CLIMATE ACTION FACT SHEET

# Address vulnerable private and public buildings

## ENHANCE RESILIENCY BY RETROFITTING AND RELOCATING VULNERABLE BUILDINGS

Housing & Development

**Description and purpose of strategy:** Support approaches to develop resilient structures through relocation and retrofitting to address vulnerable buildings and structures threatened by flooding and erosion. This may include raising, floodproofing, and moving buildings out of the floodplain. Historic building preservation is also considered to maintain the Cape Cod character.

**Content of fact sheet:** Information on economic and equity implications, best practices, and the state of practice for retrofitting and relocating buildings within the community located in vulnerable areas.

**Implementation support:** This fact sheet expands upon strategies and actions from the Climate Actions Database, which can be found at: capecodcommission.org/climate.

### BENEFITS

- ☐ Greenhouse gas (GHG) emissions reductions or sequestration
- ☐ Health improvement from reduced pollutants
- ☐ Increased recreation
- ☐ Lower maintenance/operational costs
- ☐ Environmental enhancement/protection
- ☑ Less damage to infrastructure
- ☑ Higher property values
- ☑ Increased resilience
- ☑ Job and economic growth

### COSTS

- ☑ Higher capital costs
- ☑ Higher maintenance costs
- ☑ Higher operational costs
- ☑ Additional time for municipal staff to implement

## KEY FINDINGS

**Equity:** Strategies to foster equitable transitions that favor close community collaboration and focus on reducing potential risks and losses from climate hazards should be considered, which can be particularly burdensome for vulnerable communities.

**Financial benefits:** Preventive actions can reduce damage to building infrastructure and lessen losses to property value and tax revenue, in addition to providing job and economic growth if local companies carry out the retrofitting and relocating projects.

**Non-market benefits:** These projects can help preserve historic buildings that are part of the iconic Cape Cod character; they also enhance coastal resilience, with benefits to natural habitats from decreased development and relocation of structures out of the floodplain.

**GHG reductions:** There are no expected GHG reductions, as this is a resilience-only activity.

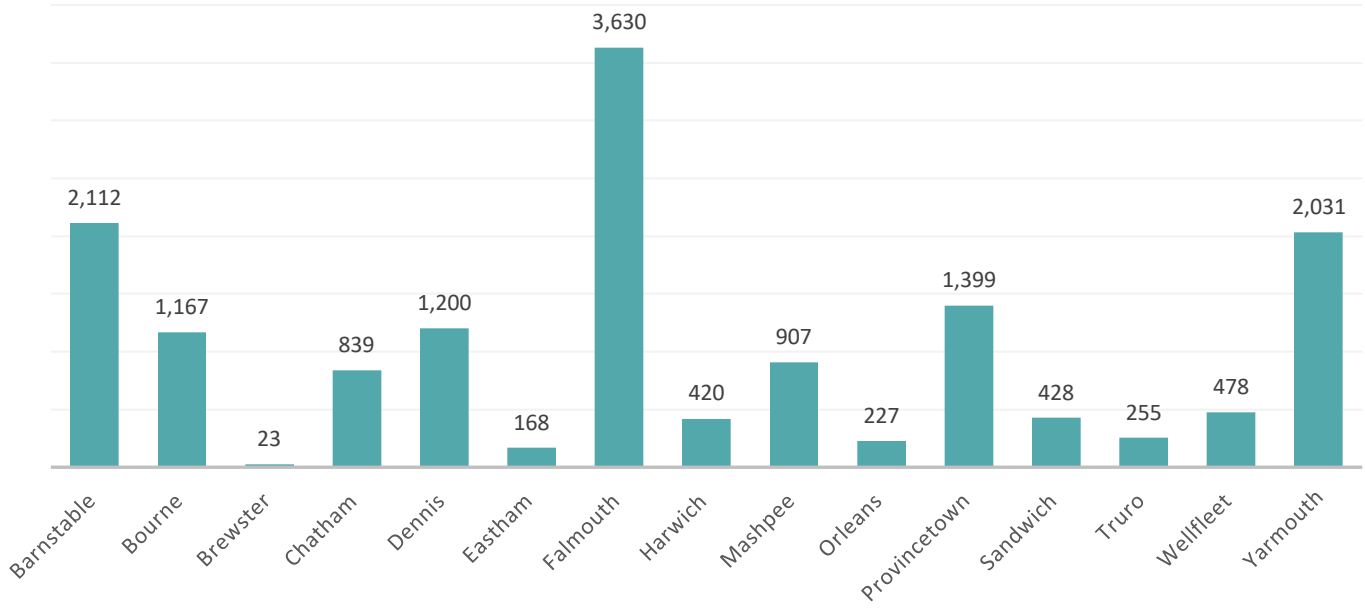
**Ease of implementation:** Adoption of floodplain and building design guidelines that local towns can use to foster preservation while adding resilient design features to historic buildings can assist with implementation.

## BENEFIT COST ANALYSIS

Cape Cod communities have billions of dollars of private property, businesses, and critical public infrastructure along the shorelines and within coastal hazard areas. Without adaptations in place, many properties could be lost to permanent flooding and many more could be exposed to storm surge damage. Sea level rise and storm surge are expected to damage buildings and undeveloped land, with associated impacts on local tax revenues.

The cumulative projected damages to buildings on Cape Cod between 2021 and 2100 are estimated to be $15.3 billion. In addition, sea level rise is estimated to result in over $5 billion in damage to undeveloped land. Damage to buildings and land have further implications as local governments are expected to lose almost $200 million in tax revenue due to sea level rise, with Barnstable and Falmouth expected to experience the highest losses: nearly $38 and $27 million, respectively, in lost tax revenue from 2021 to 2030.

### CUMULATIVE DAMAGE 2021–2100 (IN THOUSANDS OF 2020 USD)




Planning and action to protect buildings within floodplains will increase resiliency during storm events and protect against damage due to rising sea levels. Retrofitting and relocating vulnerable buildings will reduce expected damage. However, the costs of various approaches can be significant, as outlined below.

### ESTIMATED CAPITAL AND OTHER UP-FRONT COSTS

| ADAPTATION STRATEGY | TOTAL ESTIMATED CAPITAL AND OTHER UP-FRONT COSTS PER BUILDING |
|---|---|
| Relocation | $349,000 |
| Floodproofing | $100,000 |
| Elevating | $192,000 |
| Ringwalls—commercial/apartment building | $3,680,000 |
| Ringwalls—industrial building | $4,840,000 |

Note: Relocation, floodproofing, and elevating primarily pertain to coastal houses.
Source: (U.S. Army Corps of Engineers, 2015)

Relocating buildings is not currently practical on a large scale, but it may be a viable path for individual property owners and historic buildings—cases in which cost may be a significant obstacle, but relocation is deemed to be worth it. Building relocation requires extensive planning and is more complex and time-consuming in more densely developed areas.

Retrofitting is often a more feasible approach, despite operational and maintenance costs such as material management. New concrete ringwall foundations, which are installed at ground level and commonly designed to fit storage tanks, should only be put in place when the foundation or foundation wall of a building is not salvageable. For other retrofitting options, the Cape Cod Commission has been working to develop guidelines for floodproofing and elevating structures, including for housing of different styles. The guidelines include design considerations aimed at preserving the iconic Cape character by including a belt line to differentiate between historic and new building elements, flood vents matching window fenestration with contemporary details, new entry stairs that face the street, and fences and landscaping across the front to minimize visual impacts. The total capital and other up-front costs associated with raising a 1,400-square-foot building by 8 feet are estimated to be $208,385.

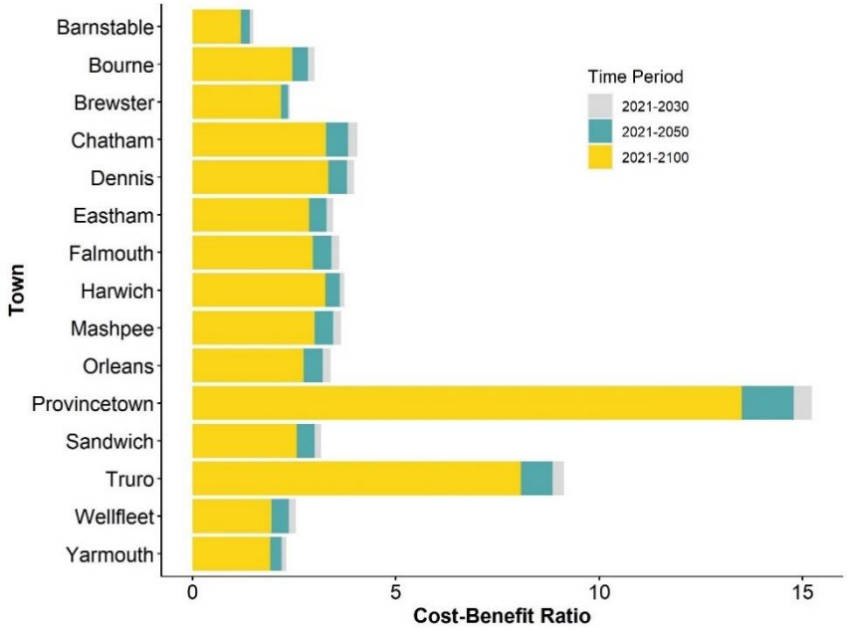
**COSTS OF RAISING A 1,400-SQUARE-FOOT BUILDING 8 FEET (IN 2020 USD)**

| CATEGORY | TOTAL COST |
|---|---|
| Elevation* | $132,837 |
| Temporary housing | $10,835 |
| Contingency** | $35,918 |
| Construction and management† | $17,959 |
| Engineering and design | $10,835 |
| **Total** | **$208,385** |

* Calculated assuming $94.88/square foot.
** Typically around 25% of the combined subtotal for temporary housing and elevation costs.
† Another 10% of the new subtotal including contingency costs.
Source: (U.S. Army Corps of Engineers, 2015)

The benefit cost ratio for raising buildings increases over time as avoided damages increase, ultimately climbing to $3 to $5 of avoided damages through 2100 per dollar spent. This strategy is especially successful in Provincetown and Truro due to the large amount of damage that raising buildings can prevent, such as the sizeable pier in Provincetown that would be economically beneficial to raise.

### BENEFIT COST RATIO FOR RAISING BUILDINGS BY TOWN




The appropriateness of different strategies will depend on the context. A more economical approach for towns with densely developed areas may be investments in shoreline solutions (establishing a boundary along the shoreline). Areas with less density per mile of shoreline may benefit from building-level strategies (e.g., floodproofing and raising buildings) in the near term to prevent damage from single events. Meanwhile, state and local governments often use buyouts to move residents out of flood zones and then use the acquired land to improve community resilience, rather than relocating buildings as a community-wide strategy.

### SUMMARY: RECOMMENDED ADAPTATION STRATEGIES

| ADAPTATION STRATEGY | RECOMMENDED USE |
|---|---|
| Relocation of buildings | Historic/high-priority buildings in especially vulnerable/environmentally sensitive settings (not practical on a large scale) |
| Retrofitting of buildings | Less densely populated areas and historic buildings |
| Shoreline solutions | Densely developed areas |
| Buyouts | Areas with severe and frequent flooding; an alternative to relocation |

## EQUITY

Retrofitting and relocating vulnerable buildings can reduce burdens on communities who face disproportionate impacts from climate hazards. The risk of coastal floods damaging or destroying low-income homes is projected to triple by 2050; Massachusetts is the third-highest state in terms of exposed affordable housing (Climate Central, 2020), with 4,817 units of housing exposed. Applying these principles can:

- **Reduce potential loss.** Enhanced building resiliency is crucial to reduce risks and potential losses. Climate hazards can be particularly burdensome for vulnerable communities, who may have fewer available resources to address property damage or loss when it occurs. Residents in flood zones can experience profound disruptions to their properties and vehicles, which hinders getting to work, school, or medical care.

- **Protect economic and natural resources.** Actions related to this strategy could increase protection of economic and natural resources that communities rely on for their livelihoods and wellbeing, such as income generated from tourism, wetland health (from enhanced zoning[1]), and water quality (from reduced debris[2]).
- **Preserve cultural and social value.** Retrofitting, as opposed to relocation, offers the opportunity to preserve the cultural and social value of the existing properties and communities that constitute the iconic Cape character. Similar to the above, preservation can help sustain existing sources of revenue and economic opportunities that communities across Cape Cod rely on—such as tourism to historical and cultural sites and buildings.

## Optimizing Equity During Implementation

Prominent or expensive properties often receive headline attention or permitting for shoreline structures, which can overlook structures at risk of significant damage from flooding. For actions to be equitable, though, the region's priority strategies must include all vulnerable properties. It is also critical to consider potential impacts to low-income or vulnerable residents from retrofits/repairs and building relocation, because additional community resources could play a role in a smoother transition. Increased support could include provision of alternative housing during a retrofit or moving process, along with transportation cost assistance to account for potentially longer travel times to reach work or essential services. In making decisions and allocating resources, municipalities need to be aware that strategies such as elevating buildings are costly and may not be available to everyone in the community, and that government housing security programs often overlook renters.

Best practices for retrofitting and relocation strategies include working closely with communities from the start of discussions and ensuring sufficient funds and resources are allocated for the community engagement process. Designing phased processes, not just short-term and standalone efforts, is another key part of facilitating more equitable transitions (Georgetown Climate Center, 2023). A multi-stage planning process is especially important because building relocation could cause secondary impacts to populations adjacent to climate-vulnerable areas. These potential impacts include further displacement within neighborhoods, gentrification, and increased housing costs.

# STATE OF PRACTICE

## General State of Practice

Federal Emergency Management Agency (FEMA) provides a manual to support planning, constructing, and maintaining residential buildings in coastal areas. For Massachusetts in particular, the Boston Planning and Development Agency provides coastal flood resilience design guidelines, with guidance for retrofits and new construction.

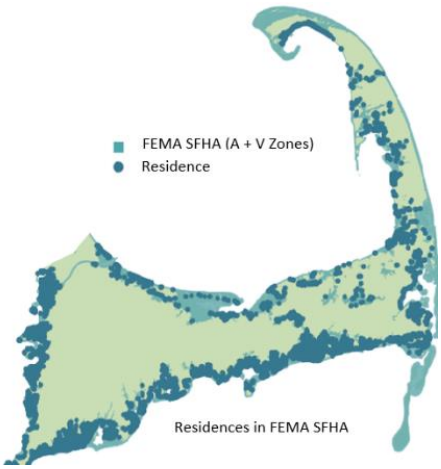
[1] A Cape Cod Commission project aims to develop complementary model wetlands and zoning regulations for coastal floodplains that help communities regulate development in high-hazard areas, while ensuring long-term protection of natural coastal systems.

[2] Proactive building retrofits and relocation could reduce structural damage and debris in waterways following hazard events.

## Cape Cod Context

Working with four communities—Bourne, Sandwich, Brewster, and Eastham—the Cape Cod Commission and partners have developed a model coastal resiliency bylaw that identifies strategies to mitigate risk in the floodplain and adapt to sea level rise. Any town can adapt the bylaw to fit its needs, or have its conservation commission adopt elements of the bylaw (e.g., performance standards) as local regulations. The bylaw identifies natural resource protection, flood protection, and land use strategies to further protect the natural and built environment within the Cape Cod region.

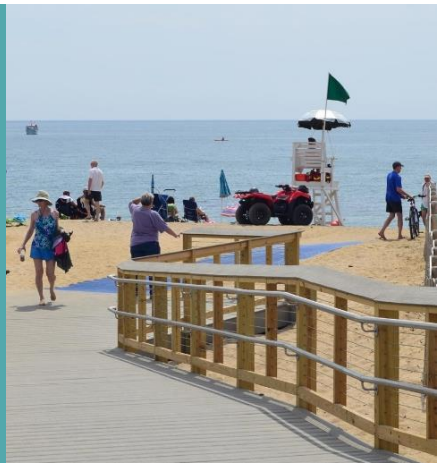
The Cape Cod Commission has also contributed to a guide to floodplain regulations and historic structures in Massachusetts and is currently developing guidelines that local towns can use to ensure consistency in flood hazard areas across the region.




19% of the region is in the FEMA Special Flood Hazard Area (SFHA)
Source: Cape Cod Climate Action Plan

### CASE STUDY: CAPE COD NATIONAL SEASHORE, MA

Damaged by a storm in 2011, the Herring Cove visitor center needed a collaborative effort to design replacement facilities that avoid permanent infrastructure placement in highly vulnerable areas. In July 2013, the bathhouse was removed and replaced with moveable structures to reduce vulnerability to sea level rise. Green design techniques included a 2-foot freeboard above base flood elevation and sustainably harvested wood. This project illustrated some important practices: incorporating climate change considerations into plans to enhance resiliency; conducting vulnerability assessments; implementing an adaptation plan; and public awareness, education, and outreach efforts (Borrelli, 2015).



## IMPLEMENTATION

Municipalities can take the following actions to protect vulnerable buildings:

- **Develop regulatory tools.** Tasks to aid development in the floodplain include identifying regulatory measures to support the model wetland bylaw, drafting and completing wetlands regulations, developing a model zoning bylaw for floodplain development, and conducting public outreach.
- **Design approach and estimate costs.** Work with the Army Corps of Engineers to model floodproofing measures and create cost estimates and design recommendations for historic buildings within the floodplain.
- **Draft floodplain design guidelines.** Ensure consistency in flood hazard areas across the region by developing design guidelines that local towns can use.
- **Community outreach.** Increase awareness among private property owners of strategies to prevent property damage due to sea level rise and storm surge.

#### REQUIRED EXPERTISE

**Internal:** Town planner, conservation commission, building officials, grant writer

**External:** Structural engineer

Resources that may assist in retrofitting and relocating vulnerable buildings are listed below.

| FINANCIAL AND TECHNICAL SUPPORT | |
|---|---|
| Hazard Mitigation Assistance (HMA) Grant Programs | Describes annual sub-grant programs from Massachuestts Emergency Management Agency (MEMA) for the federal Hazard Mitigation Grant Program, Flood Mitigation Assistance grants, Pre-Disaster Mitigation grants, and Building Resilient Infrastructure and Communities grants. |
| Coastal Resilience Grant Program | Offers retrofits and construction projects that upgrade or adapt vulnerable public facilities and infrastructure to withstand flooding and erosion over the design life given higher tides, greater storm surges, and more intense precipitation. Projects that relocate public facilities and infrastructure outside hazardous areas, where feasible, are strongly encouraged. |
| Federal Historic Preservation Tax Incentives Program | National Park Service program that encourages private sector investment in the rehabilitation and reuse of historic buildings. |
| **ADDITIONAL INFORMATION** | |
| Cape Cod Commission's Coastal Resiliency Bylaw | Includes the model bylaw (which focuses on risk reduction in the floodplain), communication frameworks for the four partner towns, and a catalog of regulatory and non-regulatory best practices. |
| Cape Cod Commission's Floodplain Regulations | Guide to floodplain regulations and historic structures in Massachusetts, provided by the Cape Cod Cooperative Extension, Woods Hole Sea Grant, and Cape Cod Commission. |
| Cape Cod Commission Sea Level Rise Viewer | Web mapping application intended to illustrate vulnerability to climate change and hazards related to significant meteorological events. |
| Cape Cod Coastal Planner | Online decision-support tool to explore tradeoffs associated with different coastal management strategies. Includes coastal hazard planning data layers. |
| Standards for the Treatment of Historic Properties | Standards from the Secretary of the Interior, with guidance for historic building owners and building managers, preservation consultants, architects, contractors, and project reviewers before they begin work. |

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Additional climate change information and resources can be found at capecodcommission.org/climate.