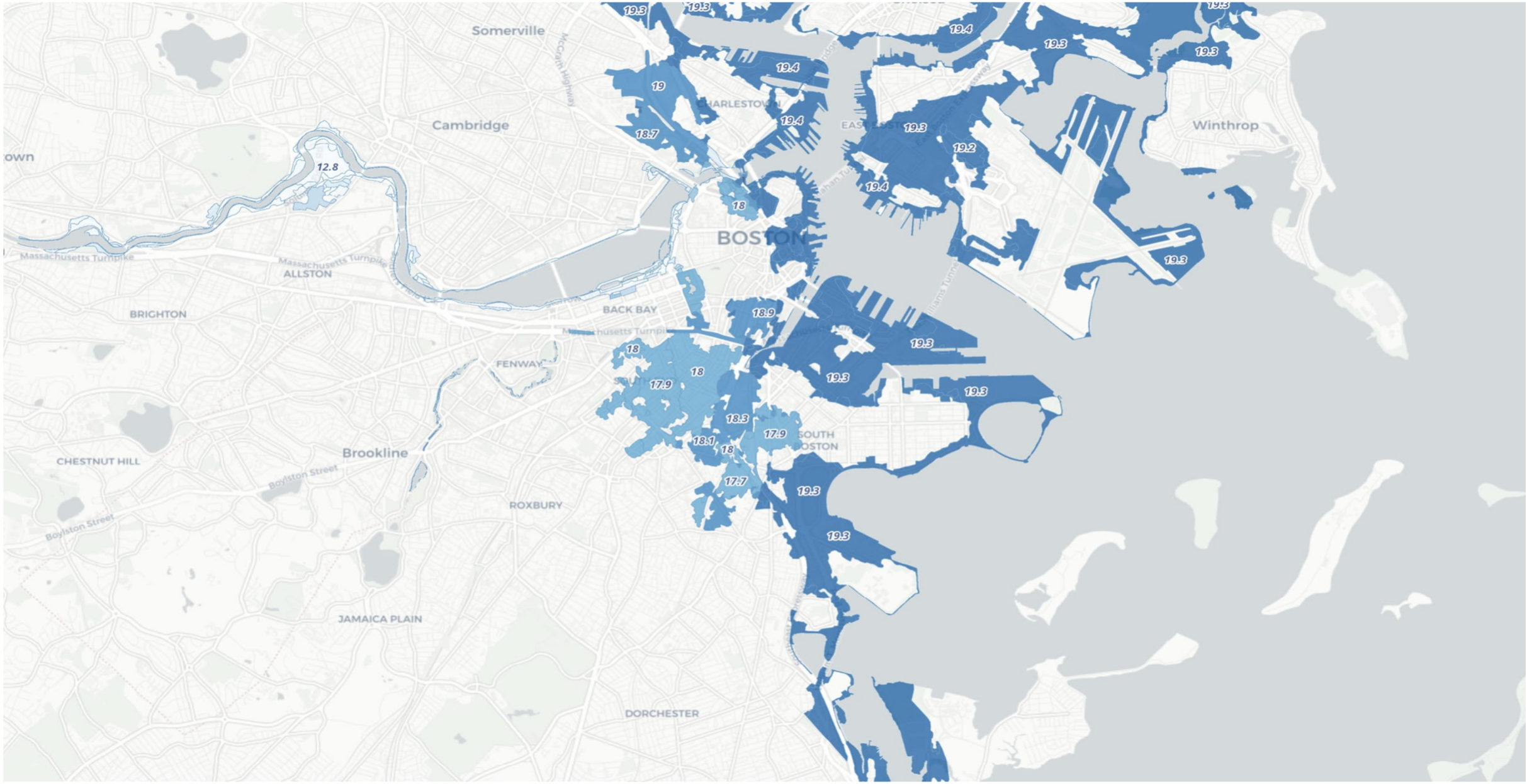


Coastal Resilience Design Guidelines

Guidelines - Resilient Design Principles



Coastal Resilience Design Guidelines



Coastal Resilience Design Guidelines

Protect Critical Systems

Building utility systems, including electrical and mechanical equipment, should be protected from flood risk to avoid costly damage, safety risks, and loss of habitability and other critical building functions during a flood event. This should be among the highest priority resilience actions for property owners.

For all new construction and substantial improvements, electrical, heating, ventilation, plumbing and air-conditioning equipment and other service facilities shall be designed and/or located so as to prevent water from entering or accumulating within the components during conditions of flooding. These systems and equipment include:

Mechanical
- Boilers and furnaces
- Air-handlers, condenser units, and heat pumps
- Ductwork and piping
- Fuel storage tanks
- Water heaters
- Fire-suppression sprinkler controls
- Elevator machine rooms

Electrical
- Electrical panels and switchgear
- Backup generators
- Alarm controls and components
- Service wiring and receptacles
- Building management systems
- Telecommunications equipment
- Electric and gas meters
- Utility shut-off switches

With proper planning, new buildings can easily accommodate the protection of critical systems by locating equipment in upper floors or in a mechanical penthouse. For renovation projects, the three main types of protection are elevation, relocation, and protection in place.
- **Elevate:** Outdoor equipment or ground floor equipment located in spaces with high ceilings can usually be elevated on pedestals or platforms to bring the systems above the flood elevation.
- **Relocate:** Depending on the available space within an existing building, service equipment from a basement or other area below the flood level can be relocated to an upper floor to bring the equipment and distribution systems above the flood elevation.
- **Protect in place:** When elevating and relocating are not practical or feasible, the last option to increase the resilience of critical systems is to protect them in place. This includes elevating to the greatest extent possible and dry floodproofing with low floodwalls and shields and with anchors and tie downs to prevent flotation.

Applicability

Project Scale	Non-Art. 80 renovations and new construction, Art. 80 renovations and new construction

Sustainability Co-benefits Considerations
- When replacing equipment, choosing high-efficiency models can reduce energy use, utility bills, and emissions of greenhouse gases and other pollution. It also reduces strain on the energy grid, making the whole system more resilient. This is exemplified in the case of replacing an old sub-grade furnace with a more fuel-efficient electric heat-pump system, located above the SLR-DFE.
- Electrification of heating systems, in combination with choosing clean sources of electricity and implementing energy efficiency improvements, will support Boston's efforts to achieve carbon neutrality.

Cost and Insurance Considerations:

$	$$	$$$	$$$$

- In FEMA V zones, elevating mechanical equipment is required for NFIP premium reduction.
- Relocating/Replacing critical utilities is also an opportunity to upgrade and increase the energy efficiency of a building's systems, which may lead to a reduction in annual utility costs.

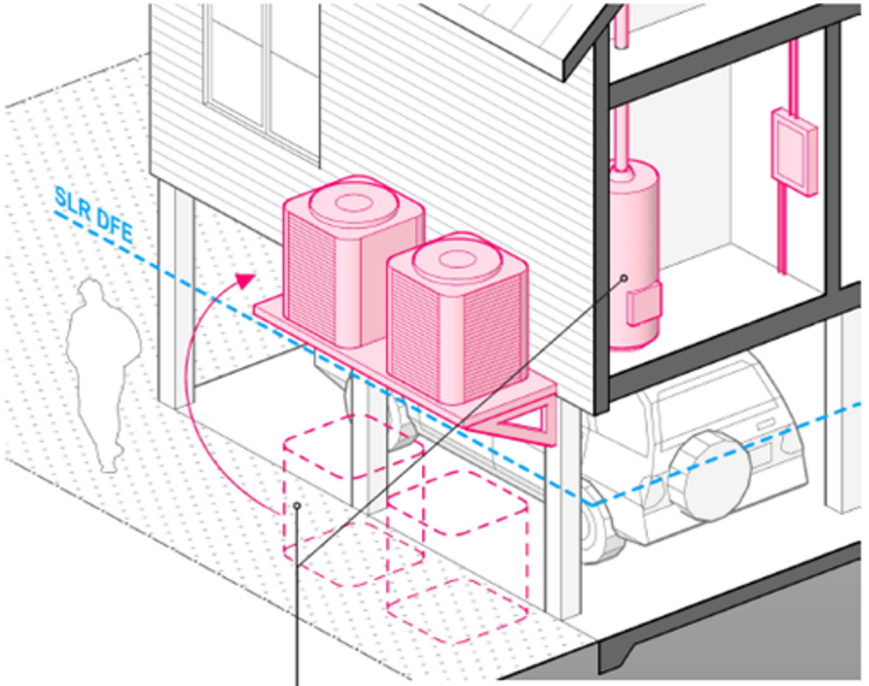
Additional Resources
- FEMA 348: Protecting Building Utilities From Flood Damage
- FEMA P-312, Homeowner's Guide to Retrofitting
- A Better City Report, Enhancing Resilience in Boston: A Guide for Large Buildings and Institutions
- FEMA Recovery Advisory 2: Reducing Flood Effects in Critical Facilities

Technical Considerations

Repair and Replacement
Use natural cycles of repair and replacement as opportunities to improve the flood resilience of building utility systems and equipment. For example, replacing an old furnace in the basement with a more compact mini-split heat pump can improve efficiency, reduce fossil fuel use, and make relocating or elevating heating and cooling systems more feasible in space-constrained buildings.

Energy Audits
Building owners should conduct an energy audit to identify opportunities for improvements in energy efficiency to coincide with resilience upgrades. This is not only limited to replacing old equipment with higher-efficiency models. An energy audit can reveal how upgrades to the building envelope can reduce heating and cooling loads, which can result in equipment down-sizing in addition to added efficiency.

Utility Coordination
Coordinate with the local utility company when planning modifications to the placement of electric and/or gas meters.



Protecting in Place
If protecting in place is the most feasible option, watertight walls and shields are most practical when flood depths are less than 3'. Utilize a watertight closure panel if a floodwall is too high to step over. Utilize anchors and tie-downs to hold equipment in place.

Elevating Equipment
When relocating or elevating MEP systems, consider horizontal and vertical clearances for routine maintenance; venting requirements for combustion equipment; drain pans for equipment containing water storage to prevent leakage; and provisions to prevent equipment from freezing.

Coastal Resilience Design Guidelines

Elevate Lowest Interior Floor with Exterior Circulation to DFE

Circulation to reach the elevated first floor level is provided outside the building through exterior walkways, ramps, or stairs. Design measures like planted areas, seating, lighting, and contextually appropriate materials are used to contribute to visual interest, break up the scale of larger surfaces, and add to neighborhood character.

To avoid disrupting visual connectivity and interest along the streetscape, designers should carefully consider the public realm when elevating a building's first floor above the SLR-DFE for flood protection.

Applicability

Project Scale	Non-Art. 80 renovations, Art. 80 renovations and new construction
Building Type	Triple decker, Townhouse, pre-war mixed use, contemporary mixed use
Location	Buildings outside of FEMA AE zones

Cost and Insurance Considerations

$ | $$ | $$$ | $$$$

- For projects within Article 25 (FEMA zone), the elevation of structures insured under the NFIP may be eligible for FEMA Hazard Mitigation Assistance grants and flood insurance premium reductions.

Public Realm Considerations

- This strategy can enhance the public realm if designed to add visual interest and to incorporate additional amenities such as landscape and seating.
- The design of exterior circulation elements should pay careful attention to universal design and accessibility. For example, ramps should be designed to be appealing to all users.

Additional Resources

- FEMA P-1037, Reducing Flood Risk to Residential Buildings That Cannot Be Elevated

Technical Considerations

Alternatives for Access
If a front yard ramp is not possible, an accessible exterior ramp may be provided within the side yard or rear yard.

Resisting Flood Loads
Stairs, ramps, and walkways must be designed to structurally resist design flood loads.

Floodproofing below the DFE
This strategy should be combined with floodproofing measures below the DFE to protect against flood damage. This would include either wet floodproofing to allow automatic entry and/or exit of floodwaters or dry floodproofing.

Consider the Public Right-of-way
Exterior ramps and stairs may not encroach into the public right-of-way. If a building has intentional setbacks that provided publicly accessible private space, that space may be used for accessible external ramps.

Furthermore, such additions added onto existing historic buildings will need to observe design guidelines within landmark districts.

Exterior Circulation and Vegetation
Saltwater tolerant planting is woven into the edges and railings that flank stairs and ramps, adding to visual interest along the sidewalk and softening the presence of paved areas. The use of vegetated areas also provides additional opportunities for stormwater and temperature mitigation.

Coastal Resilience Design Guidelines

Detached two-family

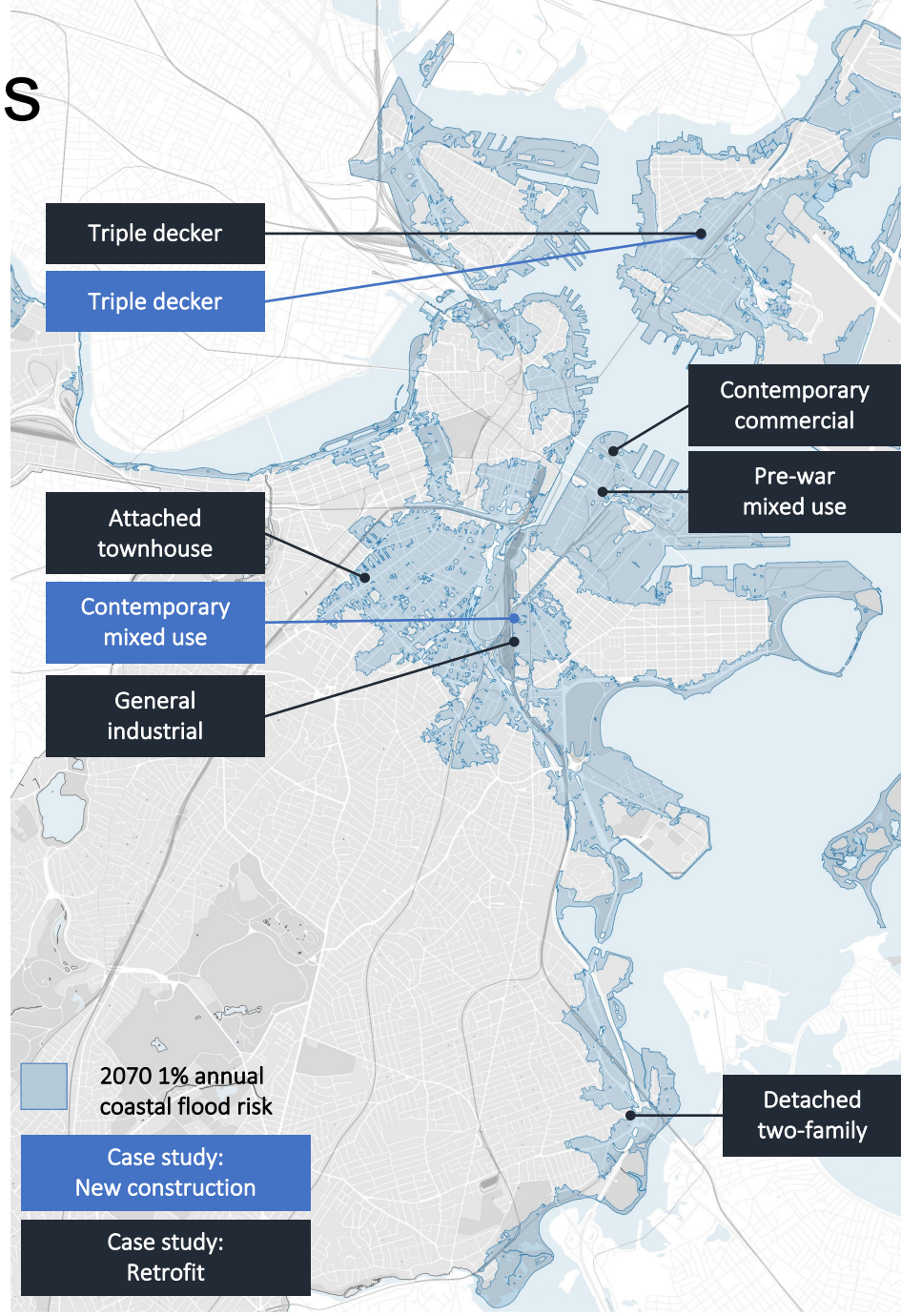
Triple decker

Attached townhouse

Pre-war mixed use

General industrial

Contemporary commercial

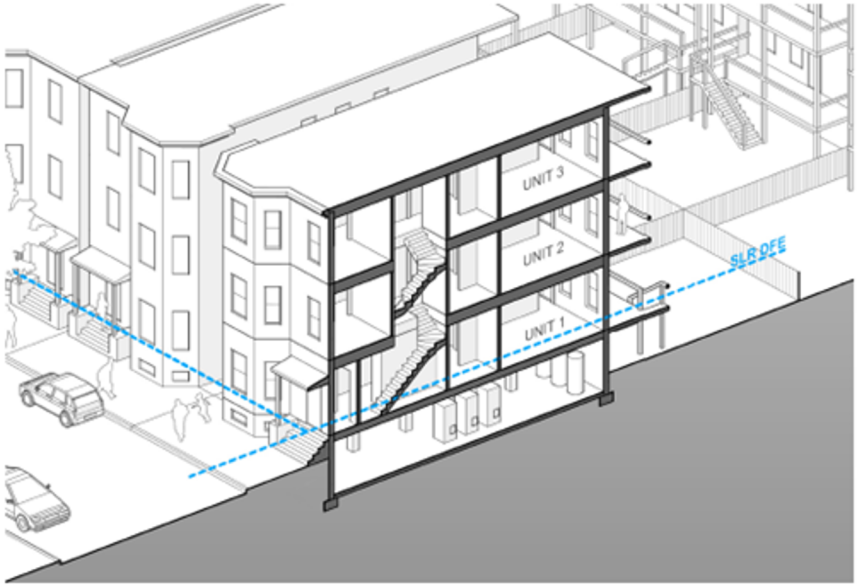


Coastal Resilience Design Guidelines

Triple-decker

Existing Conditions

One of the most prevalent building types in Boston, triple-deckers are commonly found in the Overlay neighborhoods of East Boston, South Boston, Dorchester, and Charlestown. They are typically free-standing, three-story wood structures commonly supported on fieldstone and brick foundations, with bay windows and covered stoops facing the sidewalk and tiered decks facing the rear yard.



Case Study Location

Sea Level Rise Conditions

SLR-BFE	19.50' BCB
SLR-DFE	20.50' BCB
FEMA BFE	17.46' BCB

Other Neighborhoods

Dorchester, Charlestown

Building Characteristics

Grade elevation	approx. 15.56' BCB
Lowest occupiable floor	approx. 18.75' BCB
Cellar elevation	10.10' BCB
Critical systems location	Basement
Construction type	Wood frame
Year built	Late 19th–early 20th century
Stories	3
Units	3
Sidewalk width	10'
Zoning district	Three-family Residential

Long-term Strategy

Supporting Strategies

Enhanced Envelope

Conduct energy audit and blower door test to identify air leaks.

Install blown-in cellulose insulation to wall cavities; add roof insulation outboard of deck.

Upgrade windows to low-e, low-U-factor casement windows.

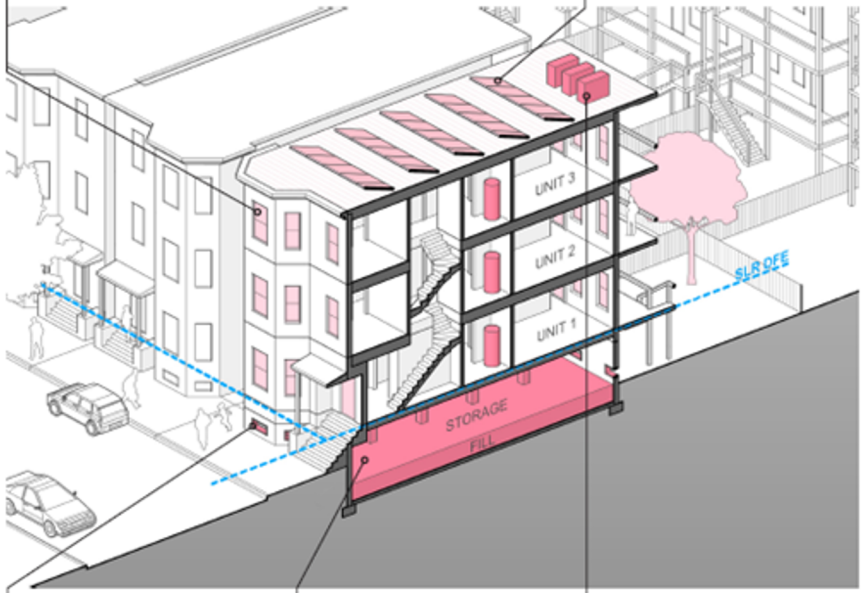
Cool roofing mitigates overheating by reducing roof temperatures

Consider envelope upgrades in conjunction with replacing critical systems for resilience. A better envelope can result in down-sized HVAC systems that are less expensive to operate.

Supporting Strategies

On-Site Energy Generation

Install islandable, grid-connected solar PV system on the roof.



Building Envelope and Access

Wet Floodproof

Install flood vents at foundation walls in order for water to enter and balance hydrostatic forces.

Use saltwater-damage-resistant materials below SLR-DFE.

Eliminate any habitable spaces below SLR-DFE. Limit uses below SLR-DFE to parking, access, and storage.

Building Form

Elevate Building on Extended Foundation Walls

Abandon basement and fill it to the lowest adjacent grade.

Elevate building such that first occupiable floor is above SLR-DFE. Extend foundation walls.

When filling basement, consider structure and envelope to prevent wicking of moisture up into building after flooding.

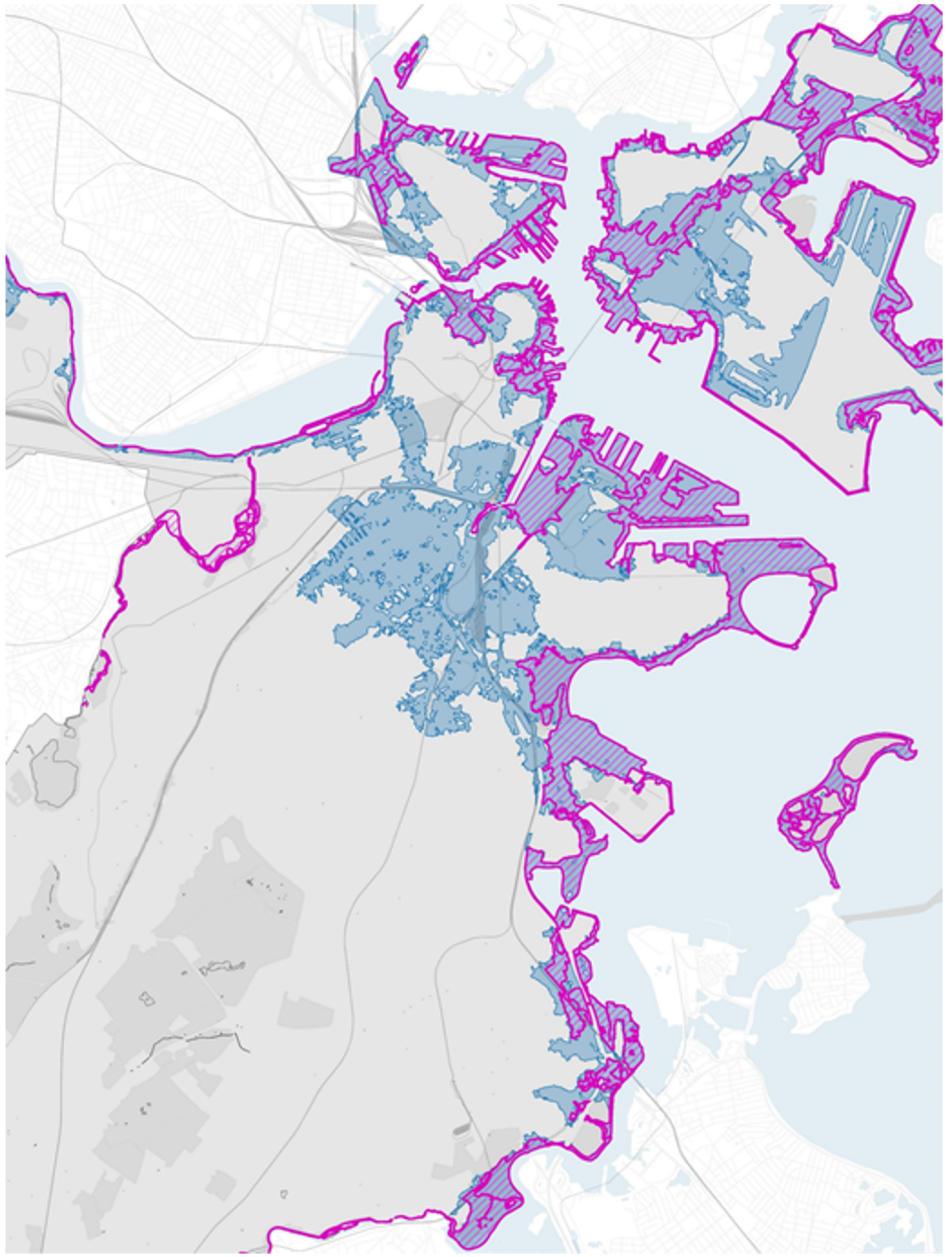
Building Systems

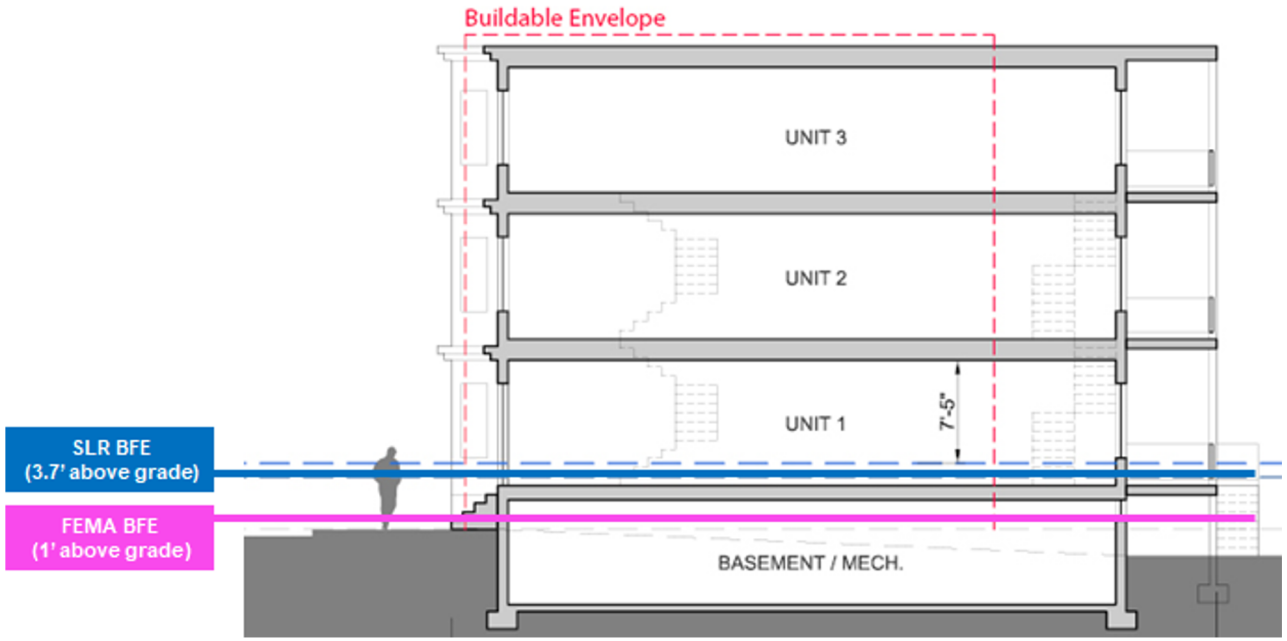
Protect Critical Systems

Locate water heater and critical systems above the SLR-DFE.

Upgrade heating to high-efficiency mini-split heat pump system with equipment located outside and above the SLR-DFE.

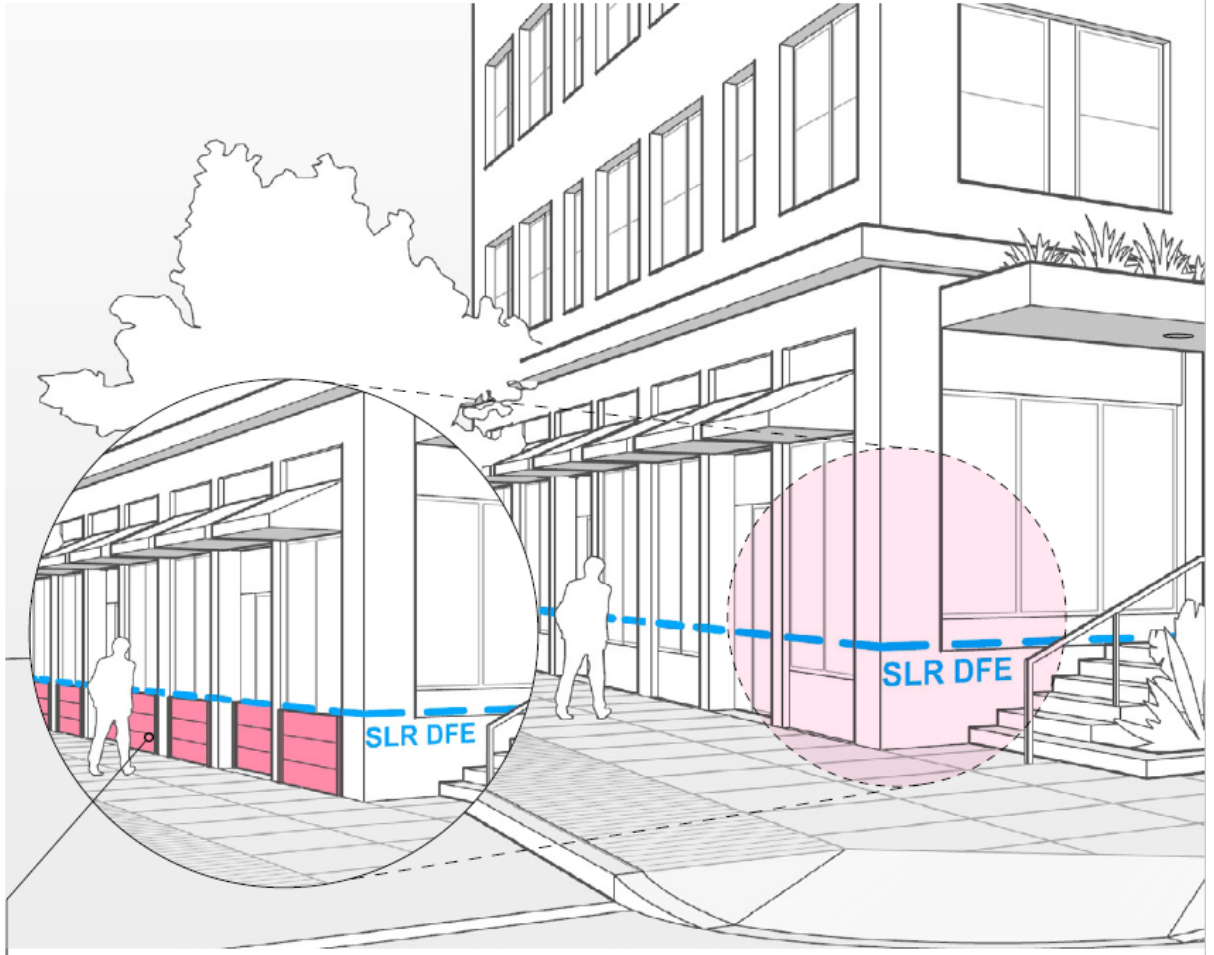
Coastal Flood Resilience Zoning Overlay





Coastal Flood Resilience Zoning Overlay

- Article 80 Resiliency Review & Guidelines
- Building Height (SLR-DFE)
- Gross Floor Area
- Lot Coverage & Setbacks
- Essential & Hazardous Uses



Resilient Design Strategy

Building Envelope and Access
Dry Floodproofing

Retail is kept at grade for sidewalk activation. During storm events, storefront doors are fitted with flood shields into built-in brackets. Retail space must be vacated prior to storm event. Walls, glazing supports, and building structure must be engineered to withstand hydrostatic pressure from floodwaters.

Building Envelope and Access
Wet Floodproofing

Residential access doors have flood vents and wet floodproofed lobby has saltwater-resistant materials. Access door and flood vents not shown.

Supporting Strategy
Enhanced Envelope

Exterior insulation and high performance windows allow interior spaces to maintain interior temperatures despite loss of heating during a power outage.