TOWN OF BELMONT

2020 HAZARD MITIGATION PLAN – MUNICIPAL VULNERABILITY PREPAREDNESS PLAN

Belmont
MASSACHUSETTS
The Town of Homes

Prepared by:

Weston & Sampson
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EXECUTIVE SUMMARY

Hazard mitigation planning is a proactive process used to systematically identify policies, actions, and tools that can be used to reduce the dangers to life and property from natural hazard events. Climate adaptation planning recognizes that climate change will exacerbate the vulnerabilities and risks associated with natural hazards. The Town of Belmont completed a planning process focused on both hazard mitigation planning and climate adaptation, which provides a robust assessment and implementation plan to build the Town's resilience. The Town is now also eligible for hazard mitigation funding through the Federal Emergency Management Agency (FEMA) and climate adaptation funding through the Massachusetts Executive Office of Energy and Environmental Affairs' Municipal Vulnerability Preparedness (MVP) Grant Program.

Planning Process

The Hazard Mitigation Plan and Municipal Vulnerability Preparedness Plan (HMP-MVP Plan) planning process was completed through the following steps.

1) Convened a core team of municipal department heads who provided key input through meeting, online surveys, and interviews.
2) Created a set of hazard mitigation and climate adaptation goals.
3) Established a list of critical facilities and assets.
4) Engaged the public through a Community Resilience Building Workshop and online public engagement techniques.
5) Conducted a vulnerability and risk assessment of historic hazards and the potential impact of climate change.
6) Documented the Town's capacity to mitigation and respond to hazard.
7) Developed an action and implementation strategy.
8) Sought public feedback on the final document.

Vulnerability and Risk

The Belmont HMP-MVP Plan assesses the potential impacts to the Town from a variety of natural disasters including flooding, high winds, winter storms, brush fire, geologic hazards, extreme temperatures, and drought. These are anticipated to worsen with climate change.

- Flooding
- Drought, Extreme Heat, & Wildfires
- Severe Thunderstorms, Wind, Tornadoes, & Hurricanes
- Ice, Nor'easters, & Extreme Cold

The HMP-MVP Plan documents the location and exposure of over 170 critical facility and assets. Among them are emergency services, roads, utilities, social services, and natural resources.

Hazard Mitigation and Climate Adaptation Goals

The Town endorsed the following set of hazard mitigation and climate adaptation goals.

- Prevent and reduce the loss of life, injury, public health impacts and property damages resulting from all major natural hazards and anticipated impacts of climate change. This may include preventing damages to:
  - Commercial, industrial, and residential structures.
  - Cultural and historic resources.
  - Public infrastructure, buildings, and essential services, such as electric power, drinking water, and the sewer system.
  - Vulnerable populations, such as elderly residents.
- Identify and seek funding for measures to mitigate or eliminate each known significant hazard area and reduce the impacts of climate change.
- Integrate hazard mitigation planning and climate change projections as an integral factor in all relevant municipal departments, committees and boards.
- Facilitate collaboration in hazard mitigation planning, including collaboration with surrounding communities; state, regional and federal agencies; the business community, major institutions and non-profits.
- Ensure that future development meets federal, state, and local standards for preventing and reducing the impacts of natural hazards today and under climate change projections.
- Take maximum advantage of resources from FEMA and MEMA to educate Town staff and the public about hazard mitigation and climate change.

Hazard Mitigation Strategy

Through the planning process, several hazard mitigation and climate adaptation measures were identified as high priorities.

- Culvert replacements and upgrades using climate projection design standards
- Implement a sewer lining program and repair failing infrastructure
- Decrease potential leaching hazard from former incinerator and develop site into beneficial use
- Complete a Stormwater Computer Model
- Conduct a Low Impact Development (LID) stormwater management opportunities analysis
- Implement measure identified in planning efforts that intersection with hazard mitigation and climate resilience
- Identify a stable and reliable funding source for stormwater management
- Develop an Emergency Response Plan and Ongoing Communication Program
- Improve the resilience of municipal buildings

Next Steps

The Town of Belmont is dedicated to implementing the findings of this plan and documenting the process. As a now eligible community for funding through the MVP Program and FEMA, the Town will look to secure resources, and to work with regional and local stakeholders, to complete the projects identified herein. The Town will also continue to document hazard impacts and needed improvements to the Town's capacity to mitigation and adapt. Lastly, the Town will proactively incorporate the hazard mitigation and climate adaptation goals into municipal planning, budgeting, and operations. By doing so, the Town will be ready to update this plan in five years to maintain its eligibility for grant funding.

1.0 INTRODUCTION

The Town of Belmont prepared a joint Hazard Mitigation Plan and Municipal Vulnerability Preparedness Plan (HMP-MVP Plan) as an action strategy to reduce the impacts of natural hazards and climate change within the community and the region. The Belmont HMP-MVP Plan was adopted by the Select Board and approved by Federal Emergency Management Agency (FEMA) to update and replace the *Town of Belmont Hazard Mitigation Plan (2013).*

1.1 What is a Hazard Mitigation Plan and Municipal Vulnerability Preparedness Plan?

Natural hazards, such as earthquakes, hurricanes, and flooding, can result in loss of life, disruptions to everyday life, and property damage. Hazard mitigation is the effort to reduce these disruptions through community planning, policy changes, education programs, infrastructure projects, and other activities (FEMA, 2020a). Hazard mitigation *planning* uses a stepped process with participation of a wide range of stakeholders to:

1. Define local hazards.
2. Assess vulnerabilities and risks.
3. Review current mitigation measures.
4. Develop priority action items.

The resulting HMP and action strategy saves lives and money. For every dollar spent on federal hazard mitigation grants, an average of six dollars are saved (FEMA, 2018a). There are many additional benefits of mitigation planning. HMPs increase public awareness of natural hazards that may affect the community. They allow state, local, and tribal governments to work together and combine hazard risk reduction with other community goals and plans. HMPs focus resources and attention on the community's greatest vulnerabilities. The vulnerability assessment of an HMP documents data related to the National Flood Insurance Program (NFIP), such as repetitive loss sites, and ongoing work by the community related to floodplain management.

Figure 1-1. FEMA Hazard Mitigation Planning Saves Money Graphic (FEMA, 2018a)

By completing an HMP, municipalities also become eligible for specific federal funding and allow potential funding sources to understand a community's priorities (FEMA, 2019a). Hazard mitigation funding is available through the FEMA. To be eligible for FEMA grants, local governments are required to prepare an HMP meeting the requirements established in the *Robert T. Stafford Disaster Relief and Emergency Assistance Act*, as amended by the *Disaster Mitigation Act of 2000.* See Table 1-1 for a description of FEMA Grants.

Table 1-1. FEMA Grants

FEMA Grants	Purpose
Hazard Mitigation Grant Program (HMGP)	Helps communities implement hazard mitigation measures following a Presidential Major Disaster Declaration.
Pre-Disaster Mitigation Program (PDM)	Assists in implementing a sustained pre-disaster natural hazard mitigation program, in order to reduce risk to the population and structures from future hazard events.
Public Assistance Grant Program (PA)	Provides supplemental grants so that communities can quickly respond and recover from major disasters or emergencies.
Fire Management Assistance Grant Program (FMAG)	Available for the mitigation, management, and control of fires on publicly or privately owned forests or grasslands.

(FEMA, 2020b)

1.2 What is a Municipal Vulnerability Preparedness Program?

In 2017, the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) initiated the Commonwealth's MVP grant program to help communities become more resilient to the impacts of climate change. The program provides two grant phases. The first grant phase is the planning grant, which funds a planning process to identify priorities action items to address vulnerabilities and utilize strengths in preparation for climate change. The MVP planning process includes convening a team of municipal staff, engaging stakeholders in a Community Resilience Building Workshop following a guidebook developed by The Nature Conservancy (n.d.) and engaging the public. Communities that complete the planning grant program and prepare an MVP Plan become eligible for the second phase of MVP grant funding, the action grants, and receive increased standing in other state grant programs. MVP action grants fund the implementation of priority climate adaptation actions described in the MVP Report. Since these action grants are only distributed to Massachusetts municipalities, they are much less competitive than a similar grant that is awarded nationally.

Community Resilience Building Workshop Guidebook

The *Community Resilience Building Workshop Guidebook* provides a process for developing resilience action plans. The process has been implemented and successful in over one-hundred communities. The process, outlined below, is rich in information and dialogue and results in actionable plans and strong collaboration.

The Community Resilience Building Workshop Guidebook's central objectives are to:

- Define top local natural and climate-related hazards of concern.
- Identify existing and future strengthen and vulnerabilities.
- Develop prioritized actions for the community.
- Identify immediate opportunities to collaboratively advance actions to increase resilience.

1.3 Hazard Mitigation and Municipal Vulnerability Preparedness Planning in Belmont

The Town of Belmont (The Town) received an MVP Planning Grant to simultaneously prepare an MVP Summary of Findings and an HMP. Many of the required steps of the MVP process also satisfy requirements for updating an HMP. As a result, the Town created an action strategy that considers both the impacts based on historic data and climate change protected threats, following the lead established by the Commonwealth when it adopted the first-ever Massachusetts State Hazard Mitigation and Climate Adaptation Plan (MA EOEEA and EOPSS, 2018).

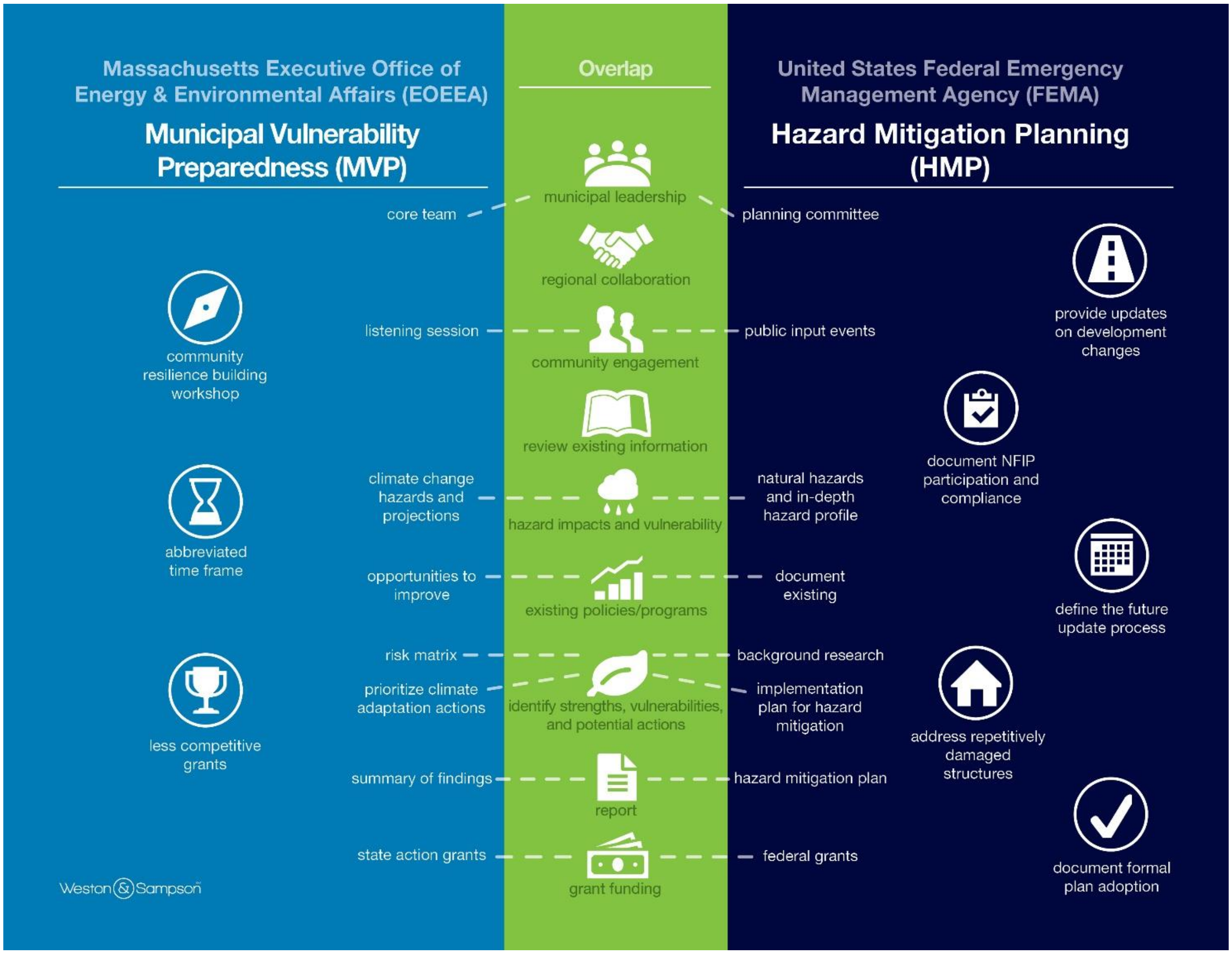


Figure 1-2. Comparison of MVP and HMP Planning Process (Weston & Sampson, 2020)

1.4 Planning Process Summary

To prepare for the development of this HMP-MVP Plan, the Town convened a core team of municipal leaders to lead the process and provide local expertise. The Town also followed the process described in the *Community Resilience Building Workshop Guidebook.* The guidebook provides a clear approach on how to organize the public process for mitigating the impacts of, and increasing resilience against, natural hazards and climate change. An important aspect of the natural hazard and climate change impact mitigation planning process is the discussion it promotes among community members about creating a safer, more resilient community. Developing a plan that reflects the Town's values and priorities is likely to produce greater community support and result in greater success in implementing mitigation strategies that reduce risk.

Federal regulations for HMP approval also guided the process. Most importantly, FEMA requires that stakeholders and the general public have opportunities to be involved during the planning process and in the plan's maintenance and implementation. Community members can therefore provide input that can affect the content and outcomes of the mitigation plan. The planning and outreach strategy used to develop this HMP-MVP Plan had three tiers: 1) the core team, with representation from municipal leadership at the Town, 2) stakeholders who could be vulnerable to, or provide strength against, natural hazards and/or climate change, and 3) the public, who live and work in the Town.

1.4.1 Core Team

The Town convened the Core Team to act as a steering committee for the development of the HMP-MVP Plan. The Core Team met on October 15, 2019 to plan for the Workshop, review public comments, develop the mitigation plan, and transition to implementation of the plan's mitigation strategies. More information on these meetings is included in Appendix A.

The Core Team established goals for the plan, provided information on hazards affecting the Town, identified critical infrastructure, identified key stakeholders, reviewed the status of existing mitigation measures, and developed proposed mitigation measures for this plan. Members of the Core Team are listed in Table 1-2.

Table 1-2. Belmont's Core Team

Name	Title
Diana Ekman	Assistant Director of Health Board
Glenn Clancy	Community and Economic Development Director
Jason Marcotte	Department of Public Works Director
Jon Marshall	Assistant Town Administrator, Parks and Recreation Department
Mary Trudeau	Conservation Commission
Patrice Garvin	Town Administrator
Steve Dorrance	Facilities Director
Wesley Chin	Health Department Director
Wayne Haley	Director of Emergency Management Agency, Assistant Fire Chief
James MacIsaac	Assistant Police Chief

The Core Team developed the invitation list for the Community Resilience Building Workshop at which key stakeholders were invited to help the Town identify hazards, vulnerabilities, strengths, and proposed actions to mitigate the impacts of natural hazards and climate change. The Core Team sought to include municipal leaders as well as politicians, representatives from local nonprofit organizations, local universities, other local jurisdictions, regional organizations, and state government. The Core Team was also interviewed to update the status of the previous hazard mitigation plan and weighed in the prioritization of the action items through a survey. The Core Team also suggested or made available reports, maps, and other pertinent information related to natural hazards and climate change impacts in Belmont. These included:

- *Town of Belmont Hazard Mitigation Plan* (Town of Belmont and MAPC, 2013)
- *Open Space and Recreation Plan 2008 Update* (Town of Belmont, 2008)
- *Town of Belmont Climate Action Plan* (Town of Belmont, 2009)
- *Town of Belmont Comprehensive Plan 2010-2020. A Vision for Belmont: Mapping a Sustainable Future* (Town of Belmont, 2010)
- *A Working Vision for Belmont's Future: Priorities and Progress* (Town of Belmont, 2015)
- Town of Belmont Stormwater Management and Erosion Control By-Law (Town of Belmont, 2013)
- Stormwater Management and Erosion Control Rules and Regulations (Town of Belmont, 2014)

- *Rock Meadow: A Conservation Master Plan* (Belmont, 2018)
- Massachusetts Climate Change Projections (NECASC, 2018)
- *Massachusetts Climate Change Adaptation Report* (EEA, 2011)
- *Massachusetts State Hazard Mitigation and Climate Change Adaptation* (EEA and EOPSS, 2018)
- *Local Mitigation Plan Review Guide* (FEMA, 2013)
- Flood Insurance Rate Maps for Middlesex County, MA, (FEMA, 2010)
- National Center for Environmental Information (NOAA)
- National Water Information System (USGS)
- US Decennial Census (US Census Bureau, 2010)
- American Community Survey (US Census Bureau, 2018)

1.4.2 Stakeholder Involvement: Community Resilience Building Workshop

Stakeholders with subject matter expertise and local knowledge and experience, including public officials, regional organizations, neighboring communities, environmental organizations, and local institutions, were invited to engage in a two-part Community Resilience Building Workshop, held on January 27th, 2020. During the first part of the Workshop, Weston & Sampson provided information about natural hazards and climate change and participants identified top hazards; infrastructural, societal and environmental features in the Town that are vulnerable to or provide strength against these challenges. During the second part of the Workshop, participants identified and prioritized key actions that would improve the Town's resiliency to natural and climate-related hazards. Community representatives who were invited and those who participated in the process are presented Appendix C with the materials from the Workshop.

Town leadership, including a member of the Select Board, the Town Administrator, and Assistant Town Administrator participated in the CRB Workshop. Staff members of the Town Planning Board, Community Development, Fire Department and Department of Public Works, who all play a role in land use planning or site development approvals, attended as well. Other perspectives were represented, such as the Stormwater Working Group, Information Technology Advisory Committee, Emergency Management Committee, Capital Budget Committee, and the Health Board. Representatives from the Council on Aging, School Committee, and the Cultural Council also participated. Regional representation included the MVP Regional Coordinator and representatives from the Office of the Massachusetts Representative Dave Rogers, Mystic River Watershed Association, and Massachusetts Water Resource Authority. Municipal staff from neighboring communities of Lexington, Arlington, Waltham, and Cambridge were invited to participate. The names and positions of all the stakeholders who were invited and those who were able to attend the Workshop are available in Appendix C. This broad representation of local and regional entities ensures the HMP-MVP Plan aligns with the operational policies and any hazard mitigation strategies at different levels of government and implementation.

Figure 1-3. Belmont CRB Workshop (Weston & Sampson, 2019)

1.4.3 Listening Session

To gather information from the public and to educate the public on hazard mitigation and climate change, the Town hosted planned to host an in person public listening session. However, with the public health concerns surrounding the development of the COVID-19 pandemic, the Town shifted to an online engagement format. The Town hosted an online event to give a summary of the HMP-MVP Plan on April 22nd and over 25 people attended. The event was recorded and posted online for review by residents and stakeholders unable to make the meeting. An online survey was available to provide additional input along with the video recording. The online survey had 97 participants and was open until 05/06/2020. The listening session was promoted through the Town's communication channels, including the website and social media. The first draft of the MVP report was sent out for public review on 05/19/2020. Residents had two weeks to comment on the draft. Two participants responded with their inputs. A summary of the public input is available in Appendix D and the input was integrated throughout this plan including the public comments.

1.4.4 Report Layout

The report presents the results and input derived from the core team, CRB workshop, and listening session in addition to the documentation of features, hazard profiles, and a vulnerability assessment. Features are assets or characteristics of the Town that may contribute to the Town's resilience or may be a considered a vulnerability. Features are categorized into several types—societal, economic, infrastructure, land use, and environmental. The strength and vulnerability of these features are generally documented in Chapter 3, but Chapter 4 provides a more detailed assessment of the Town's vulnerability and strengths by hazard type. The hazard types cover flooding, wind-related risks (hurricanes, tropical storms, tornados, nor'easters, severe thunderstorms) winter storms, geological hazards (earthquakes and landslides), brushfires, extreme temperatures, and drought. Each hazard type's historic occurrences and impact, frequency, level of risk, and climate change projections are also described in each hazard profile. Chapter 5 lays out the existing mitigation measures the town is already taking. Chapter 6 provides an update of the progress made since the last HMP and Chapter 7 provides the action plan for moving forward. Chapter 8 describes the plan adoption and maintenance, and details on implementation.

1.5 Planning Timeline

The HMP-MVP planning process proceed according to the timeline below.

2.0 HAZARD MITIGATION AND CLIMATE ADAPTATION GOALS

The Town of Belmont's Core Team convened to review and discuss the hazard mitigation and climate adaptation goals for the HMP-MVP Plan. The following six goals were developed and endorsed by the Core Team.

1. Prevent and reduce the loss of life, injury, public health impacts and property damages resulting from all major natural hazards and anticipated impacts of climate change. This may include preventing damages to:
    a. Commercial, industrial, and residential structures.
    b. Cultural and historic resources.
    c. Public infrastructure, buildings, and essential services, such as electric power, drinking water, and the sewer system.
    d. Vulnerable populations, such as elderly residents.

2. Identify and seek funding for measures to mitigate or eliminate each known significant hazard area and reduce the impacts of climate change.

3. Integrate hazard mitigation planning and climate change projections as an integral factor in all relevant municipal departments, committees and boards.

4. Facilitate collaboration in hazard mitigation planning, including collaboration with surrounding communities; state, regional and federal agencies; the business community, major institutions and non-profits.

5. Ensure that future development meets federal, state, and local standards for preventing and reducing the impacts of natural hazards today and under climate change projections.

6. Take maximum advantage of resources from FEMA and MEMA to educate Town staff and the public about hazard mitigation and climate change.

3.0 COMMUNITY PROFILE, LAND USE AND DEVELOPMENT TRENDS

3.1 Community Profile

The Town of Belmont was settled in 1636 and established in 1859. The Town of Belmont is bordered by Cambridge, Arlington, Lexington, Waltham, and Watertown and is just six miles from Boston. The historically consisted of expanse agricultural lands and supplied produce and livestock to the City of Boston. Belmont was known for its market gardens and the large amount of fruit and vegetables it produced. In the early 19th century, roads and railroads linked the town to Boston, which sparked suburban growth (Town of Belmont and MAPC, 2013). Despite its growth, Belmont has been able to maintain hundreds of acres of parks and agricultural lands. The Town had a population of just over 1,000 when it was established and has since grown to a population of 26,330 people in 2018 (U.S. Census Bureau, 2018).

The Town is home to a wealth of dedicated and able volunteers; hundreds of acres of parks, playgrounds, and recreational lands; and an excellent school system. During the CRB Workshop, one participant called Belmont, "the best town in America." Others commented on the Town's beautiful downtown area and wealth of municipal services. The Town is governed by a three-person Select Board and an appointed Town Administrator. The Town operates under the representative Town Meeting format. The Town maintains a website at https://www.belmont-ma.gov/.

3.2 Societal Features

The Town offers numerous social services including an active Beech Street Center, Belmont Public Library, and youth programming. The Town's volunteer base and services are strengths that can be utilized for hazard mitigation planning, especially to reach the Town's most vulnerable populations. Vulnerable populations are folks whose everyday stressors make it harder to adapt and recover when shocks or hazards occur. In Belmont, seniors, youth, people who are disabled, households with limited English-speaking skills, and individuals with low incomes are considered vulnerable. Youth are a make up a large percentage of Belmont (25%), which is higher than the percentage of youth across the state (20%). Table 3-1 lists societal statistics for the Town in comparison to the rest of Massachusetts.

Table 3-1. Belmont Demographic Characteristics

Population	Belmont	Massachusetts
2010	24,729	6,547,790
2018	26,043	6,902,149
Age		
Under Age 18	25%	20%
Over Age 65	17%	17%
Education		
Bachelor's degree or higher	73%	42.1%
Additional Information		
Median household income	$118,370	$74,167
Individuals Living Below the Poverty Level	6%	11%
With a Disability	3%	8%
Households with Limited English	4%	6%
Number of Housing Units		2,864,989
Renter-Occupancy Rate	37%	38%

(US Census Bureau, 2014-2018)

3.2.1 CRB Workshop Discussion of Societal Features

Workshop participants identified those key societal aspects of Belmont that are most vulnerable to, or provide protection against, natural hazards and climate change impacts. Group discussions focused on vulnerable populations, such as the elderly, youth, homeless, low income, and disabled populations. Workshop participants discussed how information was disseminated in Belmont and how it could be distributed to reach these populations more effectively. The complete list of Workshop participant identified strengths and vulnerabilities can be found in Table 3-2.

Table 3-2. Societal Features and Natural Hazards/Climate Change in Belmont

Strengths	Vulnerabilities
• Multiple business centers • Neighborhood and worship communities • Well-connected and informed residents • Diverse perspectives and experiences across ages, abilities, and cultures • Regional partnerships – Mystic River Watershed Association • Current Housing Authority and Housing Trust properties • Emergency shelters • Senior Center	• Households with limited English-speaking abilities if communication is not translated • At-risk of isolation or need of additional support (possibly youth, seniors, people with disabilities) • Barriers to building personal resilience (income or homelessness) • Need for more affordable and safe housing and to upgrade current facilities • Need for shelter capacity checks • Heat-related illnesses

3.3 Economic Features

A small, primarily residential community, Belmont's rapid growth has also turned it into business-friendly community. It is important to note that unemployment rate in Belmont is half of State's average (Table 3-3). A strong workforce strengthens both personal resilience and community resilience. The top employment industries in Belmont are Business Management, Science, and Arts (United States Census Bureau, 2014-2018). The largest employer in Belmont is by far Mclean Hospital, but other large employers are the Belmont Country Club, Belmont Hill School, Belmont Manor Nursing Center, and People's United Bank. Belmont is also home to a growing number of technology-based companies including Custom Learning Designs and Horizon International TRD (EOLWD, 2019). Belmont has four public elementary schools, one public middle school, one public high school, and several private schools. Belmont is home to a number of independent kindergartens, pre-schools, and day cares. Communication between businesses, schools, and the Town will be key when moving forward the hazard mitigation planning efforts and ensuring large employers and schools have emergency protocols in place. Table 3-3 lists economic statistics for the Town in comparison to the rest of Massachusetts.

Table 3-3. Economic Statistics

	Belmont	Massachusetts
Labor Force	13,802	3,755,481
Unemployment Rate	3.0%	6.0%
Employed in Top Employment Industry	31.9%	28.2%
Commuters who drove to work	69.3%	78.1%
Commuters with > 30 min travel time to work	55.1%	45.1%

(US Census Bureau, 2014-2018)

3.4 Infrastructural Features

Route 2 borders Belmont to the North. This provides easy access to I-95 and connects Belmont to Boston. There are two MBTA Commuter Rail stops in Belmont, and the Red Line terminus is located in neighboring Cambridge. Belmont has less commuters that drive to work than the state (Table 3-3), indicating that many uses public transit, bike, and walk. However, percentage of residents with more than 30-minute travel time to work is higher compared to the state's average percentage. This is probably due to the Town's proximity to Boston. Commuters who drive through the Town often faces heavy traffic. Roads and bridges can be impacted by snow, ice, downed trees, and in some cases flooding. The Town has multiple business centers that are pedestrian friendly, and there is a section of bike path that connects Belmont to Cambridge.

The current emergency shelter is at the Middle School, and the Senior Center can also be used in an emergency, though it lacks the infrastructure for a generator. The Town of Belmont purchases water and sewer services from the Massachusetts Water Resources Authority (MWRA), but maintains their own Department of Public Works, Water Division, and Highway Division. Belmont Light (formerly Belmont Municipal Light Department) is the electricity utility in the Town. Electricity for the town is generated outside of Belmont in wholesale generating plants all over New England and transported to through several interconnections (Belmont Light, n.d.).

3.4.1 CRB Workshop Discussion of Existing Infrastructure

Workshop participants identified those key infrastructure features in Belmont that are most vulnerable to, or provide protection against, natural hazards and climate change impacts. Group discussions centered around roadway and drainage infrastructure and how extreme precipitation and snowstorms impact them. There was also extensive discussion around emergency backup energy sources for the Town, specifically the emergency shelters and other critical facilities. As noted below in Table 3-4, the majority of the existing infrastructure features were determined to be both a vulnerability and a strength.

Table 3-4. Infrastructure Features

Strengths	Vulnerabilities
• Mobility options: commuter rail, buses, and bike path • Critical facilities • Data centers • Emergency communication • Drinking water infrastructure is all new • MWRA has adequate water supply • Locally managed electric infrastructure • Municipal buildings • Roadway access • Opportunities for nature-based stormwater solutions • Multiple large, private buildings and entities that could be great resources	• Sanitor sewer system and pollutant loading • Reliance on critical services and facilities and need for redundancies • Occasional brownouts during high temperature events • Aging and undersized stormwater infrastructure (Beaver Brook Culvert, Clifton and Hickory, Belmont St and Lexington St, Trapelo Rd) • High maintenance demand to upkeep roadways and sidewalks • Aging municipal building stock • Flooding of Substation 1 (decommissioning) • Need additional data storage

3.5 Environmental Features

Belmont has a total land area of 4.7 square miles (U.S. Census Bureau 2010). Belmont is a town rich with environmental resources including waterbodies and forested land. Multiple brooks are located in Belmont, including Beaver Brook, Alewife Brook, and Winn Brook. The Town also has ponds including

Little Pond, Mill Pond, and Claypit Pond, which is located near the high school and has been a source of flooding in the past. The Town has a multitude of green space, open space, and recreation space, including the Rock Meadow Conservation Area, Beaver Brook Reservation, Lone Tree Hill, and multiple playing fields.

3.5.1 CRB Workshop Discussion of the Environment

Workshop participants identified those key environmental features in Belmont that are most vulnerable to, or provide protection against, natural hazards and climate change impacts. Participants discussed pests at length, noting that rats, coyotes, ticks, geese, and mosquitoes were all common pests in Belmont. In addition, there are also environmental concerns around tree health, invasive species, and vector borne diseases. Participants also discussed the strengths of Belmont's natural spaces at length, while also acknowledging that these spaces can be vulnerable to pollution, flooding, and other hazards.

Workshop participants were concerned about pollution in Belmont, noting the former incinerator site and stormwater pollution. The former incinerator site may be a concern if water were to infiltrate into the site and potentially leach out, which would contaminate the surrounding area. The Town is currently planning clean up under the direction of MassDEP. Stormwater pollution occurs from polluted runoff that enters the stormwater system in addition to having some areas of Town that are combined stormwater sewer systems. Workshop participants were also concerned about the annual air temperatures and possible increase in air pollution. The complete list of Workshop participant identified environmental strengths and vulnerabilities can be found in Table 3-5.

Table 3-5. Environmental Features and Natural Hazards/Climate Change in Belmont

Strengths	Vulnerabilities
• Overall access to open space and recreation • Little industrial activity compared to other communities • Solar energy installments and opportunities • Tree canopy and street trees • Wetlands provide flood storage	• Few dense areas with less open space • Air quality on hot days • Aging gas lines • Water quality (inflow and infiltration pollution, illicit connections, stormwater runoff) • Vector borne diseases (from mosquitos and ticks) • Invasive species and pests (rats, coyotes, geese) • Native species in hotter temperatures and drought • Flooding of waterbodies and flash flooding of streams • Erosion near Beaver Brook, Wellington, and Winns Brook • Loss or deterioration of wetlands • Hazardous waste sites (historic incinerator and transfer site) • Lots of impervious surface • Trees are aging and need to plant more

3.6 Land Use

The most recent land use statistics available are based on MassGIS Standardized Assessors data. Figure 4 displays the land use categories and percentages within Belmont. The approximate land area of Belmont is 3,019 acres Residential land use makes up 51.82% of the town land. Commercial use makes of 7.77% of the town land. Open space and recreation comprise another 7.36%. Governmental properties are owned by state and local agencies, some of which, are also used for recreational purposes or would be classified as open space.

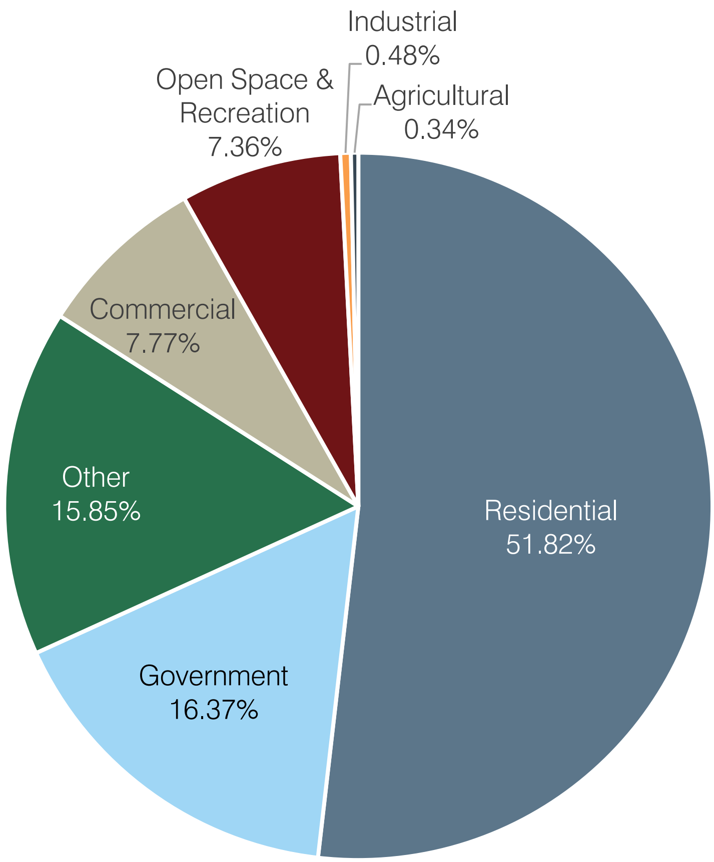


Figure 3-1. Land Use in Belmont (MassGIS, 2020)

3.7 Recent and Potential Development

MAPC's MassBuilds Database provides an inventory of recent, future, and potential development along with development acreage, number of housing units, commercial area, and project type. The database was queried for Belmont and was reviewed by the Director of Community Development. A final list of recent and planned three residential developments, three educational developments, one retail development, one commercial development, and three mixed use developments in the Town. The earliest development identified was 2013 in the MassBuilds Database and was provided as a parameter to Town staff. The developments in Belmont include a total of 435 housing units, 22 commercial units, and 32,117 square feet of educational space (see Table 3-6).

Table 3-6 Developments in Belmont

Name	Status	Housing Unit/ Commercial sqft.	Project Type
Oakmont Lane Subdivision - 108 Woodfall Rd	In Construction - 2020	4 units	Residential
The Barn at Belmont Day School – 55 Day School Ln	Completed - 2019	25,817 sq ft.	Educational
75 Leonard Street	Completed - 2019	5,068 sq ft.	Commercial

Table 3-6 Developments in Belmont

Name	Status	Housing Unit/ Commercial sqft.	Project Type
National Armenian Studies and Research Library Expansion – 395 Concord Ave	Completed - 2020	6,300 sq ft.	Educational
344 Pleasant Street	Completed - 2019	3,516 sq ft.	Retail
Uplands – 375 Acorn Park Drive	Completed - 2019	299 units	Residential
Oakley – 15 Oakley Rd	Completed - 2013	17 units	Residential
Bradford Development – 112 Trapelo Rd	In Construction - 2020	115 units/ 37,500 sq ft.	Residential/ Commercial
Middle and High School project – 221 Concord Avenue	In Construction - 2020	451,575 sq ft.	Educational
493 Trapelo Rd	In Construction - 2020	12 units/ 4,148 sq ft.	Commercial/ Mixed Use
945-505 Trapelo Rd	In Construction - 2020	10 units/ 4,000 sq ft.	Commercial/ Mixed Use

(MAPC, 2020)

3.8 Critical Facilities & Vulnerable Populations

Critical facilities are extremely essential components to the Town's function and protecting them from natural hazards is paramount. Critical facilities range in function from: 1) resources that can be utilized to respond and recover from natural hazards; 2) facilities where additional assistance might be needed; and 3) hazardous sites that could be dangerous if it is compromised during a natural disaster. Critical facilities in the Town of Belmont have been identified with help from knowledgeable Town staff, MassGIS data, existing Town and Regional Plans, and the assessment of other Town features presented in previous sections. Critical facilities and vulnerable populations have been broken into five categories:

1. Emergency Response Sites
2. Non-Emergency Response Facilities
3. Potentially Dangerous/Hazard Materials and Facilities
4. Community Facilities and Census Tracts with Denser Youth and Senior Populations
5. Natural Resources

3.8.1 Category 1 – Emergency Response Sites

Emergency response facilities that are necessary for the Town in the event of a disaster.

<u>Police and Fire Department</u>

Belmont Police Department	460 Concord Avenue
Temporary Police Department	40 Woodland St
Fire Headquarters (Roland A. Weatherbee)	299 Trapelo Rd
Fire Station 2	99 Leonard St

Town Facilities

Belmont Highway Department Office	19 Moore Street, 1st Floor
Belmont DPW Garage	37 C Street

Emergency Shelters

Winthrop L Chenery Middle School	95 Washington St

Communication Facilities

Communication Tower	780 Concord Ave
Communication Tower	460 Concord Ave

Primary Evacuation Routes

Route 60 (Pleasant Street)

Critical Bridges, Intersections, and Sites

Stone Railroad Overpass-Belmont Center

Lexington St and Trapelo Rd Bridge

3.8.2 *Category 2 – Non-Emergency Response Facilities*

The Town has identified these facilities as non-emergency facilities; however, they are considered essential for the everyday operation of Belmont.

Town Facilities

Town Hall	455 Concord Ave
Homer Municipal Building	19 Moore Street
Belmont School Department	644 Pleasant Street
DPW Water Yard	35 Woodland Street
DPW Yard Waste Facility	1130 Concord Ave
Belmont Light Department	40 Prince Street
Belmont Public Library	336 Concord Ave

Sewer Pumping Station

Sewer Pumping Station	Woodbine Rd
Sewer Pumping Station	Stony Brook Rd
Sewer Pumping Station	Channing Rd

Water Pumping Station

MWRA Water Pumping Station	Alexander Ave

Transit Facility

Belmont Center Train Station	Railroad and Concord Ave
Waverly Square Commuter Rail Station	495 Trapelo Road

3.8.3 Category 3 – Potentially Dangerous/Hazardous Materials and Facilities

Category 3 are facilities that are potentially dangerous if they were to fail or stop functioning.

Dams

Payson Park Reservoir Dam
Mill Pond Dam
Duck Pond Dam

Landfill

Town of Belmont Landfill (BFI Landfill)	1150 Concord Ave

Underground Storage Tanks

Cambridge Plating Co. Inc.	39 Hittinger Street
White Street Garage	43 White Street
Cityside Subaru	790 Pleasant Street
TNT Service Corp.	55 Brighton Street
Belmont Police Department	460 Concord Ave
Town of Belmont Water Department	35 Woodland Street
Belmont Springs Water Co. Inc.	1010 Pleasant Street
Belmont Hill School	350 Prospect Street
Cushing Square Exxon	90 Trapelo Road
Tarabelsi Brothers Service Inc.	280 Trapelo Road
McLean Hospital	115 Mill Street
Town of Belmont Light Dept.	450 Concord Ave.
Light Dept. Yard	40 Prince Street
Peter Fuller Dodge Inc.	1000 Pleasant Street
New England Telephone Co.	115 Leonard Street
James Flett Equipment Co. Inc.	800 Pleasant Street
Garber Auto Service	50 Brighton Street
Best - Belmont #6	80 Concord Ave
01PM7	365 Concord Ave
Belmont Gas & Service Sta.	350 Trapelo Road
01193	337 Pleasant Street
Mobil Oil Corp. 01-196	27 Lexington Street
Leonard Forziati	768 Pleasant Street
Benny's Service Center	130 Trapelo Road
Prop #1404	563 Trapelo Road
Pleasant Street Texaco	368 Pleasant Street
Getty Prop #1339	350 Pleasant Street
Belmont Citgo	500 Common Street
P & M Service Center	82 Concord Ave
Belmont Springs Water Co. Inc.	1010 Pleasant Street
Belmont DPW Garage	37 C Street

Hazardous Materials Site

Auto Repair SHop	50 Brighton Street
Belmont Volkswagon	263Trapelo Road
Mobil Station	82 Concord Ave
Near Flanders Road	11 Brighton Street
1000 Pleasant Street	1000 Pleasant Street
The Belmont Country Club Inc.	181 Winter Street
Purecoat North, LLC (Cambridge Plating)	39 Hittinger Street

Gas Stations

365 Concord Ave
337 Pleasant St
500 Common St Suite A
90 Trapelo Rd
563 Trapelo Rd
768 Pleasant St
27 Lexington St
180 Belmont St
350 Trapelo Rd
368 Pleasant St
82 Concord Ave
337 Mill St
188 Belmont St

Electric Substation/Powerplants

Power Substation	20 Flanders Road
Electric Light Substation 1	
Electric Light Substation 2	
Electric Light Substation 3	

3.8.4 Category 4 – Community Facilities and Census Tracts

Category 4 are facilities serve the broader community and groups within the community that have been identified as vulnerable due to their circumstances, for example, possible isolation. A display of Census Tracts with denser youth and senior populations is available in Appendix C on the critical facilities map.

Housing Authority Properties

Waverly Woods Apartments	10 Olmstead Drive
Belmont Village	59 Pearson Road
Waverly Oaks Apartments	Trapelo Rd
Sherman Gardens	Thayer Rd and Sycamore St

Elderly Living

Belmont Manor Nursing Home, Inc.	34 Agassiz Ave
Hill Estates	Brighton St
Flett Apartments	Trapelo Rd

Belmont Public Schools (BPS), Private Schools, and Daycares

Belmont Day School	55 Day School Lane
Belmont Hill School	350 Prospect Street
BPS - High School	221 Concord Avenue
BPS - Chenery Middle School w/Library	95 Washington Street
BPS – Butler School	90 White Street
BPS – Burbank School	266 School Street
BPS - Winn Brook School	97 Waterhouse Road
BPS – Wellington School	121 Orchard Street
Kendall Nursery and Kindergarten	577 Belmont Street
Plymouth Nursery School	582 Pleasant Street
Belmont Co-op Nursery School	130 Common Street
Payson Park PreSchool	365 Belmont Street
Butler Extended Day Program	90 White Street
Winn Brook Extended Learning	97 Waterhouse Road
Burbank After School Program	266 School Street
BASEC@Chenery	95 Washington Street
Waldorf School	160 Lexington Street
Winchester School of Chinese Culture	582 Pleasant Street
Petit Feet Academy Preschool	24 Trapelo Road
Belmont Nursery School	773 Belmont Street
Adventures Pre-School	160B Lexington Street
Little Sprouts	259 Beech Street
Christ Lutheran Childcare and Nursery School	597 Belmont Street
The Learning Zone	277-281 Belmont Street
Willows Christian Childrens Academy	310 Trapelo Road
Waverley Square Daycare	430 Trapelo Road
The Wonder School	37 White Street
Global Montessori School	15 Clark Street
McLean Hospital - Child Care Center	115 Mill Street

Religious Centers

St. Joseph's Church	120 Common Street
Payson Park Church	365 Belmont Street
Belmont United Methodist Church	421 Common Street
First Baptist Church	129 Lexington Street
First Church of Christ Scientist	199 Common Street
St. Lukes Church	132 Lexington Street
First Unitarian Church	404 Concord Avenue
First Armenian Church	380 Concord Avenue
Beth El Temple Center	2 Concord Avenue

Belmont Hill School - Chapel	350 Prospect Street
Christ Evangelical Lutheran Church	597 Belmont Street
Open Door Baptist Church	300 Pleasant Street
Belmont Community Church of God	25 Marlboro Street
All Saints Church	17 Clark Street
Cornerstone Baptist Church	54 Brighton Street
Mormon Church	15 Ledgewood Place
Boston Temple	86 Frontage Road
Holy Cross Armenian Catholic Church	200 Lexington Street
Mount Hope Church	51 Lexington Street

Grocery Stores

535 Trapelo Road
62 Concord Ave
265 Belmont St
369 Trapelo Rd
264 Trapelo Rd

Hospitals

McLean Hospital

3.8.5 *Category 5 – Natural Resources*

Natural resources can help protect against natural hazards and are climate adaptation assets.

Water Resources

Payson Park Reservoir (Cambridge Reservoir)
Beaver Brook
Alewife Brook
Winn Brook
Clay Pit Pond
Mill Pond
Duck Pond
FEMA National Flood Hazards
DEP Wetlands

Open Space & Conservation Land

Rock Meadow	Concord Ave
Beaver Brook Reservation	Concord Ave
McLean Hospital	Concord Ave, Mill St, Pleasant St
Ogilby Property (Sergi Farms)	Blanchard Road
Clay Pit Pond Park	Concord Avenue
Joey's Park	177 Cross Street
Pequossette Park	72 Maple Street
Habitat Education Center and Wildlife Sanctuary	Juniper Rd
Alewife Brook Reservation (Metropolitan Park)	Route 2, Lake Street

4.0 HAZARD PROFILES, RISK ASSESSMENT & VULNERABILITIES

Each hazard profile contains information on the areas vulnerable to the hazard, documentation of historic events, a risk and vulnerability assessment, and projected climate risk. The risk and vulnerability assessment examines both the frequency and severity of hazards, and their potential impact to the Town of Belmont. Each hazard risk and vulnerability assessment uses previous occurrences and along with climate projections to determine areas that are more at risk as well as the likelihood that a hazard will occur. The vulnerability analysis looks at various factors in the community, such as existing and future buildings, infrastructure, and critical facilities. In some cases, an estimate of the potential dollar loss to vulnerable structures is available. Land uses and development trends were of particular interest in the flood vulnerability assessment.

The hazard profiles were updated with information from the *2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan* (SHMCAP) (EEA and EOPSS, 2018) and additional research and assessment. The Core Team, CRB workshop, and listening session results provided local accounts of each hazard. A Geographic Information System (GIS) assessment was conducted to analyze the potential impact of flooding in Belmont on current and future development. FEMA's Hazus software was used to model potential damage of hurricanes and earthquakes.

4.1 Statewide Overview of Hazards

4.1.1 Massachusetts *State Hazard Mitigation and Climate Adaptation*

The 2013 Massachusetts State Hazard Mitigation Plan (MEMA and DCR, 2013) and the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) (EEA and EOPSS, 2018) examined the natural hazards that have the potential to impact the Commonwealth. These plans summarize the frequency and severity of hazards of greatest concern. The frequency classification ranges from very low to high. Severity classifications are listed as a range from minor severity to catastrophic. The box below gives further definitions of the frequency and severity characterizations. Table 4-1 summarizes the frequency and severity of hazard risk in Belmont and the State. These frequency and severity classifications will assist the Town in prioritizing mitigation actions for each hazard.

Definitions used in the Commonwealth of Massachusetts State Hazard Mitigation Plan

Frequency

- *Very low frequency*: events that occur less frequently than once in 100 years or less than 1% per year
- *Low frequency*: events that occur from once in 50 years to once in 100 years or 1% to 2% per year
- *Medium frequency*: events that occur from once in 5 years to once in 50 years or 2% to 20% per year
- *High frequency*: events that occur more frequently than once in 5 years or greater than 20% per year

Severity

- *Minor*: Limited and scattered property damage; limited damage to public infrastructure and essential services not interrupted; limited injuries or fatalities.
- *Serious*: Scattered major property damage; some minor infrastructure damage; essential services are briefly interrupted; some injuries and/or fatalities.
- *Extensive*: Widespread major property damage; major public infrastructure damage (up to several days for repairs); essential services are interrupted from several hours to several days; many injuries and/or fatalities.
- *Catastrophic*: Property and public infrastructure destroyed; essential services stopped; numerous injuries and fatalities.

Table 4-1. Hazard Risk Summary

Hazard	Frequency	Severity
Inland Flooding	High (1 flood disaster declaration event every 3 years; 43 floods per year of lesser magnitude)	Serious to Catastrophic
Dam failures	Very Low	Extensive to Catastrophic
Coastal Hazards	High (6 events per year over past 10 years)	Serious to Extensive
Tsunami	Very Low (1 event every 39 years on East Coast, 0 in MA)	Extensive to Catastrophic
Hurricane/ Tropical Storm	High (1 storm every other year)	Serious to Catastrophic
High Wind	High (43.5 events per year)	Minor to Extensive
Tornadoes	High (1.7 events per year)	Serious to Extensive
Thunderstorms	High (20 to 30 events per year)	Minor to Extensive
Nor'easter	High (1 to 4 events per year)	Minor to Extensive
Snow and Blizzard	High (1 per year)	Minor to Extensive
Ice Storms	High (1.5 per year)	Minor to Extensive
Earthquake	Very Low (10-15% probability of magnitude 5.0 or greater in New England in 10 years)	Minor to Catastrophic
Landslide	Low (once every two years in western MA)	Minor to Extensive
Brush Fires	High (at least 1 per year)	Minor to Extensive
Extreme Temperatures	High (1.5 cold weather and 2 hot weather events per year)	Minor to Serious
Drought	High (8% chance of "Watch" level drought per month [recent droughts in 2016 and 1960s])	Minor to Serious

(Adapted from MEMA and DCR, 2013, and EEA and EOPSS 2018, with assistance from Belmont)

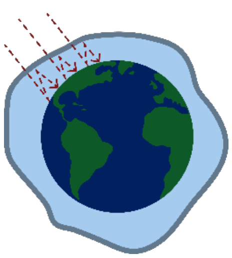
Not all hazards included in the 2018 State Hazard Mitigation and Climate Adaptation Plan or the 2013 Massachusetts State Hazard Mitigation Plan apply to the Town of Belmont. Given Belmont's inland location, coastal hazards and tsunamis are unlikely to affect the Town. Given the type of fires that have occurred in Belmont's history, the Town will focus on brush fires rather than wildfires. It is assumed that the entire Town of Belmont and its critical facilities are susceptible during the occurrence of events such as earthquakes, high wind events, hurricanes, winter storms, temperature extremes and snow and ice. Flood risk from riparian flooding is elevated in the vicinity of the flood zones. Landslides are more likely in areas with more unstable soils types.

4.1.2 Federally Declared Disasters in Massachusetts

Tracking historic hazards and federally declared disasters that have occurred in Massachusetts, and more specifically Middlesex County, help planners understand the possible extent and frequency of hazards. Historically, Massachusetts has experienced multiple type of hazards, including flooding, blizzards, and hurricanes. Since 1991, there have been 22 storms in Massachusetts that resulted in federal or state disaster declarations. Sixteen disaster declarations occurred in Middlesex County. Federally declared disaster open up additional FEMA grant opportunities for regional recovery and mitigation projects. The hazard profiles provided below contain further information about federally declared disasters.

4.1.3 Impacts of Climate Change

Many of the hazards that Belmont commonly experiences are projected to worsen due to climate change. Climate change refers to changes in regional weather patterns that are linked to warming of the Earth's atmosphere as a result of both human activity and natural fluctuations. The Earth's atmosphere has naturally occurring greenhouse gases (GHGs), like carbon dioxide (CO_2), that capture heat and contribute to the regulation of the Earth's climate. When fossil fuels (oil, coal and gas) are burned, GHGs



are released into the atmosphere and the Earth's temperature tends to increase. The global temperature increase affects the jet stream and climate patterns. The climate in Massachusetts is expected to reflect historic climate patterns of Southern New England or Mid-Atlantic States depending upon GHG emission scenarios. Climate change has already started to change the climate in Massachusetts and these trends are likely to continue. Climate change is likely to affect Massachusetts's typical precipitation cycle, leading to more intense rainfall and storms and more episodic or flash droughts. Temperatures will increase in both summer and winter. Each of the hazard profiles provided below includes more detail on how hazard frequency and intensity are likely to shift with climate change.

4.1.4 Top Hazards as Defined in the CRB Workshop

Workshop participants were asked to identify the four top hazards Belmont faces. There was extensive discussion that lead to the selection of these top hazards. They were:

Extreme Temperatures | Wind | Extreme Precipitation and Snowstorms | Drought

Figure 4-1: Top Hazards Defined by Belmont's CRB Workshop Participants

Workshop participants expressed concern that poorly designed stormwater management systems can cause localized flooding during extreme precipitation events. In recent years improvements have been made to reduce stormwater flooding, such as the trash trap on Wellington Brook, but it is still an issue and will be exacerbated with climate change. Maintenance and upgrades to the system must continuously occur to ensure that the system is functioning efficiently.

Belmont’s roadways were brought up frequently in the discussion. Belmont’s roads are utilized by thousands of commuters daily, and thus require regular upkeep from the Town’s Highway Division. Maintenance of roadways often overlaps with stormwater management, as lack of efficient drainage causes flooding in roadways. There were discussions about the roadway maintenance during winter, after heavy precipitation to mitigate flooding, after strong winds to remove downed trees and also about the low impact development opportunities of the roadway system. In the winter, it is often difficult to manage snow removal on the roads because of the busy urban traffic. Additionally, if there are downed trees due to a winter weather event, the Highway Division splits the manpower between tree cleanup and road plowing. This results in delays in both services.

The groups also talked extensively about tree management in Belmont. Trees can be a problem when they are not maintained properly around roadways, power lines, and structures. During wind events and snowstorms, Belmont experience power outages due to downed trees It was also noted that periods of drought can degrade tree health and make them more susceptible to falling. This can be a potential problem related to global warming. Therefore, it will be beneficial for the town in the long run to allocate more resources for hazardous tree removal. Electrical infrastructure will also benefit from increased hazardous tree removal. Other challenges with electric infrastructure were also discussed, such as flooding of power stations, lack of public education on electricity use, and lack of redundancy.

Figure 4-2. Belmont's CRB Workshop (Weston & Sampson, 2020)

4.2 Flood-Related Hazards

Flooding can be caused by various weather events including hurricanes, extreme precipitation, thunderstorms, nor'easters, and winter storms, which were identified as main hazards during Belmont's MVP Workshop. While Belmont experiences these events, the impacts of climate change will likely lead to increasingly severe storms and, therefore, increasingly severe impacts. The impacts of flooding include injury or death, property damage, and traffic disruption. Areas within the FEMA Flood Zones, repetitive loss sites, and local areas identified as flood prone are more vulnerable to the impacts of flooding. The following sub-sections provide more information on historic flooding events, potential flood hazards, a vulnerability assessment, locally identified areas of flooding, and information on the risk of dam failures. This analysis of flood hazard areas was informed by the FEMA NFIP Flood Insurance Rate Maps (FIRMs), a GIS vulnerability assessment, information from Belmont town staff, and accounts of past flood events provided by participants during the Belmont MVP Workshop.

Flood hazards are also directly linked to erosion, which can compromise the stability of building foundations. This puts current and future structures and populations located near steep embankments, or along water bodies, at risk. Erosion can also undercut streambeds and pose a risk to those walking along the banks. Structures or critical facilities located near the water bodies in Belmont may be considered at risk from fluvial erosion.

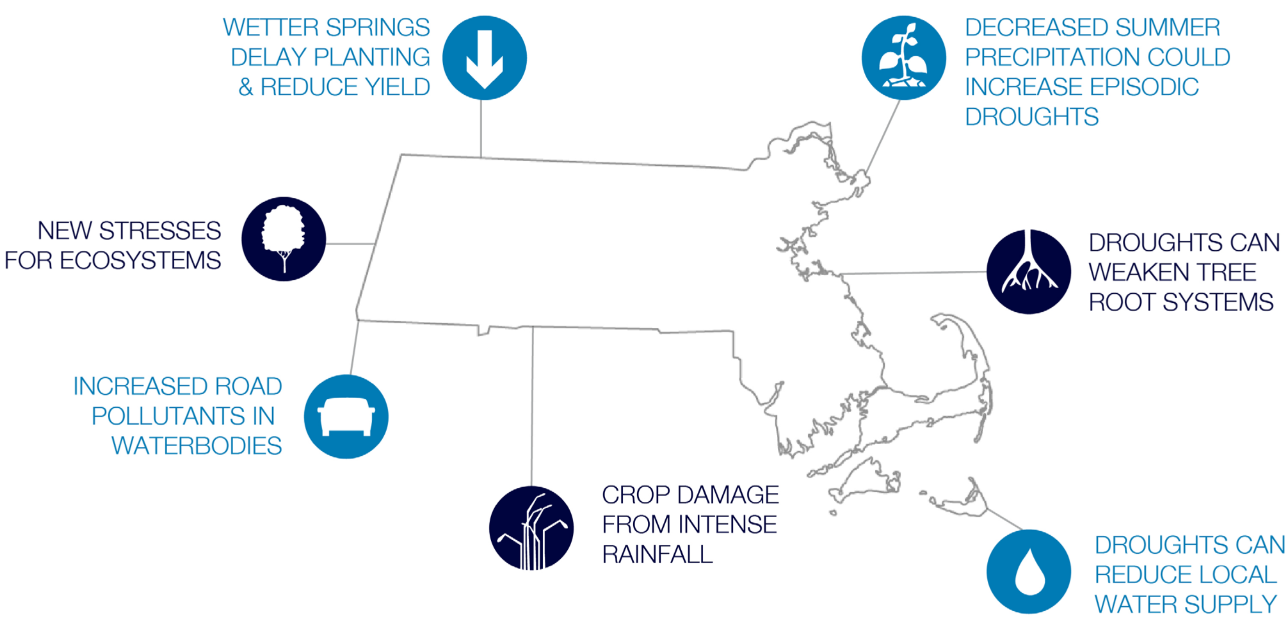


Figure 4-3. Potential Impacts of Increasing Precipitation (Weston & Sampson based on EEA, 2018)

4.2.1 Areas Vulnerable to Flooding

Flooding can be both riverine (topping the banks of streams, rivers, ponds) and from stormwater that is not properly infiltrated into the ground.

Riverine Flooding

Belmont is located within the Mystic River Watershed, borders the Fresh Pond Reservoir, and is home to several other water bodies, such as:

- Clay Pit Pond
- Little Pond
- Mill Pond
- Duck Pond
- Beaver Brook
- Alewife Brook
- Winn Brook

Areas within the flood zones are more vulnerable to storm events that have a 1% chance or a 0.2% chance of occurring on an annual basis. The definitions of these flood zones are provided below. Most of the FEMA floodplain in Belmont borders Clay Pit Pond, Alewife Brook, and Beaver Brook.

Flood Insurance Rate Map Zone Definitions

Zone A (1% annual chance or 100-year flood zone): Zone A is the flood insurance rate zone corresponding to the 100-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Detailed hydraulic analyses are not performed for such areas, therefore, no BFEs (base flood elevations) or depths are shown within this zone. Mandatory flood insurance purchase requirements apply.

Zone AE and A1-A30 (1% annual chance or 100-year flood zone): Zones AE and A1-A30 are the flood insurance rate zones that correspond to the 100-year floodplains that are determined in the FIS by detailed methods. In most instances, BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.

Zone X (0.2% annual chance or 500-year flood zone): Zone X is the flood insurance rate zone that corresponds to the 500-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs or depths are shown within this zone.

(FEMA, 2019b)

Repetitive Loss Sites

As defined by FEMA and the NFIP, a repetitive loss property is any insured property which the NFIP has paid two or more flood claims of $1,000 or more in any given 10-year period since 1978 (FEMA and NFIP 2018a). There were four total repetitive loss structures in Belmont. Two of the losses were insured. The repetitive loss payments totaled $46,465 and the majority of the payments were to insured properties ($31,600) (DCR, 2019). The Town has put in the request for the information on Repetitive Loss Properties and will revise the plan once the information is received.

Table 4-2. Flood Insurance Data

Flood Insurance Data		Repetitive Loss (RL) Data	
Flood Insurance Policies in Force	56	RL Buildings	2
Premium	$30,410	RL Losses	4
Insurance in Force	$17,660,300	RL Payments (total)	$46,425
Number of Closed Paid Losses	17	RL Payments (building)	$46,032
Dollar Amount of Closed Paid Losses	$114,003	RL Payments (contents)	$393

(DCR, 2019)

Flooding events in Belmont have been classified as a high frequency event. As defined by the Massachusetts State Hazard Mitigation and Climate Adaptation Plan (EEA and EOPSS 2018), this hazard occurs once in three years (33% chance per year) in Massachusetts. During Belmont's MVP Workshop in January 2020, participants expressed concern about flooding in Belmont. There was discussion about flooding near culverts and on roadways.

Stormwater Flooding

Stormwater flooding occurs during a precipitation event where the rate of rainfall is greater than the stormwater management system can handle. This may be due to an undersized culvert, poor drainage, topography, high amounts of impervious surfaces, or debris that causes the stormwater system to function below its design standard. In these cases, the stormwater management system becomes overwhelmed, causing water to inundate roadways and properties. Stormwater flooding can occur anywhere in Town and is not limited to areas surrounding water bodies.

Most stormwater systems in Massachusetts are aging and have been designed with rainfall data that is no longer accurate. Figure 4-4 shows how the amount of rainfall of design storm data has increased from 1961 to 2015, especially for the larger 24-hour, 100-year event. Green infrastructure or low impact development improvements can help reduce stress on the capacity of the existing stormwater system by increasing infiltration on site. A rain garden or pervious pavement are example strategies. Upsizing culverts with new rainfall data was also recommended.

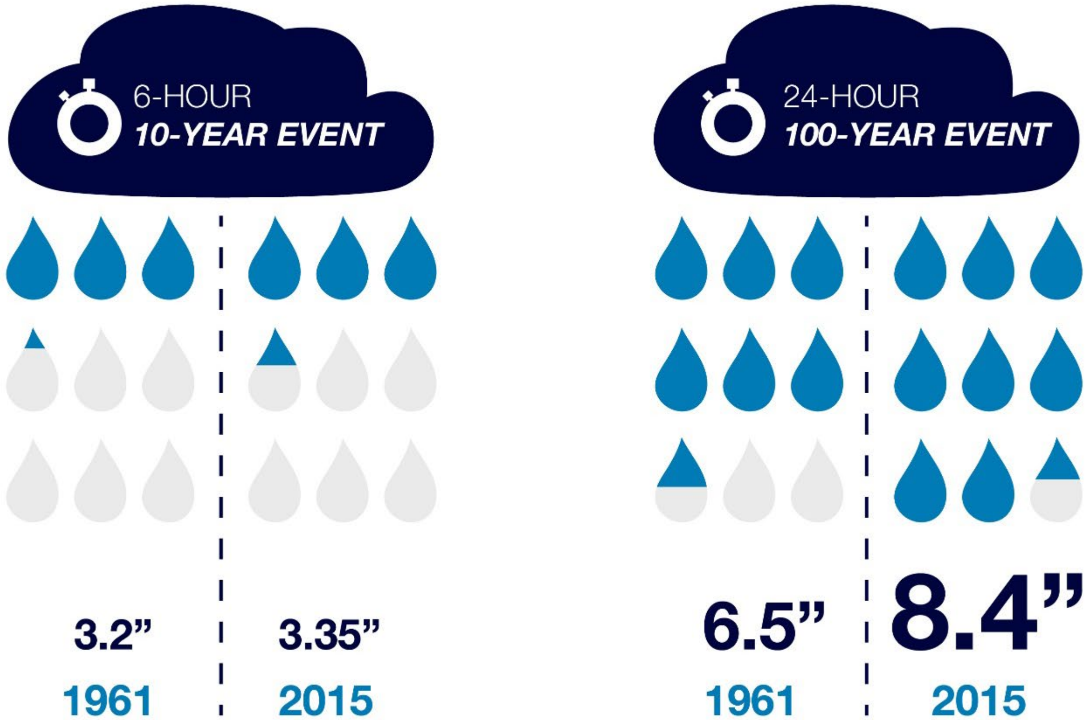


Figure 4-4. Design Storms in History. Engineers will need to design and size culverts with future precipitation data in mind (NOAA TP-40, 1961) and NOAA Atlas Volume 10 (2015)

Locally Identified Areas of Flooding

Town staff and MVP Workshop participants helped identify local areas of flooding, which are summarized in Table 4-3 below. These areas may not directly overlap with the FEMA-designated flood zones previously discussed; however, these areas have been noted to flood during a significant rain event. This is often due to topography and/or insufficient drainage.

One area that has been historically prone to flooding is the Clay Pit Pond area. The flooding around this area has been reduced in recent years with the installation of a trash trap on Wellington Brook, but additional work is needed to further protect the Town buildings and residential buildings in this area.

Flooding also occurs on Trapelo Road near Waltham. Beaver brook runs under the road through a culvert in this area, and during high water periods, the water exceeds the culvert's capacity and flood the road. This culvert is scheduled to be replaced within the next two years by the towns of Waltham and Belmont.

The Town of Belmont sources electricity from the Eversource Substation at Fresh Pond Mall in Cambridge, which is a flood prone area. Therefore, it is important that Belmont communicates with Cambridge regarding flooding, redundancy, and electricity backup before any major storm events. The areas of Acorn Park Drive and Pequossette Park have historically been prone to flooding during severe storm events, however the Town has resolved the flooding issues in these areas, and flooding has not been a problem since then. Recently, development of a large apartment building in Acorn Park required significant stormwater management in order to not exacerbate the flooding problem.

Table 4-3. Locally Identified Areas of Flooding

Name	Description of Issue and Efforts to Address
Clay Pit Pond	Some flooding has been resolved in this area since the last HMP, but it is still a minor concern.
Trapelo Rd	In discussions with Waltham on resolving the undersized culvert under Trapelo Rd.
Acorn Park Rd	Flooding issues have been addressed with stormwater improvements since the last HMP
Winn Brook	Flooding results from the combined sewer overflows

4.2.2 Historic Flood Events

<u>Locally Significant Floods</u>

Since the 1950s, several significant floods have impacted the Town of Belmont. Major floods events that affected the Town are presented in the list below.

- August 1954
- March 1968
- January 1979
- April 1987
- October 1991
- October 1996
- June 1998
- June, 2000
- March 2001
- March 2003
- April 2004
- May 2006
- March 2010
- July 2010
- July 2014
- December 2014
- April 2018
- June 2018
- September 2019

(Storm Events Database, NOAA, 2019, Town of Belmont and MAPC, 2013)

Middlesex Flooding Events

NOAA's National Centers for Environmental Information Storm Events Database (NOAA, 2018a) provides information on previous flood events for Middlesex County, where the Town of Belmont is located. Flash Flood events are considered by the NOAA's National Centers for Environmental Information Storm Events Database as "a life-threatening, rapid rise of water into a normally dry area beginning within minutes to multiple hours of the causative event (e.g., intense rainfall, dam failure, ice jam)." Floods are considered, "any high flow, overflow, or inundation by water which causes damage. In general, this would mean the inundation of a normally dry area caused by an increased water level in an established watercourse, or ponding of water, that poses a threat to life or property" (NOAA, 2018c). Middlesex County had 160 flood events between 2000 and 2019. Thirty of these events were flash floods. No deaths or injuries were reported. The property damage totaled $53.439 million dollars (not adjusted for inflation). Incredibly, flooding during March 2010 caused more than 80% of the total property damage reported during this time period (over $35 million dollars). Property damages ranged from $1,000 to $26 million. Events like this are significant because climate change projections suggest that precipitation events will become increasingly frequent and severe.

Two events listed in the database were documented as county-wide impacts in May of 2006 with $5 million in damages. Although most of the flooding documented in the database did not directly affect Belmont, monetary cost that flooding can have on an area is a proxy for the potential damage that could occur. Damages that occur regionally can also have an indirect impact on Belmont, especially because Belmont's utilities are regionally dependent.

Federally Declared Flood Disasters in Middlesex County

A disaster declaration is a statement made by a community when the needs required by a disaster or emergency is beyond the capabilities of that community. Ten disaster declarations were made in Middlesex County due to flooding between 2000 and 2015, as can be seen in Table 4-4 below.

Table 4-4. Previous Federal and State Disaster Declarations- Flooding

Disaster Name and Date of Event	Disaster Number	Type of Assistance	Counties Under Declaration
Severe Storms/Flooding October 20-25, 1996	DR-1142	FEMA Hazard Mitigation Grant Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
Heavy Rain and Flooding June 13-July 6, 1998	DR-1224	FEMA Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
Severe Storms & Flooding March 5-April 16, 2001	DR-1364	FEMA Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
Flooding April 1-30, 2004	DR-1512	FEMA Individual & Households Program; FEMA Hazard Mitigation Grant Program	Essex, Middlesex, Norfolk, Suffolk, Worcester

Table 4-4. Previous Federal and State Disaster Declarations- Flooding

Disaster Name and Date of Event	Disaster Number	Type of Assistance	Counties Under Declaration
Severe Storms and Flooding October 7-16, 2005	DR-1614	FEMA Public Assistance; FEMA Individual & Households Program; FEMA Hazard Mitigation Grant Program	All 14 Massachusetts Counties
Severe Storms and Flooding May 12-23, 2006	DR-1642	FEMA Public Assistance; FEMA Individual & Households Program; FEMA Hazard Mitigation Grant Program	Middlesex, Essex, Suffolk
Severe Winter Storm and Flooding December 11-18, 2008	DR-1813	FEMA Public Assistance; FEMA Hazard Mitigation Grant Program	All 14 Massachusetts Counties
Severe Storm and Flooding March 12-April 26, 2010	DR-1895	FEMA Public Assistance; FEMA Individual & Households Program; FEMA Hazard Mitigation Grant Program	Bristol, Essex, Middlesex, Suffolk, Norfolk, Plymouth, Worcester
Severe Winter Storm, Snowstorm, and Flooding February 8-9, 2013	DR-4110	FEMA Public Assistance; FEMA Hazard Mitigation Grant Program	All 14 Massachusetts Counties
Severe Winter Storm, Snowstorm, and Flooding January 26-28, 2015	DR-4214	FEMA Public Assistance; FEMA Hazard Mitigation Grant Program	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester

(MEMA, 2019; FEMA, 2018b; MA EOEEA and EOPSS, 2018)

4.2.3 GIS Flooding Exposure Analysis

Hazard location and extent of riverine flooding was determined using the current effective FEMA Flood Insurance Rate Map (FIRM) data for Belmont. The FIRM is the official map on which FEMA has delineated both the special flood hazard areas and the risk premium zones applicable to the community under the NFIP. This includes high risk areas that have a one percent chance of being flooded in any year (often referred to as the "100-year floodplain"), which under the NFIP, is linked to mandatory purchase requirements for federally backed mortgage loans. It also identifies moderate to low risk areas, defined as the area with a 0.2 percent chance of flooding in any year (often referred to as the "500-year floodplain"). For purposes of this exposure analysis, the following special flood hazard areas as identified in the Town of Belmont's current FIRMs were included: Flood Zone AE – Regulatory Floodway; Flood Zone A (AE, AH); and Flood Zone X (shaded).

A flood exposure analysis was conducted for critical facilities and vulnerable populations throughout the municipality using MassGIS data, FEMA flood maps, and information gathered from the municipality. Table 4-5 below displays critical infrastructure in Belmont that are located within either the 100-year or 500-year FEMA flood zone. Seven critical facilities are in the FEMA flood zones. Flooding of the BFI Landfill, underground storage tank, and the hazardous material site all present concerns related to leaching of pollutants. The dams integrity, if overtopped, could cause damage downstream. Finally, the electric substation and terminal station would cause major power outages if flooding caused damage.

Table 4-5. Critical Facilities Located within the FEMA Flood Zone

Facility	Address	100-Year	500-Year
BFI Landfill	1150 Concord Avenue	X	
Mill Pond Dam	N/A	X	
Duck Pond Dam	N/A	X	
Underground Storage Tank	39 Hittinger Street		X
Hazardous Material Site	11 Brighton Street		X
Belmont Municipal Light Terminal Station	70 Hittinger Street		X
Power Substation	20 Flanders Road		X

During the workshop, stakeholders discussed concern around the location of vulnerable populations. Some of these community members rely on assistance and it is important that someone is able to access them if needed. It becomes a concern if the vulnerable populations are located within a flood zone or in an area that extreme flooding could isolate them from the rest of the town. A GIS analysis found that 13 census blocks containing high percentages of seniors and youth are located within the 100-year flood zone. More data related to this analysis is included in Appendix B.

The Town's existing tax parcel and property value data obtained from MassGIS were used to estimate the number of parcels (developed and undeveloped) and buildings located in identified hazard areas along with their respective assessed values. The parcel data set provides information about the parcel size, land use type, and assessed value among other characteristics. The parcel data was also classified into various land use types based on the Massachusetts Department of Revenue's Property Type Classification Code for Fiscal Year 2019.

There is a common concern in every community around the location of vulnerable populations. Some of these community members rely on assistance and it is important that someone is able to access them if needed. It becomes critical if the vulnerable populations are located within a flood zone or in an area where extreme flooding could isolate them from the rest of the City. Based on the GIS analysis, out of 13 census blocks that have a high percentage of a vulnerable population in Belmont, there are only 3 that have population above 65 years. In total there are 5 blocks that are partially located in the 100-year flood zone, but 7 are partially located in 500-yr flood zone. Only one of the blocks with a high percentage of minors has 67% within 500-year flood zone. Rest of them are below 40%. This data is promising compared to a lot other towns and cities in the Commonwealth.

An analysis was conducted on all developed parcels in the Town. To determine the vulnerability of each parcel and building, a GIS overlay analysis was conducted in which the flood hazard extent zones were overlaid with the parcel data and existing building footprint data. These developments were overlaid with historic flood zones to determine these parcels vulnerability to flooding. They were categorized by land use type, and the exposure of each land use type was documented by the total area and percentage of parcels that overlap with a flood zone. The risk or impact of potential flooding was captured by summarizing the total property value in each parcel (Table 4-6 and Table 4-7).

Table 4-6. Exposure of Developed Parcels to the 100-Year Flood Zone

Land Use Type	Total Number of Parcels	Total Area of Parcels (acres)	Number of Parcels in Flood Zone	Total Area of Parcels in the Flood Zone (acres)	Percentage of the Parcels in the Flood Zone	Property Value in the Flood Zone
Residential	6955	1565	63	33	2	152,994,000
Commercial	230	235	2	9	4	$4,755,900
Industrial	14	15	1		7	$2,527,500
Government	83	494	4	56	11	37,571,000
Agricultural	1	10	1	2	23	$133,700
Open Space	14	222	N/A	N/A	N/A	N/A
Total	**7297**	**2541**	**71**	**101**	**4**	**$7,417,100**

Table 4-7. Exposure of Developed Parcels to the 500-Year Flood Zone

Land Use Type	Total Number of Parcels	Total Area of Parcels (acres)	Number of Parcels in Flood Zone	Total Area of Parcels in the Flood Zone (acres)	Percentage of the Parcels in the Flood Zone	Property Value in the Flood Zone
Residential	6955	1565	108	38	2	165,156,000
Commercial	230	235	9	12	5	$10,451,900
Industrial	14	15	6	5	35	$10,452,500
Government	83	494	3	44	9	37,512,000
Agricultural	1	10	N/A	N/A	N/A	N/A
Open Space	14	222	N/A	N/A	N/A	N/A
Total	**7297**	**2541**	**126**	**99**	**4**	**$20,904,400**

Recent developments, or redevelopments, within the past 10 years (2010 – 2020) were then isolated and an additional exposure analysis was done on these parcels. The methodology for this exposure analysis is the same as above. This data was pulled from the MassBuilds database (MAPC, 2020) and confirmed by the Community Development Director. Results are shown in Table 4-8 and Table 4-9.

Table 4-8. Exposure of Recently Developed Parcels to the 100-Year Flood Zone

Development Name	Development Address	Land Use Type	Total Area of Parcels (acres)	Total Area of Parcels in the Flood Zone (acres)	Percentage of the Parcels in the Flood Zone	Property Value in the Flood Zone
Uplands	375 Acorn Park Drive	Residential	13	5	38	121,979,000
Total			**13**	**5**	**38**	**$121,979,000**

Table 4-9. Exposure of Recently Developed Parcels to the 500-Year Flood Zone

Development Name	Development Address	Land Use Type	Total Area of Parcels (acres)	Total Area of Parcels in the Flood Zone (acres)	Percentage of the Parcels in the Flood Zone	Property Value in the Flood Zone
Uplands	375 Acorn Park Drive	Residential	13	4	31	121,979,000
Total			**13**	**4**	**31**	**$121,979,000**

Belmont is a growing community and as the population grows, so does the demand for additional facilities in the town. To further resiliency in the Town, a flood exposure analysis was completed on all vacant, developable parcels. The analysis was conducted utilizing MassGIS data (MAPC, 2020), FEMA flood maps, and information from the Town. The result of this analysis will bring light to future flooding that could occur on these parcels if they were to be developed.

The output of the ArcGIS overlay analysis showed all vacant, developable parcels that intersected with a flood zone. The number of parcels was totaled for each land use type within each of FEMA Flood Zones. While there are 3,176 acres of land in Belmont that are vacant and developable, 9% of that land is located within the 100-year flood zone (Table 4-10), and 7% is located within the 500-year flood zone (Table 4-11).

Table 4-10. Exposure of Developable, Vacant Land to the 100-Year Flood Zone

Land Use Type	Total Number of Parcels	Total Area of Parcels (acres)	Number of Parcels in Flood Zone	Total Area of Parcels in the Flood Zone (acres)	Percentage of the Parcels in the Flood Zone
Residential	224	409	N/A	N/A	N/A
Commercial	18	73	N/A	N/A	N/A
Industrial	36	201	N/A	N/A	N/A
Government	83	511	16	223	44
Agricultural	7	29	N/A	N/A	N/A
Open Space	434	1954	1	61	3
Total	**470**	**3176**	**17**	**283**	**9**

Table 4-11. Exposure of Developable, Vacant Land to the 500-Year Flood Zone

Land Use Type	Total Number of Parcels	Total Area of Parcels (acres)	Number of Parcels in Flood Zone	Total Area of Parcels in the Flood Zone (acres)	Percentage of the Parcels in the Flood Zone
Residential	224	409	2	0.7	0.2
Commercial	18	73	1	0.2	0.3
Industrial	36	201	N/A	N/A	N/A
Government	83	511	17	227	44.
Agricultural	7	29	N/A	N/A	N/A
Open Space	434	1954	N/A	N/A	N/A
Total	802	3176	20	228	7

Potential development areas that were noted by MassBuilds as being in the planning phase of development were reviewed by the Director of Community Development and additional planned facilities were added. These locations were overlaid with FEMA flood zone maps to determine the vulnerability to flooding. These areas were categorized by land use type, which was downloaded from MassGIS. The exposure of potential development within each land use type was documented by the area and percentage of parcels that overlap with a flood zone and is shown in Table 4-12 and Table 4-13.

Table 4-12. Exposure of Locally Identified Areas for Potential Development to the 100-Year Flood Zone

Development Name	Development Address	Land Use Type	Total Area of Parcels (acres)	Total Area of Parcels in the Flood Zone (acres)	Percentage of the Parcels in the Flood Zone
Middle School and High School	221 Concord Ave	Government	39	15	38
Total			39	15	38

Table 4-13. Exposure of Locally Identified Areas for Potential Development to the 500-Year Flood Zone

Development Name	Development Address	Land Use Type	Total Area of Parcels (acres)	Total Area of Parcels in the Flood Zone (acres)	Percentage of the Parcels in the Flood Zone
Middle School and High School	221 Concord Ave	Government	39	6	15
Total			39	6	15

4.2.4 Sea Level Rise

Due to climate change, sea level in Boston is expected to rise between 4 ft and 10.2 ft by the year 2100. There will also be an increase in coastal flooding, increase in shoreline erosion, and low-lying coastal areas will be permanently inundated (NECASC, 2018). Though Belmont is not a coastal community, Beaver Brook is a tributary in the Mystic River Watershed, which is tidally influenced.

Currently, the Fresh Pond area is not prone to stormwater surge flooding because of the Amelia Earhart Dam, which is located across the Mystic River on the border of Somerville and Everett, MA. In a 100-year storm event, the seawater surge comes to 1.5 feet from the edge of the dam, and the dam prevents seawater from entering Belmont. The Dam will likely fail within the next 30 years, and this, along with sea level rise will allow brackish water to encroach into the Mystic River and Fresh Pond area (see Figure 4-5 and 4-6). Further analysis should be conducted in this area to determine the extent of flooding.

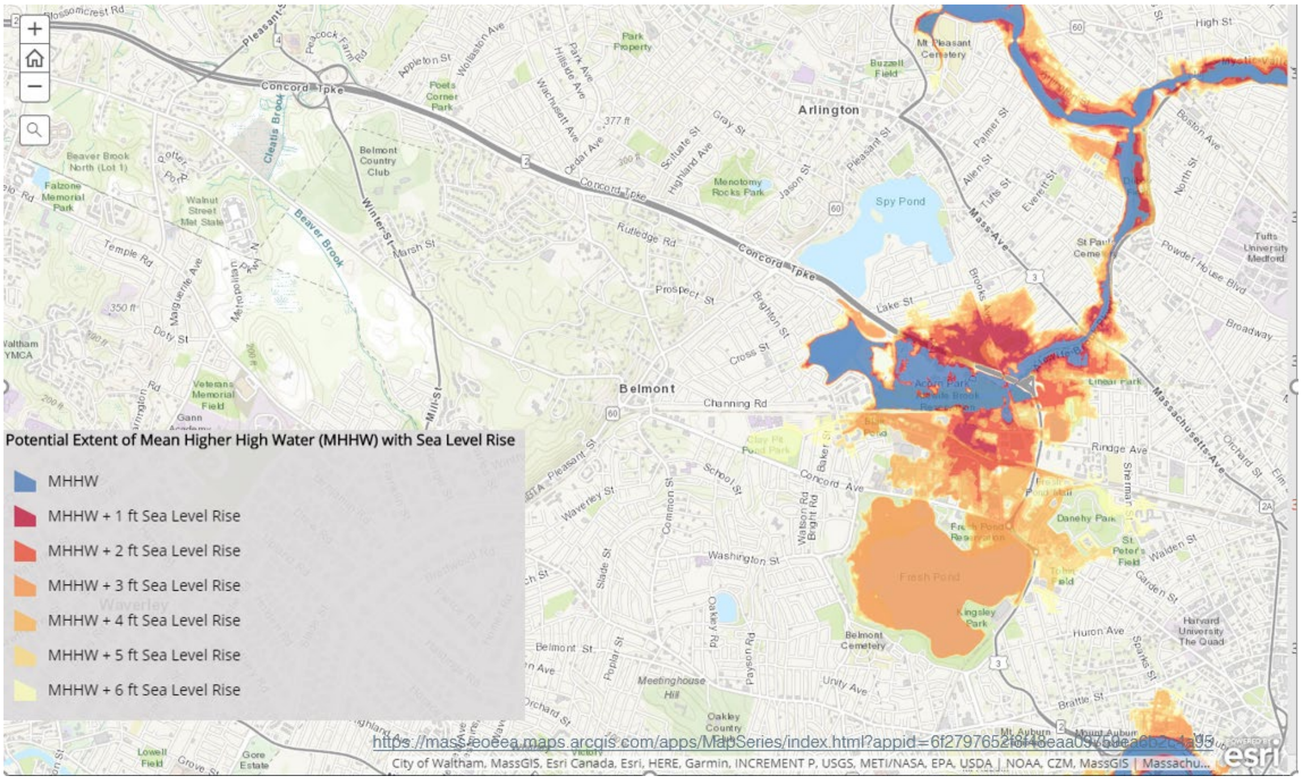


Figure 4-5. Potential Extent of Mean Higher High Water (MHHW) with Sea Level Rise (EOEEA, n.d.)

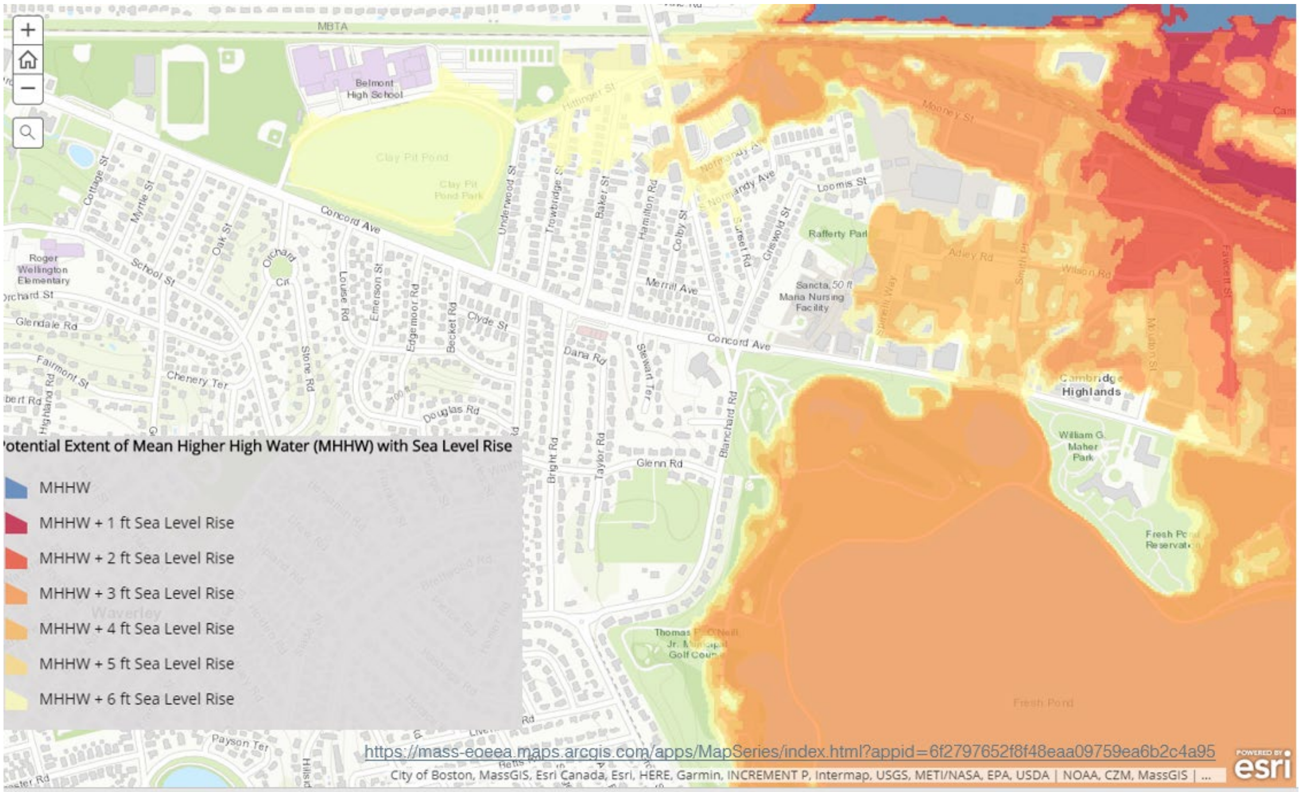


Figure 4-6. Potential Extent of Mean Higher High Water (MHHW) with Sea Level Rise in Belmont (EOEEA, n.d.)

4.2.5 Dams and Dam Failure

Dam failure is defined as a collapse of an impounding structure resulting in an uncontrolled release of impounded water from a dam (DCR, 2017a). Dam failures during flood events are of concern in Massachusetts, given the high density of dams constructed in the 19th century (MEMA and DCR, 2013).

Dams can fail due to overtopping caused by floods that exceed the capacity of the dam, deliberate acts of sabotage, structural failure of materials used in dam construction, movement and/or failure of the foundation supporting the dam, settlement and cracking of concrete or embankment dams, piping and internal erosion of soil in embankment dams, and inadequate maintenance and upkeep (MEMA and DCR, 2013).

Many dam failures in the United States have been secondary results of other disasters. The prominent causes are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage (MEMA and DCR, 2013).

Although dam failure does not occur frequently in Belmont, it can cause property damage, injuries, and potentially fatalities. These impacts can be at least partially mitigated through advance warning to communities impacted by a dam failure. In addition, the breach may result in erosion on the rivers and stream banks that are inundated.

Climate change may indirectly affect dam breaches for a variety of reasons. Dams are typically designed based on historic water flows and known hydrology. Climate change projections indicate that the frequency, intensity, and amount of precipitation will increase in New England. Increased precipitation may push dams over capacity. Therefore, dams will have to be monitored for safety. There are several mechanisms in place to manage increases in water, such as slowly releasing water. It is advised that these events are monitored as it can add additional stress on the dam infrastructure.

There have been no recorded dam failures in Belmont. Although dam failure is classified as a very low frequency event in the Town, a dam failure can still present a high level of risk and could result in a catastrophic event with extreme damage and loss of life. As defined by the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (EEA and EOPSS 2018), a very low frequency hazard may occur less frequently than once in 100 years (less than a 1% chance per year).

According to Town officials and the Massachusetts Department of Conservation and Recreation's (DCR) Office of Dam Safety, there are three dams in Belmont. Information related to these dams is summarized in Table 4-14. This summary table includes the hazard classification for each dam, which is defined by DCR as described below:

> *High:* Dams located where failure or mis-operation will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s) or railroad(s).
>
> *Significant:* Dams located where failure or mis-operation may cause loss of life and damage home(s), industrial or commercial facilities, secondary highway(s) or railroad(s), or cause interruption of use or service or relatively important facilities.
>
> *Low:* Dams located where failure or mis-operation may cause minimal property damage to others. Loss of life is not expected.

Table 4-14. Inventory of Dams in Belmont

Dam Name	Dam Owner	Hazard Potential Classification	Next Inspection Due Date
Payson Park Reservoir Dam	City of Cambridge	Non-jurisdictional	N/A
Mill Pond Dam	DCR	Non-jurisdictional	N/A
Duck Pond Dam	DCR	Low	02/08/2027

(Army Corps of Engineers, 2019)

If the hazard classification is listed as "N/A" this is because the dam is non-jurisdictional, meaning it does not meet the impoundment volume criteria for regulation. Two of the dams in Belmont, Payson Park Reservoir Dam and Mill Pond Dam are non-jurisdictional. The third dam in Belmont, the Duck Pond Dam, is owned by MA DCR, which is responsible for inspections. The Duck Pond Dam has a "Low" hazard potential classification.

4.2.6 Climate Change Impacts: Flooding

Boston's average annual precipitation is 53.32 inches (NOAA, 2019b). Extreme rain and snow events are becoming increasingly common and severe particularly in the Northeast region of the country (Figure 4-7). Large rain or snow events that happened once a year in the middle of the 20th century now occur approximately every nine months. Additionally, the largest annual events now generate 10% more rain than in 1948. Regionally, New England has experienced the greatest increase in frequency of extreme rain and snow events. These events now occur 85% more frequently than they did 60 years ago (Madsen and Willcox, 2012).

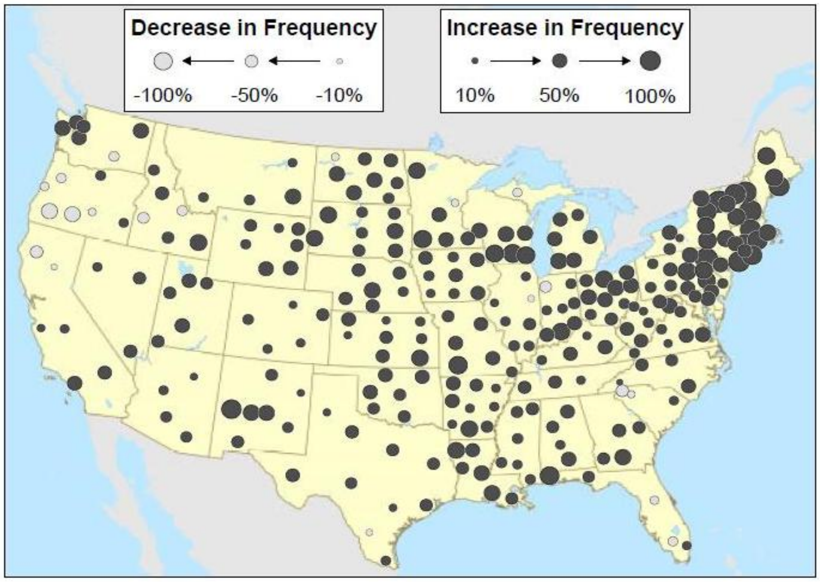


Figure 4-7. Changes in Frequency of Extreme Downpours (Madsen and Willcox, 2012)

4.3 Wind Related Hazard

High winds can occur during hurricanes, tropical storms, tornadoes, nor'easters, and thunderstorms. The entire planning area is vulnerable to the impacts of high wind. All current and future buildings including critical facilities and populations are considered to be vulnerable during high wind events. Wind may down trees and power lines. High wind and storm events cause property damage and hazardous driving conditions.

Extreme winds can take down trees and branches that cause service disruptions. An identified issue during storms in Belmont is the damage to power and phone wires from overhanging trees that have not been trimmed by the electric utility (Belmont Light) or the phone or cable companies. The utilities' tree maintenance program should be upgraded in an effort to reduce the risk associated with tree damage to utility lines. High winds and heavy snow loads caused significant power line damage in Belmont during four nor'easters in 2018. Falling trees and branches can also block traffic and emergency routes. This is a regional issue that affects cities and towns beyond Belmont.

During Belmont's MVP Workshop in January 2020, attendees discussed the impact of past storms on power systems and service disruption. In recent years people have noticed more high wind advisories and t more damage to powerlines, especially when there are leaves on the trees. During March 2018, nor'easters brought down 85 trees in Belmont, which led to power outages and blocked roads. The Town does work with utility companies to perform hazard tree maintenance, but more funding and manpower would be required to reduce wind hazards in Belmont.

Belmont does have reliable communications towers that house communications equipment for the Police and several other Town departments. Town officials stated that their communications systems are not at risk during high wind events. The Town's communications towers, one of which is at the Police Department are located off of Concord Avenue. These locations do not see high wind gusts and are not considered a safety issue.

4.3.1 *Hurricanes and Tropical Storms*

Tropical cyclones (including tropical depressions, tropical storms, and hurricanes) form over the warm waters of the Atlantic, Caribbean, and Gulf of Mexico. A tropical storm is defined as having sustained winds from 39 to 73 mph. If sustained winds exceed 73 mph, it is categorized a hurricane. When hurricanes and tropical storms occur, they will impact the entire planning area. All existing and future buildings including critical facilities and populations are at risk to the hurricane and tropical storm hazard (including critical facilities). Hurricane events have a large spatial extent and would potentially affect all of Belmont's infrastructure and buildings. Impacts include water damage in buildings from building envelope failure, business interruption, loss of communications, and power failure. Flooding is a major concern as slow-moving hurricanes can discharge tremendous amounts of rain on an area. Storm surge is also a concern in coastal-adjacent areas. Hurricane storm surge in Belmont is shown in Figure 4-8.

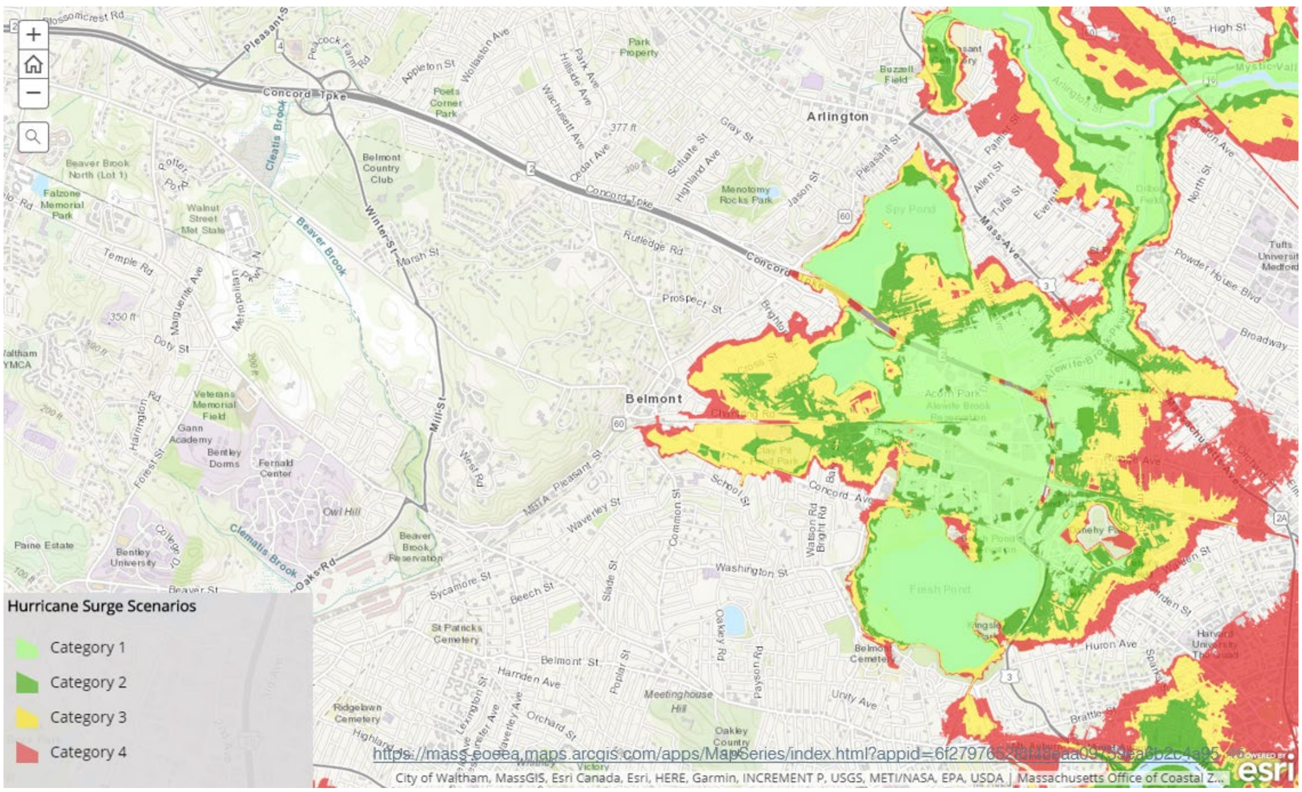


Figure 4-8. Four worst-case scenarios of hurricane storm surge in Belmont (EEA, n.d.)

The official hurricane season runs from June 1 to November 30. However, storms are more likely to occur in New England during August, September, and October (MEMA and DCR, 2013).

The region has been impacted by hurricanes throughout its history, starting with the Great Colonial Hurricane of 1635. In 1861, a tropical storm track passed directly through western Belmont. This is the only tropical storm or hurricane to track directly through Belmont, but the Town has been impacted by the effects of many other storm events (Town of Belmont and MAPC, 2013). Between 1851 and 2012, Massachusetts experienced 11 hurricanes and one named tropical storm. This includes six category 1 hurricanes, two category 2 hurricanes, and three category 3 hurricanes (Blake, Landsea, and Gibney, 2011). Hurricanes that have occurred in the region since 1938 are listed in Table 4-15:

Table 4-15. Hurricane Records for Eastern Massachusetts, 1938 to 2019

Hurricane Event	Date
Great New England Hurricane	September 21, 1938
Great Atlantic Hurricane	September 14-15, 1944
Hurricane Doug	September 11-12, 1950
Hurricane Carol	August 31, 1954
Hurricane Edna	September 11, 1954
Hurricane Diane	August 17-19, 1955
Hurricane Donna	September 12, 1960
Hurricane Gloria	September 27, 1985
Hurricane Bob	August 19, 1991
Hurricane Katrina	September 13, 2005
Hurricane Earl	September 4, 2010
Tropical Storm Irene	August 28, 2011
Hurricane Sandy	October 29-30, 2012
Hurricane Florence	September 18, 2018
Tropical Storm Dorian	September 7, 2019

(NOAA, 2020)

The Saffir-Simpson scale ranks hurricanes based on sustained wind speeds from Category 1 (74 to 95 mph) to Category 5 (156 mph or more). Category 3, 4, and 5 hurricanes are considered "Major" hurricanes. Wind gusts associated with hurricanes may exceed the sustained winds and cause more severe localized damage (MEMA and DCR, 2013). This is used to provide an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on context (MEMA and DCR, 2013). More information is included in Table 4-16 below:

Table 4-16. Saffir/Simpson Scale

Scale No. (Category)	Winds (mph)	Potential Damage
1	74 – 95	Minimal: damage is primarily to shrubbery and trees, mobile homes, and some signs. No real damage is done to structures.
2	96 – 110	Moderate: some trees topple, some roof coverings are damaged, and major damage is done to mobile homes.
3	111 – 130	Extensive: large trees topple, some structural damage is done to roofs, mobile homes are destroyed, and structural damage is done to small homes and utility buildings.
4	131 – 155	Extreme: extensive damage is done to roofs, windows, and doors; roof systems on small buildings completely fail; and some curtain walls fail.
5	> 155	Catastrophic: roof damage is considerable and widespread, window and door damage is severe, there are extensive glass failures, and entire buildings could fail.

(MEMA and DCR 2013(table originally created by NOAA))

Hurricane damage in Belmont was estimated using a hurricane modeling software. Hazus Multi-Hazard (Hazus) is a GIS model developed by FEMA to estimate losses in a defined area due to a specified natural hazard. The Hazus hurricane model allows users to input specific parameters in order to model a defined hurricane magnitude, which is based on wind speed. Based on a HAZUS Hurricane module, estimated damage in Belmont from Hurricanes was assessed (Town of Belmont and MAPC, 2013). According to the State HMP, the strongest Hurricane that passed through Massachusetts was a Category 3 storm, which occurred in 1954. For the purpose of this analysis, in order to estimate potential damage, both a Category 2 and a Category 4 hurricane were modeled. Although there have been no recorded Category 4 hurricanes recorded in Massachusetts, storm was modeled to show the impact that could occur from an extreme scenario, something that could possibly happen in the future due to climate change. Table 4-17 below lists estimated damage in Belmont for this worst-case scenario.

Table 4-17. Estimated Damages in Belmont from a Probabilistic 100- and 500-Year Hurricane

	Category 2	Category 4
Building Characteristics		
Estimated total number of buildings	8,088	8,088
Estimated total building replacement value (Year 2014 $) (Millions of Dollars)	$3,878	$3,878
Building Damages		
# of buildings sustaining minor damage	234	1,338
# of buildings sustaining moderate damage	18	220
# of buildings sustaining severe damage	1	17
# of buildings destroyed	0	5
Population Needs		
# of households displaced	0	9
# of people seeking public shelter	0	3
Debris		
Building debris generated (tons)	2,820	10,258
Tree debris generated (tons)	1,415	3,764
# of truckloads to clear building debris	56	260
Value of Damages (Thousands of dollars)		
Total property damage	$21,723.91	$83,053.60
Total losses due to business interruption	$786.52	$6,347.68

Hurricanes are a Town-wide hazard in Belmont and are considered a medium frequency event. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard can occur between once in 5 years to once in 50 years (a 2% to 20% chance per year). A full Hazus risk report for each hurricane category can be found in Appendix B.

4.3.2 Tornados

A tornado is a narrow, violently rotating column of air that extends from the base of a cloud to the ground. Tornadoes are the most violent of all atmospheric storms (EEA and EOPSS, 2018). According to the 2018 SHMCAP, the following are common factors in tornado formation:

- Very strong winds in the middle and upper levels of the atmosphere
- Clockwise turning of the wind with height
- Increasing wind speed in the lowest 10,000 feet of the atmosphere (i.e. 20 mph at the surface and 50 mph at 7,000 feet)

- Very warm, moist air near the ground, with unusually cooler air aloft
- A forcing mechanism such as a cold front or leftover weather boundary from previous shower or thunderstorm activity

Tornadoes can be spawned by tropical cyclones or the remnants thereof, and weak tornadoes can even form from little more than a rain shower if air is converging and spinning upward. The most common months for tornadoes to occur are June, July, and August. There are exceptions: The Great Barrington, Massachusetts, tornado in 1995 occurred in May; and the Windsor Locks, Connecticut, tornado in 1979. occurred in October (EEA and EOPSS, 2018).

The Fujita Tornado Scale measures tornado severity through estimated wind speed and damage. The National Weather Service began using the Enhanced Fujita-scale (EF-scale) in 2007, which led to increasingly accurate estimates of tornado severity. Table 4-18 provides more detailed information on the EF Scale.

Table 4-18. Enhanced Fujita Scale

Fujita Scale			Derived		Operational EF Scale	
F Number	Fastest ¼ mile (mph)	3-second gust (mph)	EF Number	3-second gust (mph)	EF Number	3-second gust (mph)
0	40 – 72	45 – 78	0	65 – 85	0	65 – 85
1	73 – 112	79 – 117	1	86 – 109	1	86 – 110
2	113 – 157	118 – 161	2	110 – 137	2	111 – 135
3	158 – 207	162 – 209	3	138 – 167	3	136 – 165
4	208 – 260	210 – 261	4	168 – 199	4	166 – 200
5	261– 318	262 – 317	5	200 – 234	5	Over 200

(MEMA and DCR, 2013)

Massachusetts averages 1.7 tornadoes per year. The most tornado-prone areas of the state are the central counties. Tornadoes are comparatively rare in eastern Massachusetts, although Middlesex County is considered an at-risk location (EEA and EOPSS, 2018). The most devastating tornado in Massachusetts in the history of recorded weather occurred in Worcester in 1953, it killed 94 people, injured more than 1,000, and caused more than $52 million in damages (more than $460 million in current dollars). Some more recent tornadoes in Massachusetts occurred in 2011 in Springfield, 2014 in Revere, and 2016 in Concord (Morrison 2014; Epstein 2016). There have been 18 recorded tornados in Middlesex County since 1955. One fatality and six injuries were reported (NOAA 2018A). Table 4-19 below provides additional information.

Table 4-19. Tornado Records for Middlesex County (1955-2019)

Date	Fujita	Fatalities	Injuries	Property Damage
10/24/1955	1	0	0	$2,500
6/19/1957	1	0	0	$25,000
6/19/1957	1	0	0	$250
7/11/1958	2	0	0	$250,000
8/25/1958	2	0	0	$2,500
7/3/1961	0	0	0	$25,000
7/18/1963	1	0	0	$25,000
8/28/1965	2	0	0	$250,000

Table 4-19. Tornado Records for Middlesex County (1955-2019)

Date	Fujita	Fatalities	Injuries	Property Damage
7/11/1970	1	0	0	$25,000
10/3/1970	3	1	0	$250,000
7/1/1971	1	0	1	$25,000
11/7/1971	1	0	0	$250
7/21/1972	2	0	4	$2,500,000
9/29/1974	3	0	1	$250,000
7/18/1983	0	0	0	$250
9/27/1985	1	0	0	$250
8/7/1986	1	0	0	$250,000
8/22/2016	1	0	0	$1,000,000

(NOAA, 2019)

Although tornadoes are a potential town-wide hazard in Belmont, there have been no recorded tornadoes in the Town. If a tornado were to occur in Belmont, damages would depend on the track of the tornado and would be most likely be high due to the prevalence of older construction and the density of development that exist. Structures built before current building codes may be more vulnerable. Evacuation, sheltering, debris clearance, distribution of food and other supplies, search and rescue, and emergency fire and medical services may be required. Critical evacuation and transportation routes may be impassable due to downed trees and debris, and recovery efforts may be complicated by power outages.

Tornado events in Belmont are a very low frequency event. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard may occur less than once in 100 years (a less-than 1% chance per year). Tornados are difficult to simulate well in climate models because of their small size when compared to other weather events. However, it is predicted that the frequency of tornados in eastern Massachusetts will rise in the future due to climate change.

4.3.3 Nor'easters

A nor'easter is characterized by large counter-clockwise wind circulation around a low-pressure center that often results in heavy snow, high winds, waves, and rain along the East Coast of North America. The term nor'easter refers to their strong northeasterly winds blowing in from the ocean. These weather events are among the season's most ferocious storms, often causing beach erosion, flooding, and structural damage (EEA and EOPSS, 2018).

Nor'easters generally occur on at least an annual basis, typically in late fall and early winter. Some years bringing up to four nor'easter events. This is currently the most frequently occurring natural hazard in the state. The storm radius is often as much as 100 miles and sustained wind speeds of 20 to 40 mph are common, with short-term gusts of up to 50 to 60 mph. Nor'easters are commonly accompanied by a storm surge equal to or greater than two feet. High surge and winds during a hurricane can last from 6 to 12 hours, while these conditions during a nor'easter can last from 12 hours to three days (EEA and EOPSS, 2018). Previous nor'easters events in Massachusetts are listed in Table 4-20 below.

Some of the historic events described in the "Flood-Related Hazards" section of this report were preceded by nor'easters, including the 1991 "Perfect Storm." The Blizzard of '78 was a notable storm. More recently, winter storms in 2015 and 2018 caused significant snowfall amounts.

The Town of Belmont is vulnerable to high winds, snow, and extreme rain during nor'easters. These impacts can lead to property damage, downed trees, power service disruptions, surcharged drainage systems, and localized flooding. These conditions can impact evacuation and transportation routes and complicate emergency response efforts. Due to its inland location, Belmont is not subject to the coastal hazards often associated with nor'easters.

Nor'easters in Belmont are high frequency events. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard may occur more frequently than once in 5 years (a greater than 20% chance per year). In March of 2018, there were four nor'easters, which took out 85 trees in one month and put strain on Belmont's DPW.

4.3.4 Thunderstorms and Related Wind Events

Thunderstorms can include lightning, strong winds, heavy rain, hail, and sometimes tornados. Thunderstorms typically last for about 30 minutes and can generate winds of up to 60 mph. Thunderstorms in Massachusetts are usually accompanied by rainfall; however, during periods of drought, lightning from thunderstorm cells can result in fire ignition. Thunderstorms with little or no rainfall are rare in New England but have occurred (EEA and EOPSS 2018, 4-173). Massachusetts experiences 20-30 thunderstorm days per year.

Thunderstorms are typically less severe than other events discussed in this section. However, thunderstorms can cause local damage and are a Town-wide risk in Belmont. Winds associated with thunderstorms can knock down trees resulting in power outages and blocked evacuation and transportation routes. Extreme rain during thunderstorms can cause inland flooding around waterbodies or due to surcharged drainage systems. During periods of drought, lightning from thunderstorm cells can result in fire ignition.

NOAA's National Centers for Environmental Information offers thunderstorm data for Middlesex County, which includes Belmont. Between 2008 and 2019, 292 thunderstorm events in Middlesex County caused $3,241,550 in property damages (NCEI and NOAA, 2019). Three injuries and no deaths were reported. Table 4-20 provides detailed information related to thunderstorms.

Table 4-20. Previous Federal and State Disaster Declarations for Thunderstorms

Disaster Name and Date of Event	Disaster Number	Type of Assistance	Counties Under Declaration
Severe Storms/Flooding October 20-25, 1996	DR-1142	FEMA Hazard Mitigation Grant Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
Heavy Rain and Flooding June 13-July 6, 1998	DR-1224	FEMA Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester

Table 4-20. Previous Federal and State Disaster Declarations for Thunderstorms

Disaster Name and Date of Event	Disaster Number	Type of Assistance	Counties Under Declaration
Severe Storms & Flooding March 5-April 16, 2001	DR-1364	FEMA Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
Severe Storms and Flooding October 7-16, 2005	DR-1614	FEMA Public Assistance; FEMA Individual & Households Program; FEMA Hazard Mitigation Grant Program	All 14 Massachusetts Counties
Severe Storms and Flooding May 12-23, 2006	DR-1642	FEMA Public Assistance; FEMA Individual & Households Program; FEMA Hazard Mitigation Grant Program	Middlesex, Essex, Suffolk
Severe Storm and Flooding March 12-April 26, 2010	DR-1895	FEMA Public Assistance; FEMA Individual & Households Program; FEMA Hazard Mitigation Grant Program	Bristol, Essex, Middlesex, Suffolk, Norfolk, Plymouth, Worcester

(FEMA, 2019)

Winds associated with thunderstorms can knock down trees resulting in power outages and blocked evacuation and transportation routes. Extreme rain during thunderstorms can cause inland flooding around waterbodies or due to surcharged drainage systems. Thunderstorms are considered high frequency events in Belmont. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard may occur more frequently than once in 5 years (a greater than 20% chance per year).

4.3.1 Climate Change Impacts: High Winds

While Belmont's current 100-year wind speed is 110 mph, climate change will likely increase the number of extreme wind events and their severity. Additionally, rising sea temperature could lengthen the hurricane season and fuel stronger hurricane events. The National Climate Assessment Report notes that hurricane "intensity, frequency, and duration have all increased since the early 1980s." This source predicts the continuing intensity and associated rainfall with rising temperatures (Walsh and Wuebbles, 2014). This would result in greater losses due to increased flooding, associated building damages and business interruption (Walsh and Wuebbles, 2014). The anticipated increase in frequency and intensity of severe thunderstorms may also increase the risk of tornadoes (EEA and EOPSS, 2018).

4.4 Winter Storms

Winter storm events are atmospheric in nature and can impact the entire planning area. All current and future buildings and populations are at risk of winter storms, which have a variety of potential impacts. Heavy snow loads may cause roofs and trees to collapse leading to structural damage. Deaths and injury are also possible impacts. Additional impacts can include road closures, power outages, business interruption, business losses (i.e. due to road closures), hazardous driving conditions, frozen pipes, fires due to improper heating, and second-hand health impacts caused by shoveling (such as a heart attack). Public safety issues are also a concern, as streets and sidewalks can become difficult to pass. This issue may be especially difficult for vulnerable populations such as elderly people who may have trouble crossing at intersections due to large accumulations of snow. Impassable streets can also complicate emergency response efforts during an extreme event.

Winter storms are a potential Town-wide hazard in Belmont. These events can include wind, heavy snow, blizzards, and ice storms. Blizzards and ice storms in Massachusetts can range from an inconvenience, to extreme events that cause significant impacts, and require a large-scale, coordinated response. Previous federal and state disaster declarations for winter storms are shown in Table 4-21. Belmont has been impacted by winter storms in the past. One such instance was "Snowmageddon" in 2015, when no busses trains or vehicles could be used.

Table 4-21. Previous Federal and State Disaster Declarations for Winter Storms

Disaster Name and Date of Event	Disaster Number	Type of Assistance	Counties Under Declaration
Blizzard January 7-13, 1996	DR-1090	No funding reported	All 14 Massachusetts Counties
Severe Winter Storm and Flooding December 11-18, 2008	DR-1813	FEMA Public Assistance; FEMA Hazard Mitigation Grant Program	All 14 Massachusetts Counties
Severe Winter Storm and Snowstorm January 11-12, 2011	DR-1959	FEMA Public Assistance; FEMA Hazard Mitigation Grant Program	Berkshire, Essex, Hampden, Hampshire, Middlesex, Norfolk, Suffolk
Severe Storm and Snowstorm October 29-30, 2011	DR-4051	FEMA Public Assistance; FEMA Public Assistance Snow Removal; FEMA Hazard Mitigation Grant Program	Berkshire, Franklin, Hampden, Hampshire, Middlesex, Worcester
Severe Winter Storm, Snowstorm, and Flooding February 8-9, 2013	DR-4110	FEMA Public Assistance; FEMA Hazard Mitigation Grant Program	All 14 Massachusetts Counties
Severe Winter Storm, Snowstorm, and Flooding January 26-28, 2015	DR-4214	FEMA Public Assistance; FEMA Hazard Mitigation Grant Program	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester
Severe Winter Storm and Snowstorm March 13-14, 2018	DR-4379	FEMA Public Assistance; FEMA Hazard Mitigation Grant Program	Essex, Middlesex, Norfolk, Suffolk, Worcester

(FEMA, 2019)

4.4.1 Heavy Snow and Blizzards

A blizzard is a winter snowstorm with sustained wind or frequent wind gusts of 35 mph or more, accompanied by falling or blowing snow that reduces visibility to or below a quarter of a mile. These conditions must be the predominant condition over a 3-hour period. Extremely cold temperatures are often associated with blizzard conditions but are not a formal part of the criteria. However, the hazard created by the combination of snow, wind, and low visibility increases significantly with temperatures below 20°F. A severe blizzard is categorized as having temperatures near or below 10°F, winds exceeding 45 mph, and visibility reduced by snow to near zero (EEA and EOPSS, 2018). Blizzards are classified as high frequency events in Belmont. As defined by the *2013 Massachusetts State Hazard Mitigation Plan*, this hazard can occur more than once in five years (a greater than 20% chance of occurring each year).

Winter storms include multiple risks, such as wind, ice, and heavy snow. The National Weather Service defines "heavy snow" as snowfall accumulating to 4" or more in 12 hours or less; or snowfall accumulating to 6" or more in 24 hours or less (NOAA, 2019b). Winter storms can be combined with the nor'easters discussed previously in the "Wind-Related Hazards" section.

The "Blizzard of 1978" is a well-known winter storm that deposited more than three feet of snow and led to multi-day closures of roads, businesses, and schools. Table 4-22 provides additional information on significant snow events. NOAA's National Centers for Environmental Information Storm Events Database provide information for blizzards, winter weather, heavy snow, and winter storms. There were 250 winter events between 2000 and 2019 in Middlesex County totaling $2,059,000 dollars of damage. The greatest damage was during this time frame was a storm in 2011 causing $926,000 of damage. Most of the electric customers (99%) were out of electricity during a snowstorm in October 2011 (NMCOG, 2015).

Table 4-22. Severe Winter Storm Records for Massachusetts

Type of Event	Date
Blizzard	February 1978
Blizzard	March 1993
Blizzard	January 1996
Severe Snowstorm	March 2001
Blizzard	February 1978
Blizzard	March 1993
Blizzard	January 1996
Severe Snowstorm	March 2001
Severe Snowstorm	December 2003
Severe Snowstorm	January 2004
Severe Snowstorm	January 2005
Severe Snowstorm	April 2007
Severe Snowstorm	December 2010
Severe Snowstorm	January 2011
Blizzard	February 2013
Blizzard	January 2015
Severe Snow Storm	March 2018

(NOAA, 2019)

During Belmont's MVP Workshop in January 2020, participants discussed past examples of severe winter weather. Participants discussed the opportunity for additional snow maintenance personnel and equipment, as well as more hazard snow removal at Town buildings. Participants discussed how the snow removal procedures could be updated, and adherence to the procedures could be more strictly enforced. Backup power sources are imperative to the Town in the event of power outages due to severe winter weather.

The current winter snowfall record in Eastern Massachusetts is 108.6 inches during the 2014-2015 season (NOAA, 2015). The Town provides standard snow plowing operations and clearing snow has not posed any significant challenges. However, Town officials acknowledged that it can be difficult to clear roads during storms when residents are still driving on the roads. Also, when winter storms cause downed trees, Town staff must divide their resources in order to both plow the roads and remove the trees from the roadway.

4.4.2 Ice Storms

Ice storm conditions are defined by liquid rain falling and freezing on contact with cold objects creating ice build-ups of ¼ inch or more that can cause severe damage. An ice storm warning, now included in the criterion for a winter storm warning, is for severe icing. This is issued when ½ inch or more of accretion of freezing rain is expected. This may lead to dangerous walking or driving conditions and the weighing down of power lines and trees. Icy roads can also complicate emergency response efforts during an extreme event. Ice storms are classified as medium frequency events in Belmont. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, this hazard can occur between once in five years and once in 50 years (a 2% to 20% chance of occurring each year).

Sleet occurs when raindrops fall into subfreezing air thick enough that the raindrops refreeze into ice before hitting the ground. Sleet differs from hail: sleet is a wintertime phenomenon, while hail usually falls during thunderstorms in the spring and summer (MEMA and DCR, 2013).

NOAA’s National Centers for Environmental Information Storm Events Database offers data on hail events, ice storms and sleet Middlesex County. There were 131 hail events, 3 ice storms, and no reported sleet hazards between 2000 and 2019. No deaths or injuries were reported. Over $6.2 million dollars in damages were incurred.

4.4.3 Climate Change Impacts: Winter Storms

There is evidence suggesting that nor’easters along the Atlantic coast are increasing in frequency and intensity. Future nor’easters may become more concentrated during the coldest winter months when atmospheric temperatures are still low enough to result in snowfall rather than rain (EEA and EOPSS, 2018).Climate projections indicate that climate change will result in more precipitation during the winter in the Northeast (EEA, 2018a). This trend may result in more frequent and/or more severe winter storms.

4.5 Geological Hazards

Geologic hazards can include earthquakes, landslides, sinkholes, and subsidence. Town officials did not identify any local areas that were previously recorded as being vulnerable to geologic hazards.

4.5.1 Earthquakes

An earthquake is the vibration, sometimes violent, of the earth’s surface that follows a release of energy in the Earth’s crust due to fault fracture and movement. The magnitude or extent of an earthquake is a seismograph-measured value of the amplitude of the seismic waves. The Richter magnitude scale (Richter scale) was developed in 1932 as a mathematical device to compare the size of earthquakes. The Richter scale is the most widely known scale that measures earthquake magnitude. It has no upper limit and is not a direct indication of damage. An earthquake in a densely populated area, which results in many deaths and considerable damage, can have the same magnitude as an earthquake in a remote area that causes no damage. Table 4-23 summarizes Richter scale magnitudes and corresponding earthquake effects (MEMA and DCR, 2013).

Table 4-23. Richter Scale and Effects

Richter Magnitudes	Earthquake Effects
Less than 3.5	Generally, not felt, but recorded
3.5- 5.4	Often felt, but rarely causes damage
Under 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1-6.9	Can be destructive in areas up to about 100 km across where people live.
7.0- 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or greater	Great earthquake. Can cause serious damage in areas several hundred meters across.

(Louie, 1996)

Earthquakes occur in New England, albeit infrequently, as compared to other parts of the country. The first recorded earthquake was noted by the Plymouth Pilgrims and other early settlers in 1638. Of the over 5,000 earthquakes recorded in the Northeast Earthquake Catalog through 2008, 1,530 occurred within the boundaries of the six New England States, with 366 earthquakes recorded for Massachusetts between 1627 and 2008. Historically, moderately damaging earthquakes strike somewhere in the region every few decades, and smaller earthquakes are felt approximately twice per year. (MEMA and DCR, 2013). A summary of historic earthquakes in the Boston area is included in Table 4-24 below:

Table 4-24. Historical Earthquakes in Boston or Surrounding Area, 1727-2020

Location	Date	Magnitude
MA - Cape Ann	11/10/1727	5
MA - Cape Ann	12/29/1727	NA
MA - Cape Ann	2/10/1728	NA
MA - Cape Ann	3/30/1729	NA
MA - Cape Ann	12/9/1729	NA
MA - Cape Ann	2/20/1730	NA
MA - Cape Ann	3/9/1730	NA
MA - Boston	6/24/1741	NA
MA - Cape Ann	6/14/1744	4.7
MA - Salem	7/1/1744	NA
MA - Off Cape Ann	11/18/1755	6
MA - Off Cape Cod	11/23/1755	NA
MA - Boston	3/12/1761	4.6
MA - Off Cape Cod	2/2/1766	NA
MA - Offshore	1/2/1785	5.4
MA - Wareham/Taunton	12/25/1800	NA
MA - Woburn	10/5/1817	4.3
MA - Marblehead	8/25/1846	4.3
MA - Brewster	8/8/1847	4.2
MA - Boxford	5/12/1880	NA
MA - Newbury	11/7/1907	NA
MA - Wareham	4/25/1924	NA
MA - Cape Ann	1/7/1925	4
MA - Nantucket	10/25/1965	NA

Table 4-24. Historical Earthquakes in Boston or Surrounding Area, 1727-2020

Location	Date	Magnitude
MA - Boston	12/27/1974	2.3
VA - Mineral	8/23/2011	5.8
MA - Nantucket	4/12/2012	4.5
ME - Hollis	10/17/2012	4.0
MA – Newburyport	2/20/2013	2.3
NH – Contoocook	10/11/2013	2.6
MA – Freetown	1/9/2014	2.0
MA – Bliss Corner	2/11/2014	2.2
MA – off Northshore	8/18/2014	2.0
CT - Deep River Center	8/14/2014	2.7
CT – Wauregan	1/12/2015	3.3
CT – Wauregan	1/13/2015	2.6
RI – Newport	2/3/2015	2.0
NH – Epsom	8/2/2015	2.2
NH – Contoocook	3/21/2016	2.8
MA – Rockport Coast	6/1/2016	2.2
NH – Bedford	2/11/2017	2.2
NH – East Kingston	2/15/2018	2.7
ME – Cape Neddick	7/16/2018	2.1
MA – Nantucket	8/18/2018	2.4
MA – Templeton	12/21/2018	2.1
MA – Gardner	12/23/2018	2.2
RI – Charlestown	3/1/2019	2.3
MA – Rockport	4/27/2019	2.1
MA – North Plymouth	12/3/2019	2.1

(USGS, 2020)

Ground shaking or ground motion is the primary cause of earthquake damage to man-made structures. Ground motion from earthquakes is amplified by soft soils and reduced by hard rock. Ground motion.is measured by maximum peak horizontal acceleration expressed as a percentage of gravity (%g). Peak ground acceleration in the state ranges from 10 %g to 20 %g, with a 2% probability of exceedance in 50 years.

Belmont is in an area with a PGA of 14 %g to 16 %g with a 2% probability of exceedance in 50 years (Figure 4-9). This is the third/fourth highest zone in the state: in other words, a moderate area of earthquake risk. This is not a significant hazard because, Massachusetts overall has a low risk of earthquakes compared to the rest of the United States.

Although new construction under the most recent building codes generally will be built to seismic standards, much of the development in the Town pre-dates the current building code. If an earthquake occurs, the entire region, not just the Town, would face significant challenges. Earthquakes often trigger fires. The water distribution system may be disrupted, thus posing a risk for public health and safety.

A serious earthquake in Massachusetts is possible. These events can strike without warning and can have a devastating impact on infrastructure and buildings constructed prior to earthquake resistant design considerations.

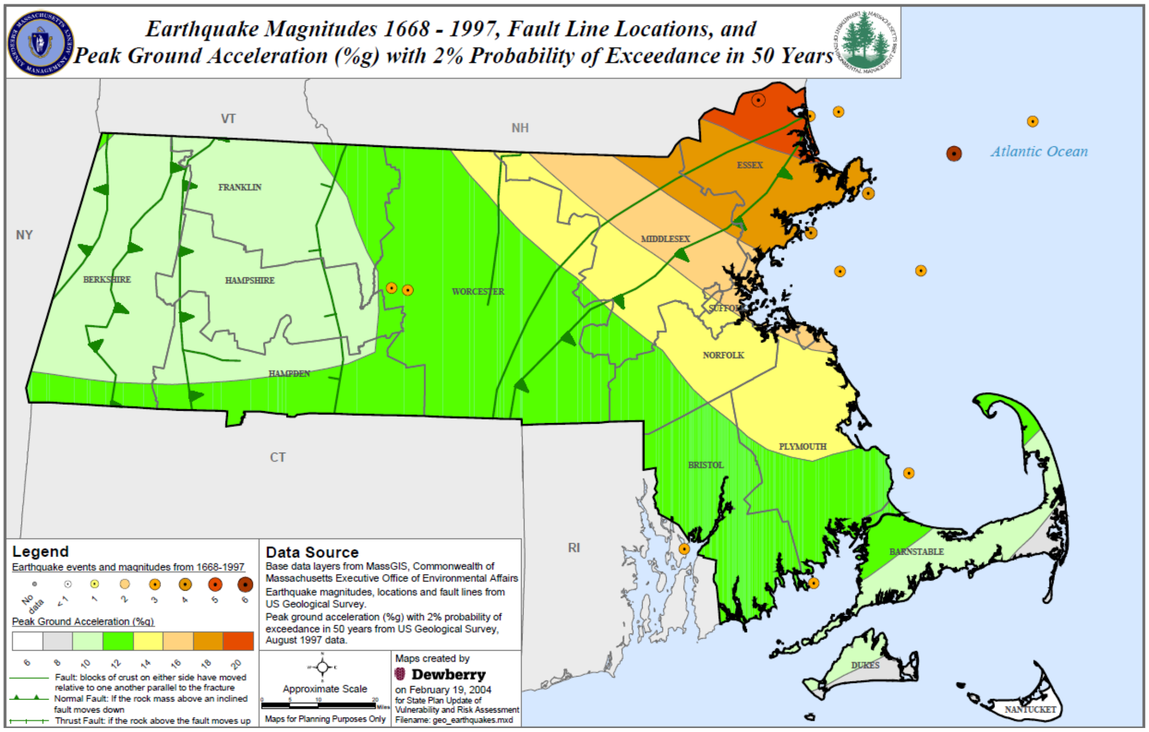


Figure 4-9. State of Massachusetts Earthquake Probability Map

(EEA and EOPSS, 2018)

It can be assumed that all existing and future buildings and populations are at risk to an earthquake hazard. Impacts from earthquakes can be from slight to moderate building damage, to catastrophic damage and fatalities, depending on the severity of the earthquake event. Events may cause minor damage such as cracked plaster and chimneys, or broken windows, or major damage resulting in building collapse. Based on the Massachusetts State Hazard Mitigation Plan (MEMA and DCR, 2013, pp-236), the degree of exposure "depends on many factors, including the age and construction type of the structures where people live, work, and go to school; the soil type these buildings are constructed on; and the proximity of these building to the fault location." Furthermore, the time of day exposes different sectors of the community to the hazard. Earthquakes can lead to business interruptions, loss of utilities and road closures which may isolate populations. People who reside or work in unreinforced masonry buildings are vulnerable to liquefaction (liquefaction is the phenomenon that occurs when the strength and stiffness of a soil is reduced by earthquake).

Potential earthquake damage was modeled for Belmont. Hazus Multi-Hazard (Hazus) is a GIS model developed by FEMA to estimate losses in a defined area due to a specified natural hazard. The Hazus earthquake model allows users to input specific parameters in order to model a defined earthquake magnitude, with the epicenter located at the center of the municipality. In this analysis, two earthquakes were modeled: a magnitude 5.0 and a magnitude 7.0 earthquake. While large earthquakes are rare in Massachusetts, there was a magnitude 5.0 earthquake recorded in 1963. There is a possibility for larger scale earthquakes to occur in Massachusetts at some point, therefore a magnitude 7.0 earthquake was modeled as well to demonstrate the damage that could occur.

In order to model each of these earthquakes, the study region must first be defined. The Town of Belmont was outlined by the census tracts in the Town. The arbitrary event scenario was used, which allows the user to input the magnitude, depth, with, and epicenter of the earthquake. This must be done for each earthquake magnitude chosen. The output shows the potential impact that could occur in Belmont if either a magnitude 5.0 or a magnitude 7.0 earthquake occurred with the epicenter located in the center of the Town. HAZUS is based on 2010 census data and 2014 dollars. The tables below show the estimated damage from both a magnitude 5.0 and a magnitude 7.0 earthquake in the municipality.

Based on an HAZUS Earthquake module, estimated damage in Belmont from Magnitude 5 and 7 Earthquakes was assessed (Town of Belmont and MAPC, 2013). Historically, an earthquake with magnitude 5 occurred in 1963. This assessment assumes an earthquake epicenter at the center of the study area which would be the worst-case scenario. Table 4-25 below lists estimated damage in Belmont for this worst-case scenario.

Table 4-25. Estimated Damage in Belmont from Magnitude 5 and 7 Earthquakes

	Magnitude 5.0	Magnitude 7.0
Building Characteristics		
Estimated total number of buildings	8,088	8,088
Estimated total building replacement value (Year 2014 $)(Millions of dollars)	$3,878	$3,878
Building Damages		
# of buildings sustaining slight damage	2,328	223
# of buildings sustaining moderate damage	1,366	1,426
# of buildings sustaining extensive damage	433	2,087
# of buildings completely damaged	118	4,332
Population Needs		
# of households displaced	574	6,362
# of people seeking public shelter	284	3,171
Debris		
Building debris generated (tons)	100,000	747,000
# of truckloads to clear building debris (@25 tons/truck)	4,000	29,880_
Value of Damages (Millions of dollars)		
Total property damage	$465.74	$3471.17
Total losses due to business interruption	$90.01	$493.24

In addition to the infrastructural damage, HAZUS also calculated the potential social impact of a magnitude 5.0 and magnitude 7.0 earthquake on the community. This is shown as monetary value of business interruption loss of wages, capital related loss, rental and relocation costs. It also estimates displaced households, persons seeking temporary public shelter, and casualties. The full Hazus earthquake global risk report can be found in Appendix B.

Earthquakes are classified as a very low frequency event in Belmont. As defined by the *2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan*, the probability of a magnitude 5.0 or greater earthquake centered in New England is about 10-15% in a 10-year period.

4.5.2 Landslides

Landslide include a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity, acting on an over steepened slope, is the primary reason for a landslide, there are other contributing factors. These contributing factors can include erosion by rivers or ocean waves over steepened slopes; rock and soil slopes weakened through saturation by snowmelt or heavy rains; earthquake created stresses that make weak slopes fail; excess weight from accumulation of rain or snow; and stockpiling of rock or ore from waste piles or man-made structures (USGS 2019).

Landslides occur throughout the United States, causing an estimated $1 billion in damages and 25-50 deaths each year. Any area composed of very weak or fractured materials resting on a steep slope will likely experience landslides. Although the physical cause of many landslides cannot be removed, geologic investigations, good engineering practices, and effective enforcement of land-use management regulations can reduce landslide hazards (USGS 2019). Landslides can damage buildings and infrastructure and cause sedimentation of water bodies.

Landslide intensity can be measured in terms of destructiveness, as demonstrated by Table 4-26 below.

Table 4-26. Landslide Volume and Velocity

Estimate Volume (m^3)	Expected Landslide Velocity		
	Fast moving (rock fall)	Rapid moving (debris flow)	Slow moving (slide)
<0.001	Slight intensity	--	--
<0.5	Medium intensity	--	--
>0.5	High intensity	---	--
<500	High intensity	Slight intensity	--
500-10,000	High intensity	Medium intensity	Slight intensity
10,000 – 50,000	Very high intensity	High intensity	Medium intensity
>500,000	--	Very high intensity	High intensity
>>500,000	--	--	Very high intensity

(Cardinali et al. 2002)

All of Belmont is classified as having a low risk for landslides. No significant landslides have been recorded for Belmont or Middlesex County (EEA and EOPSS, 2018). Rather, local officials indicate that there are occasionally localized issues of erosion during construction, as a result of development, or as a result of clearing vegetation. Landslides are classified as low frequency events in Belmont. These events can occur once in 50 to 100 years (a 1% to 2% chance of occurring each year).

4.6 Fire-Related Hazards

Fire risk is influenced by type of fuel, terrain, and weather. Strong winds can exacerbate extreme fire conditions, especially wind events that persist for long periods, or ones with significant sustained wind speeds that quickly promote fire spread through the movement of embers or exposure within tree crowns. Fires can spread quickly into developed areas.

Belmont is most susceptible to brushfire compared to a wildfire (or fire with a larger impact area). Brushfires and wildfires occur in the vegetative wildland, including grass, shrub, leaf litter, and forested-tree fuels. Fires can be caused by natural events or human activity, which then can spread quickly, igniting brush, trees, and homes (MEMA and DCR, 2013). The State Hazard Mitigation and Climate Adaptation Plan (EEA and EOPPS, 2018) states:

> *The ecosystems that are most susceptible to the wildfire hazard are pitch pine, scrub oak, and oak forests, as these areas contain the most flammable vegetative fuels. Other portions of the Commonwealth are also susceptible to wildfire, particularly at the urban-wildland interface…. Interface communities are defined as those in the vicinity of contiguous vegetation, with more than one house per 40 acres and less than 50 percent vegetation, and within 1.5 miles of an area of more than 500 hectares (approximately 202 acres) that is more than 75 percent vegetated.*

Belmont has a region of intermix areas in the western part of Town, which would be more vulnerable to fire hazards because they are where housing and vegetation intermingle. Historically, McLean Open Space, Beaver Brook Reservation, and Belmont Hill Habitat been subject to brush fires (Town of Belmont and MAPC, 2013). In the CRB Workshop, the open fields in Rock Mountain Conservation Area were highlighted as an area vulnerable to bushfires. In recent years there have not been many brush fire occurrences in Belmont. Since wildfires are not common in Massachusetts, this plan focuses on brush and urban fires.

Brush fires can lead to property damage and even death, although they have not resulted in any major property damage or deaths in Belmont. All individuals whose homes or workplaces are in brush fire hazard zones are exposed to this hazard. The most vulnerable members of this population are those who would be unable to evacuate quickly, including those over the age of 65, households with young children under the age of 5, people with mobility limitations, and people with low socioeconomic status (EEA and EOPSS, 2018). Secondary effects from brush fire include contamination of reservoirs; destroyed power, gas, water, broadband, and oil transmission lines. Brush fires can also contribute to flooding as they strip slopes of vegetation, thereby exposing them to greater amounts of runoff which may cause soil erosion and ultimately the chance of flooding. Additionally, subsequent rains can worsen erosion because brush fires burn ground vegetation and ground cover.

Although they are usually minor, the Belmont Fire Department responds to several brush fires annually, but they have not resulted in major property damage or deaths. In recent years, the number of brush fires has decreased, except for small brush fires deep in the woods. These fires are due to human carelessness, such as juvenile activity. Approximately 84% of brush fires are caused by humans (Balch et al. 2017). Lightning can also be a culprit, igniting a fire when striking dry tinder on the forest floor. The Belmont Fire Department has a truck that has been converted into a brushfire fighting vehicle, but no equipment specifically designed to fight brushfires. The makeshift vehicle can't enter marshy areas such as near Beaver Brook that are prone to dry vegetation and could be potential brushfire hazard areas. Additional equipment designed for fighting brushfires, such as a side-by-side UTV with a water tank, would be beneficial to the Fire Department. Table 4-27 shows the sites were identified by Town staff as areas that have a higher brush fire risk.

Table 4-27. Potential Brushfire Hazard Area

Hazard Area	Ownership
Beaver Brook	DCR
Rock Meadow	Town of Belmont Conservation Commission
McLean Open Space	Town of Belmont Conservation Commission
Belmont Hill Habitat	Mass Audubon Wildlife Preserve

(Town of Belmont and MAPC, 2013)

Figure 4-10 below shows the locations of historical brush fires and the number of acres burned in Massachusetts between 2001 and 2009. Belmont has experienced between 0 and 20 recordable fires, totaling between 0.26 and 9 acres burned.

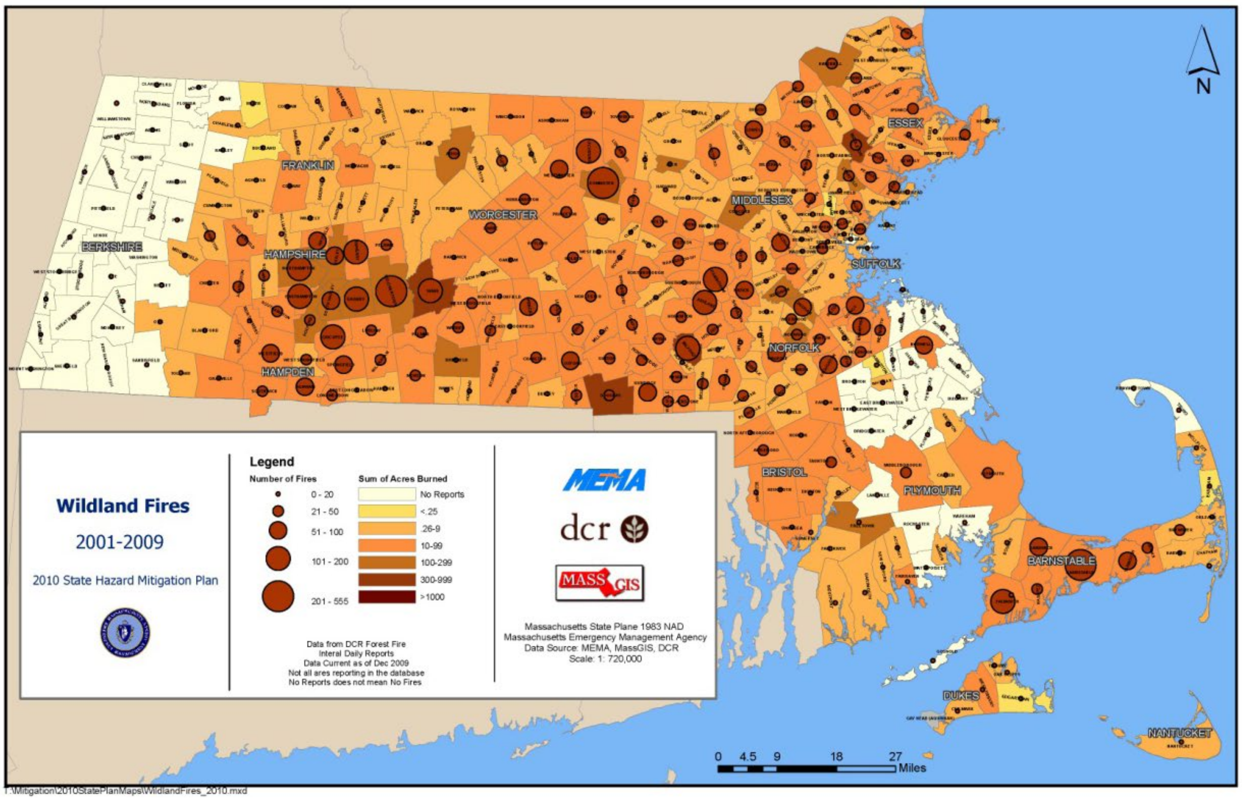


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Figure 4-10. Massachusetts Brush Fires, 2001 to 2009 (MEMA and DCR, 2013)

Brush fires are classified as medium frequency events. As defined by the 2013 State Hazard Mitigation Plan, these events occur between once in 5 years to once in 50 years (a 2% to 20% chance of occurring per year).

4.7 Extreme Temperatures

Extreme temperatures are considered a Town-wide hazard in Belmont. These events can include both temperatures over and under seasonal averages. These extreme temperature events can range from brief to lengthy.

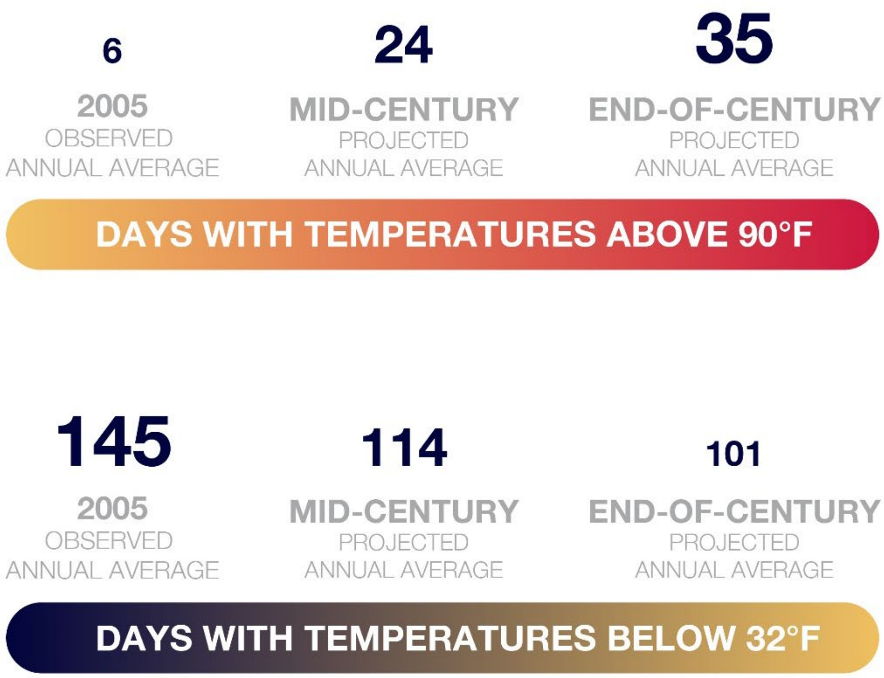

Figure 4-11. Current and Projected Temperature Changes (Weston & Sampson based on EEA, 2018a)

Massachusetts has four clearly defined seasons. Extreme temperatures fall outside of the ranges typically experienced during these seasons. Boston's average winter temperature, from December to February, is 32.2°F. Boston's average summer temperature, from June to August, is 73.8°F (NOAA 2018a).

4.7.1 Extreme Cold

Extremely cold temperatures are measured using the Wind Chill Temperature Index provided by the National Weather Service (NWS). The updated index was implemented in 2001 and helps explain the impact of cold temperatures on unexposed skin. Figure 4-12 provides more information.

Temperature (°F)

Wind (mph) \ Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes; 10 minutes; 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph) *Effective 11/01/01*

Figure 4-12 Windchill Temperature Index and Frostbite Risk (National Weather Service, n.d.)

Extremely cold temperatures can create dangerous conditions for homeless populations, stranded travelers, and residents without sufficient insulation or heat. The homeless, the elderly, and people with disabilities are often most vulnerable. In Belmont, 16.7% of the population are over 65 years old and 3.4% percent of the population has a disability (ACS 2013-2017). Cold weather events can also have significant health impacts such as frostbite and hypothermia. Furthermore, power outages during cold weather may result in inappropriate use of combustion heaters, cooking appliances, and generators in poorly ventilated areas which can lead to increased risk of carbon monoxide poisoning. NOAA's National Centers for Environmental Information Storm Events Database provides data for extreme cold events. Between 2000 and 2018, Middlesex County experienced three extreme cold and will chill events, which caused no deaths, injuries, or property damage.

4.7.2 Extreme Heat

Increased temperatures will impact all locations within Belmont. Projected heat days and heat waves can have an increased impact in densely settled urban areas. These can become "heat islands" as dark-colored asphalt and roofs store the heat from the sun. According to the Centers for Disease Control and Prevention, the populations most vulnerable to extreme heat impacts include the following:

- People over the age of 65 (e.g., with limited mobility),
- Children under the age of five,
- Individuals with pre-existing medical conditions that impair heat tolerance,
- Low-income individuals who cannot afford proper cooling,
- Individuals with respiratory conditions,
- The general population who may overexert themselves during extreme heat events.

Homeless people are increasingly vulnerable to extreme heat. The capacity of homeless shelters is typically limited. Impacts from heat stress can exacerbate pre-existing respiratory and cardiovascular conditions (CDC, 2017).

Based on Figure 4-13 below, compiled by the Massachusetts Department of Public Health Bureau of Environmental Health (MA DPH, 2019), there is at least one population vulnerability measure in each Census Tract (2010). The population vulnerability measures include: low income, minimal English proficiency, non-white (Hispanic and non-Hispanic ethnicities), and elderly. Belmont has a population density of 1,270 - 5,780 or > 5,780 per square mile.

The NWS issues a Heat Advisory when the Heat Index (Figure 4-14) is forecast to reach 100-104˚ F for two or more hours (https://www.weather.gov/bgm/heat). The NWS issues an Excessive Heat Warning if the Heat Index is forecast to reach 105˚+F for two or more hours. Heat waves cause more fatalities in the U.S. than the total of all other meteorological events combined. In Boston, over 50 people die each year due to heat-related illnesses. From 1979-2012, excessive heat exposure caused in excess of 8,000 deaths in the United States (MEMA and DCR 2013). During this period, more people in this country died from extreme heat than from hurricanes, lightning, tornadoes, floods, and earthquakes combined.

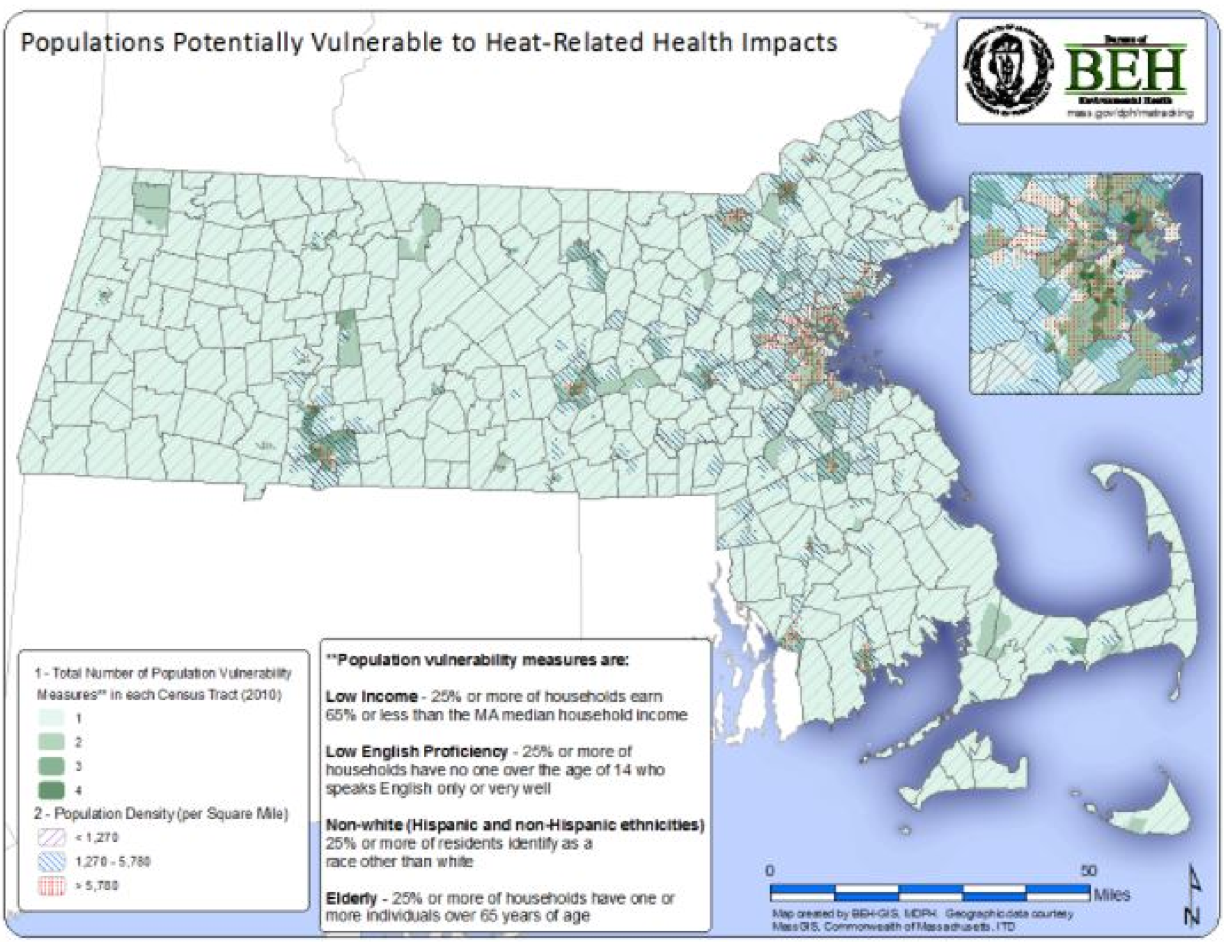

Figure 4-13. Populations Potentially Vulnerable to Heat related Health Impacts (Massachusetts Department of Public Health, Bureau of Environmental Health, 2019)

Relative Humidity (%)	Temperature (°F)															
	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Category	Heat Index	Health Hazards
Extreme Danger	130 °F – Higher	Heat Stroke or Sunstroke is likely with continued exposure.
Danger	105 °F – 129 °F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Extreme Caution	90 °F – 105 °F	Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.
Caution	80 °F – 90 °F	Fatigue possible with prolonged exposure and/or physical activity.

Figure 4-14. Heat Index Chart (https://www.weather.gov/safety/heat-index)

On July 6, 2013, a postal worker in Massachusetts collapsed and died as the Heat Index reached 100°F (EEA and EOPSS, 2018). Because most heat-related deaths occur during the summer, people should be aware of who is at greatest risk and what actions can be taken to prevent a heat-related illness or death. The populations at greater risk are the elderly, children, and people with certain medical conditions, such as heart disease. In Belmont, children under five years old make up 5% of the population, and 13.2% are over 65 years old. However, even young and healthy individuals can succumb to heat if they participate in strenuous physical activities during hot weather. Some behaviors also put people at greater risk: drinking alcohol, taking part in strenuous outdoor physical activities in hot weather, and taking medications that impair the body's ability to regulate its temperature or that inhibit perspiration (MEMA and DCR 2013; ACS 2013-2017).

Increased temperatures can lead to a longer growing season, which in turn leads to a longer pollen season. Warmer weather can also support the migration of invasive species and lead to an increase in vector-borne diseases. Increasing temperatures can also worsen air pollution, which can lead to negative health impacts such as respiratory problems. Potential impacts from increasing temperatures are show in Figure 4-15, below.

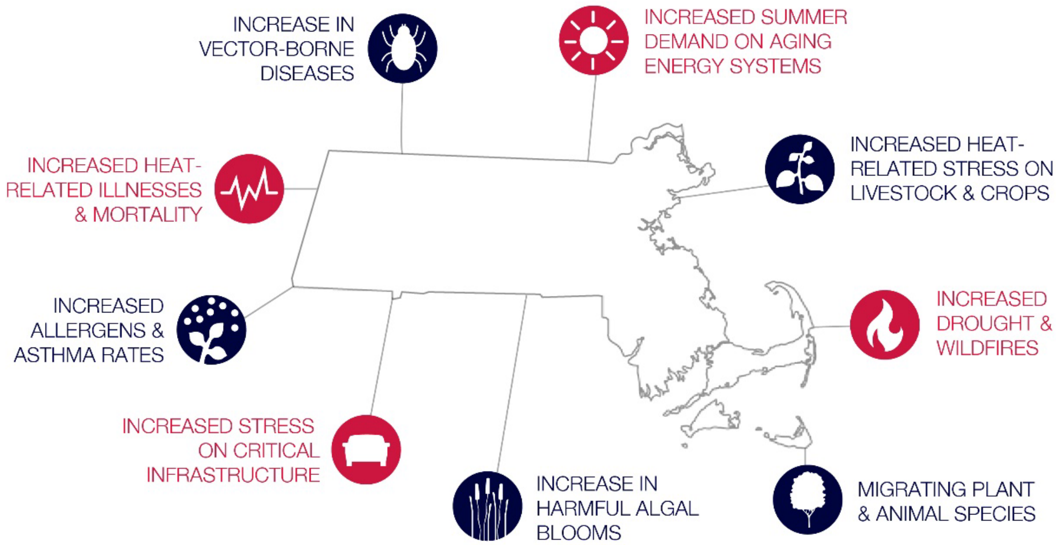

Figure 4-15. Potential Impacts from Increasing Temperatures (Weston & Sampson based on MA EOEEA, 2018)

In past years, Belmont has experienced brown outs, which are reductions of electricity supply on hot days when demand is high generally due to cooling devices. The Town is not connected to a regional electricity network, and so must manage their electricity on hot days to ensure resident's safety. The Town has improved the electrical grid to build capacity and continuously works to reduce usage during peak hours.

The Town of Belmont does not collect data on heat occurrences. The best available local data are for Middlesex County, through the National Environmental Information Center. NOAA's National Centers for Environmental Information Storm Events Database provides data on excessive heat. Between 1998 and 2018, Middlesex County experienced three extreme heat days, which did not result in injury or property damage. One event did result in a single death in 2013.

Extreme temperatures are classified as medium frequency events. According to the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (EEA and EOPSS, 2018), between four and five heat waves (3 or more consecutive days of 90˚+F temperatures) occur annually in Massachusetts.

4.7.3 Climate Change Impacts: Extreme Temperatures

Between 1961 and 1990, Boston experienced an average of one day per year in excess of 100°F. That could increase to six days per year by 2070, and 24 days per year by 2099. Under these conditions by the end of the century, Massachusetts's climate would more closely resemble that of Maryland or the Carolinas (refer to Figure 4-16 below). These changes in temperature would also have a detrimental impact on air quality and public health concerns including asthma and other respiratory conditions (Frumhoff et al. 2007).

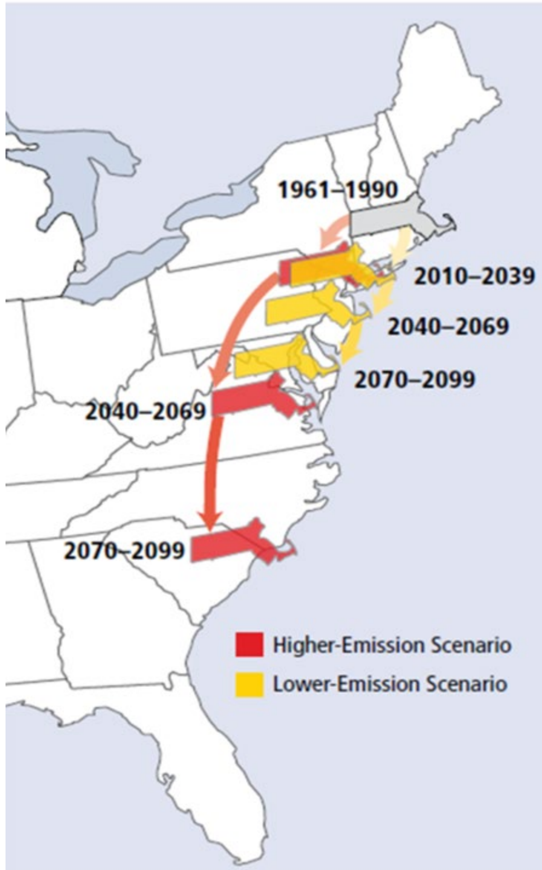

Figure 4-16. Massachusetts Extreme Heat Sc*enarios.* (Frumhoff et al. 2007)

4.8 Drought

Drought is an extended period of deficient precipitation. Drought conditions occur in virtually all climatic zones, yet its characteristics vary significantly from one region to another since it is relative to the normal precipitation in that region. Agriculture, the water supply, aquatic ecosystems, wildlife, and the economy are vulnerable to the impacts of drought (EEA and EOPSS 2018).

Average annual precipitation in Boston is 53.32 inches per year, with approximately two to five-inch average amounts for each month of the year (NOAA 2019c). Although Massachusetts is relatively small, it has several distinct regions that experience significantly different weather patterns and react differently to the amounts of precipitation they receive. In accordance with the Massachusetts Drought Management Plan, the Drought Management Task Force will make recommendations to the Secretary of Energy & Environmental Affairs about the location and severity of drought in the Commonwealth. The Drought Management Plan divides the state into six regions: Western, Central, Connecticut River Valley, Northeast, Southeast, and Cape and Islands. Belmont is located within the Northeast region (EEA and MEMA, 2013). The Drought Management Plan, which was finalized in 2019, a seventh region, representing the Islands alone, has been added (Massachusetts Water Resources Commission, 2019).

Five levels of drought have been developed to characterize drought severity: Normal, Advisory, Watch, Warning, and Emergency; these correspond to Level 0 – Normal, Level 1 - Mild Drought, Level 2 - Significant Drought, Level 3 - Critical Drought (was Warning), and Level 4 - Emergency Drought (was Emergency), respectively, of the draft Drought Management Plan update. The drought levels are based on the severity of drought conditions and their impacts on natural resources and public water supplies.

The Drought Management Plan specifies the agency response and interagency coordination and communication corresponding to the various drought levels. During normal conditions, data are routinely collected and distributed. There is heightened vigilance with additional data collection during an advisory, and increased assessment and proactive education during a watch. Water restrictions might be appropriate at the watch or warning stage, depending on the capacity of each individual water supply system. A warning level indicates a severe situation and the possibility that a drought emergency may be necessary. A drought emergency is one in which use of emergency supplies become necessary or in which the Governor may exercise his authority to require mandatory water restrictions or (EEA and MEMA, 2013).

A variety of drought indices are available to assess the various impacts of dry conditions. The Commonwealth uses a multi-index system to determine the severity of a drought or extended period of dry conditions. A determination of drought level is based on seven indices: Standardized Precipitation Index, Precipitation (percent of normal), Crop Moisture Index, Keetch-Byram Drought Index (KBDI), Groundwater levels, Stream flow levels, and Index Reservoir levels. (In its draft updated Drought Management Plan, the Drought Management Trask Force has proposed to eliminate the precipitation index that is based on percent of normal precipitation.)

Drought level is determined monthly based on the number of indices which have reached a given drought level. A majority of the indices would need to be triggered in a region in order for a drought designation to move to a more severe level. Drought levels are declared on a regional basis for each of the six regions in Massachusetts. Drought levels may also be made county by county or be watershed specific. The end of a drought is determined by precipitation and groundwater levels since these have the greatest long-term impact on streamflow, water supply, reservoir levels, soil moisture and potential for forest fires (EEA and MEMA, 2013). Figure 4-17 illustrates statewide weeks of extreme drought between 2001 and 2017 and Table 4-28 below summarizes a history of Massachusetts droughts between 1879 and 2017.

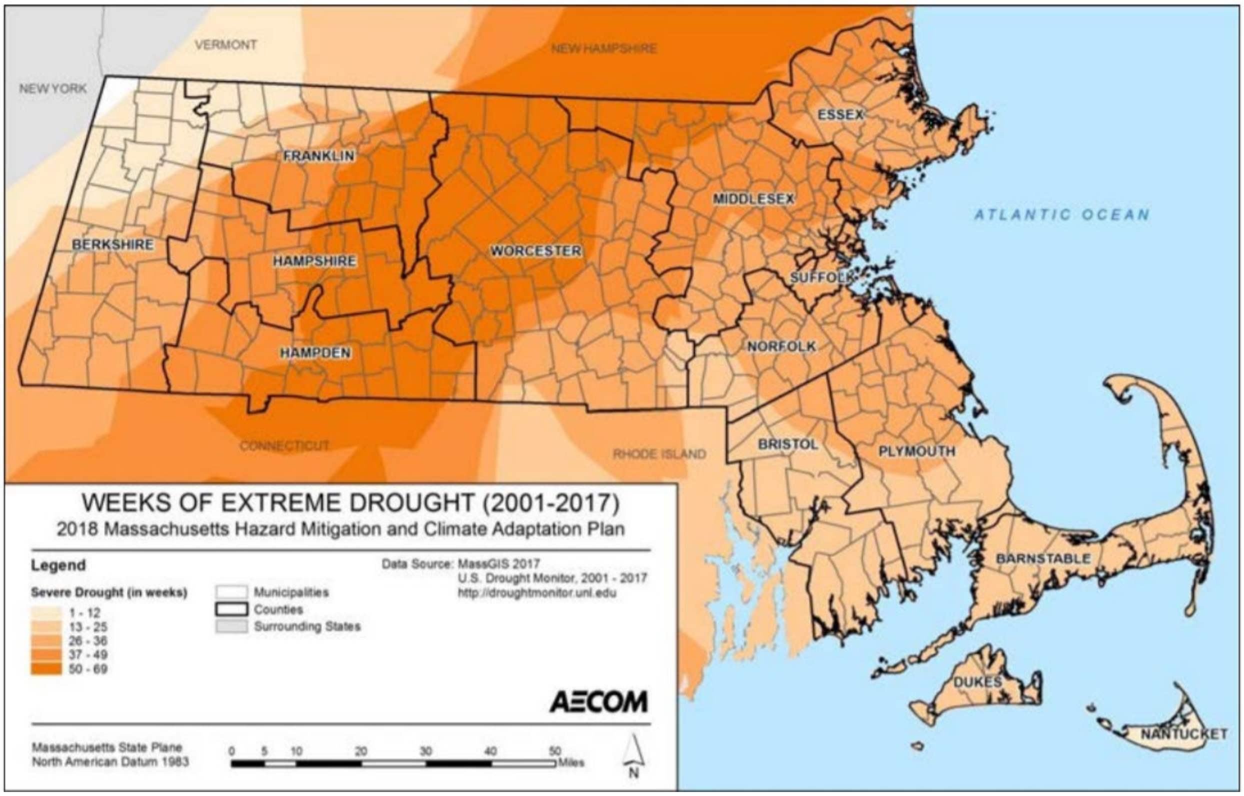

Figure 4-17. Weeks of Severe Drought (2001 - 2017)

Table 4-28. Droughts in Massachusetts Based on Instrumental Records

Date	Area Affected	Recurrence Interval (years)	Remarks
1879 to 1883	–	–	–
1908 to 1912	–	–	–
1929 to 1932	Statewide	10 to >50	Water-supply sources altered in 13 communities. Multistate.
1939 to 1944	Statewide	15 to >50	More severe in eastern and extreme western Massachusetts. Multistate.
1957 to 1959	Statewide	5 to 25	Record low water levels in observation wells, northeastern Massachusetts.
1961 to 1969	Statewide	35 to >50	Water-supply shortages common. Record drought. Multistate.
1980 to 1983	Statewide	10 to 30	Most severe in Ipswich and Taunton River basins; minimal effect in Nashua River basin. Multistate.
1985 to 1988	Housatonic River Basin	25	Duration and severity unknown. Streamflow showed mixed trends elsewhere.

Table 4-28. Droughts in Massachusetts Based on Instrumental Records

Date	Area Affected	Recurrence Interval (years)	Remarks
1995	–	–	Based on statewide average precipitation.
1998 to 1999	–	–	Based on statewide average precipitation.
2001 to 2003	Statewide	–	Level 2 drought (out of 4 levels) was reached statewide for several months.
2007 to 2008	Statewide except West and Cape and Islands regions	–	Level 1 drought (out of 4 levels)
2010	Connecticut River Valley, Central and Northeast regions	–	Level 1 drought (out of 4 levels)
2014	Southeast and Cape and Islands regions	–	Level 1 drought (out of 4 levels)
2016-2017	Statewide	–	Level 3 drought (out of 4 levels).

(EEA and EOPSS, 2018)

There are five drought emergencies on record in Massachusetts: 1883, 1911, 1941, 1957, and 1965-1966. The 1965-1966 drought is considered the most severe Massachusetts drought in modern times, given its length. On a monthly basis over the 162-year period of record, there is a one percent chance of being in a Drought Emergency (EEA and MEMA 2013, 36).

Drought Warning levels not associated with Drought Emergencies would have occurred in 1894, 1915, 1930,1985, 2016, and 2017. On a monthly basis over the 162-year period of record, there is a 2%chance of being in a drought Warning level (EEA and MEMA, 2013, 36; DCR 2017b, 1).

Drought watches not associated with higher levels of drought generally would have occurred three to four times per decade between 1850 and 1950. The Drought emergency declarations dominated the 1960s. There were no Drought Watches or above in the 1970s. In the 1980s, there was a lengthy Drought Watch level of precipitation between 1980 and 1981, followed by a Drought Warning in 1985. A frequency of drought Watches at a rate of three years per decade resumed in the 1990s (1995, 1998, 1999). In the 2000s, Drought Watches occurred in 2001 and 2002. The overall frequency of being in a Drought Watch is eight percent on a monthly basis over the 162-year period of record (EEA and MEMA, 2013, 36). There were six drought watches in Massachusetts in 2002, five drought watches in 2016, and two drought watches in 2017 (DCR, 2017b, 1). Figure 4-18 presents an example of drought conditions in the six drought regions.

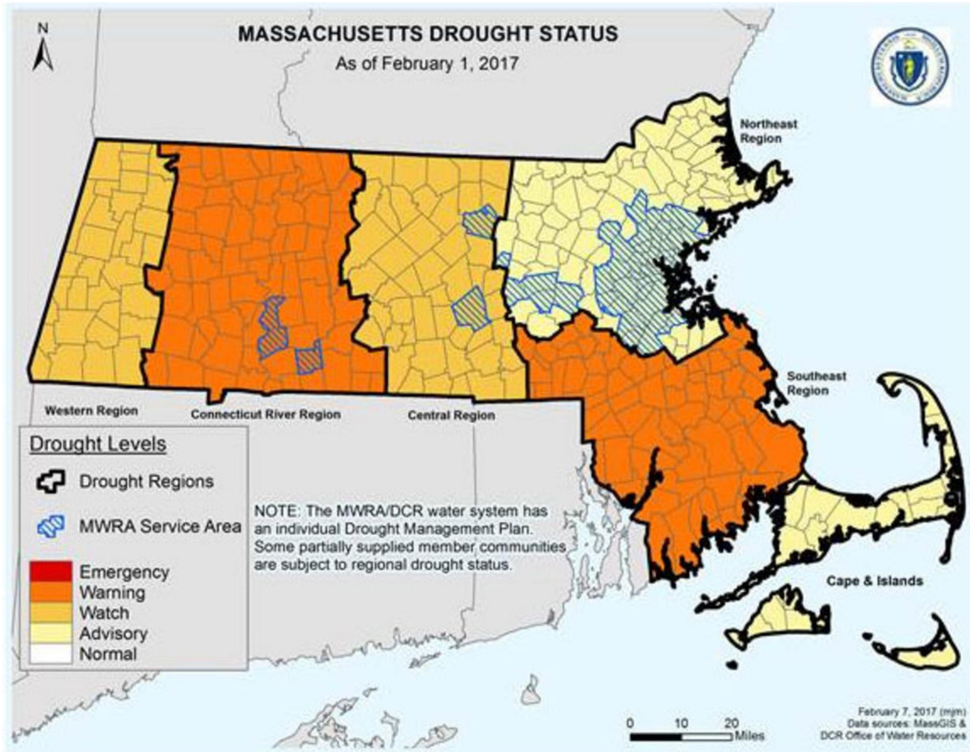

Figure 4-18. Massachusetts Drought Status, February 2017 (DCR, 2017b)

Drought is a potential Town-wide hazard in Belmont. As noted previously, temperature is projected to increase and may lead to exacerbated drought conditions especially in summer and fall months. Droughts can also increase fire risk: fires can be caused by lightning, and a 2014 study found that the frequency of lightning strikes could increase by more than 10% for every degree Celsius of warming (EEA and EOPSS, 2018). During Belmont's MVP Workshop in February 2019, workshop participants discussed the connections between multiple hazards, and their potential impact on the Town. One example given was the potential for a severe drought to increase the risk of brush fires.

A long-term drought could lead to impacts to Town's wetlands and streams, and to Beaver Brook and the Fresh Pond Reservoir, which is the drinking water supply for neighboring Cambridge. In a drought emergency affecting the water supply of the Massachusetts Water Resources Authority, water use restrictions would be implemented in Belmont. This could result in loss of landscaped areas and business revenues depending on the length of the water use restriction.

Droughts are classified as a low frequency natural hazard event. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, these events can occur between once in 50 years to once in 100 years (a 1% to 2% chance of occurring per year).

4.8.1 Climate Change Impacts: Drought

Under climate change, drought conditions will be exacerbated with projected increasing air temperatures and changes in precipitation. Between 1970 and 2000, the median number of consecutive dry fall days in Massachusetts was 11.4 days. This is in comparison to a projected median of 13.5 consecutive days by the end of the century (EEA, 2018a).

5.0 EXISTING MITIGATION MEASURES

The Town of Belmont is already doing measures to mitigate local hazards. Chapter 5 documents the Town's current operations and discusses potential improvements. FEMA's *Local Mitigation Planning Handbook* categorizes hazard mitigation measures into four types as displayed in Table 5-1 (FEMA, 2013). Belmont uses many of these tools, which are presented by hazard type.

Table 5-1. FEMA's Types of Mitigation Actions

Mitigation Category	Description	Examples
Local Plans and Regulations	These actions include government authorities, policies, or codes that influence the way land and buildings are developed and built.	• Comprehensive plans • Land use ordinances • Subdivision regulations • Development review • Building codes and enforcement • NFIP Community Rating System • Capital improvement programs • Open space preservation • Stormwater management regulations and master plans
Structure and Infrastructure Projects	These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct manmade structures to reduce the impact of hazards.	• Acquisitions and elevations of structures in flood prone areas • Utility undergrounding • Structural retrofits • Floodwalls and retaining walls • Detention and retention structures • Culverts • Safe rooms
Natural Systems Protection	These are actions that minimize damage and losses and preserve or restore the functions of natural systems.	• Sediment and erosion control • Stream corridor restoration • Forest management • Conservation easements • Wetland restoration and preservation
Education and Awareness Programs	These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. A greater understanding and awareness of hazards and risk among local officials, stakeholders, and the public is more likely to lead to direct actions.	• Radio or television spots • Websites with maps and information • Real estate disclosure • Presentations to school groups or neighborhood organizations • Mailings to residents in hazard-prone areas. • Storm-Ready or FireWise

Table adapted from Local Mitigation Planning Handbook (FEMA, 2013b).

5.1 Existing Multi-Hazard Mitigation Measures

Comprehensive Emergency Management Plan (CEMP) – Every community in Massachusetts is required to have a Comprehensive Emergency Management Plan. These plans address mitigation, preparedness, response and recovery from a variety of natural and man-made emergencies. These plans contain important information regarding flooding, hurricanes, tornadoes, dam failures, earthquakes, and winter storms. Therefore, the CEMP is a mitigation measure that is relevant to all the hazards discussed in this plan.

Community Emergency Response Team (CERT) – The Town maintains a volunteer program dedicated to responding to emergency situations.

Local Emergency Planning Committee (LEPC) – Under the Emergency Planning and Community Right to Know Act of 1986, communities are required to establish Local Emergency Planning Committees to develop a response plan for chemical emergencies. In accordance with this legislation, the Town of Belmont has identified locations where hazardous materials are stored, used, and transported.

Public Education – Emergency Preparedness public education is available on the Town's website, via the Fire Department, Police Department, Emergency Management Department, and the CERT Team.

Reverse 911 – The Town has a Reverse 911 system that automatically calls all residents and businesses to communicate emergency information. Residents may update their Reverse 911 information on the Town website.

Emergency Shelters – The Chenery Middle School would serve as a shelter in the event of a disaster. There are plans for a new high school, which will also serve as an emergency shelter.

Multi-Department Review of Developments – Multiple departments, such as Community Development, Public Works, Fire, Emergency Management and Conservation, thoroughly review all site plans prior to approval.

Stable Communications Systems – Belmont has reliable communications towers that house communications equipment for the Police and several other Town departments. Town officials stated that their communications systems are not at risk during high wind events.

Backup Generators – In the event of power outages the Town does have backup generators at all the critical Town buildings and facilities. The Town also has a mobile emergency power generator that can be brought site to site in case of an emergency. Backup generators are available at several Town buildings:

- Fire Headquarters
- Fire Station 2
- Police Station
- Homer Town Offices
- Communications Building at Radio Tower
- DPW Garage
- Butler Elementary School
- Chenery Middle School
- Belmont High School

Zoning By-Law – Zoning is intended to protect public health and safety through the regulation of land use. Belmont has a Zoning By-Law that includes many rules and regulations regarding flooding, stormwater management, and site plan review, among many others.

Massachusetts State Building Code – The Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing, and snow loads.

FEMA Deployment – FEMA can deploy vehicles in the case of an emergency.

5.2 Existing Flood-Related Mitigation Practices

Participation in the NFIP – Belmont participates in the National Flood Insurance Program (NFIP) (FEMA, 2018c). The NFIP is a Federal program administered by FEMA enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. NFIP offers flood insurance to communities that comply with the minimum standards for floodplain management.

NFIP uses a Community Rating System (CRS) to award communities that go beyond the minimum standards with lower flood insurance premiums for property owners. The incentives are awarded upon a credit system for various activities. Points are awarded to communities that prepare, adopt, implement, and update a comprehensive flood hazard mitigation plan using a standard planning process. Belmont is not currently eligible to participate in the CRS Program (as of May 2019) (FEMA, 2019b).

Belmont participates in NFIP with 55 policies in force as of June 30, 2019 (FEMA, 2019c). FEMA maintains a database on flood insurance policies and claims. This database can be found on the FEMA website at https://www.fema.gov/policy-claim-statistics-flood-insurance

The Town complies with the NFIP by enforcing floodplain regulations, maintaining up-to-date floodplain maps, and providing information to property owners and builders regarding floodplains and building requirements.

Street sweeping – The Town performs street sweeping twice a year on every road in Belmont, and on an as-needed basis if there is concerns from residents.

Catch basin cleaning – The Town hires a contractor to clean all of its catch basins annually. Approximately 2,000 catch basins are identified as Town-owned and maintained.

On-going Drainage Improvement Program – The Public Works Department provides maintenance and routine replacement to culverts, drainage pipes, and other drainage infrastructure on an as-needed basis.

Stormwater System and Outfalls Mapped in GIS – The Town has developed a drainage system inventory and integrated the data into the Town's Geographical Information System (GIS).

IDDE Program Implementation – The Town is implementing an IDDE Program to fullfil their MS4 Permit requirments.

Floodplain District –The Belmont Zoning By-Law includes a Floodplain District. The Town's Floodplain District is defined by the 100-year floodplain as designated by FEMA (*Zoning By- Law Section 2.4*). The

Floodplain District prohibits the building of new structures and filling or removal of earth material (*Zoning By- Law Section 6.6*) and other passive land uses require a special permit.

Massachusetts Stormwater Regulations – The Conservation Commission regulates and enforces the Massachusetts Stormwater Regulations.

Stormwater Bylaw and Regulations– The purpose of the Stormwater Management and Erosion Control By-Law (*§ 60-325 of the Belmont General Bylaws*) is to prevent pollutants from entering the separate storm sewer system, to promote ground infiltration, and to ensure controls for erosion, sedimentation, and stormwater runoff are incorporated into site planning. The Stormwater Management and Erosion Control Rules and Regulations were adopted by the Board of Selectmen on September 29, 2014. The regulations require a permit, including an operation and maintenance plan and adherence to design criteria, for land disturbances meeting certain thresholds and connections of pipes to the sewer or stormwater system.

Wetlands Protection Act – The Belmont Conservation Commission administers the state's Wetlands Protection Act (Chapter 131, Section 40 MGL) to protect resource areas in and around wetlands, including land subject to flooding.

Belmont Open Space and Recreation Plan (OSRP) - Belmont has protected open space and proactive land acquisition and preservation programs. The Open Space and Recreation Plan was last updated in 2008.

Reviews and Inspections of New Developments – Town staff provide reviews new developments drainage and utility connections for water and sewer.

Trash Trap on Wellington Brook – The Town has recently completed repairs to the Trash Trap behind the Belmont Library, which has reduced flooding in the Claypit Pond Area

Yard Waste Clean Up – The Town provides yard waste pick up from April to December. This reduces the amount of debris that is washed into the stormwater system and catch basins.

Maintain Up to Date Flood Maps – The Town maintains up to date flood maps from FEMA at Town offices. The FEMA flood maps were last updated in 2010.

Green Infrastructure Projects – The Town has an active citizen group that proposes green infrastructure projects. An example of a project that has been successfully implemented is the rain garden on Trapelo Road.

Tri-Community Group – The Tri-Community Group was formed to address issues like flooding Arlington, Cambridge, and Belmont. The Town is involved in the group and meets periodically to address regional flooding issues.

NPDES Phase II Stormwater Program – The Town continues to implement an aggressive NPDES stormwater program that includes measures for public education and outreach, illicit discharge detection and elimination, construction and post-construction controls, and Town-wide good housekeeping and stormwater maintenance procedures.

5.3 Existing Dam Mitigation Measures

DCR Dam Safety Regulations – All jurisdictional dams are subject to the Division of Conservation and Recreation's dam safety regulations (*302 CMR 10.00*). The dams must be inspected regularly, and reports filed with the DCR Office of Dam Safety.

Permits Required for Construction – State law requires a permit for the construction of any dam.

5.4 Existing Town-Wide Mitigation for Wind-Related Hazards

Massachusetts State Building Code – The Town enforces the Massachusetts State Building Code whose provisions are generally adequate to protect against most wind damage. The code's provisions are the most cost-effective mitigation measure against tornados given the extremely low probability of occurrence. If a tornado were to occur, the potential for severe damages would be extremely high.

Buried Utilities – Approximately half of utility lines are buried underground.

Tree Maintenance by the Town – The Town's and the Town's Tree Warden work with a contractor to address hazard tree concerns, which reduces the number of downed trees in a high wind event.

Tree Maintenance by Energy Utilities (Belmont Municipal Light Department) – Utilities trim trees along the power lines. Increased preventative maintenance of trees along the power lines would be beneficial.

5.5 Existing Town-Wide Mitigation for Winter-Related Hazards

Snow Removal Requirements in the General Code –The Town's By-Laws (Chapter 60, Section 8) requires that commercial properties and residents to clear snow and ice from their roads and sidewalks.

Snow-Plowing Operations and Roadway Treatments – The Department of Public Works provides standard snow plowing operations, including using salt and beet juice on the roadways.

5.6 Existing Town-Wide Mitigation for Fire-Related Hazards

Outdoor Burning – The Town does not allow outdoor burning.

Brush Fire Response Equipment – Belmont has one large all-wheel drive pumper to access wooded areas in Town. Additionally, they have a smaller utility truck that has been converted and outfitted with a small pump to access more difficult areas of brush.

Fire Department Review of Proposed Development – The Fire Department is involved in reviewing site plans and some special permit applications. Recommendations have been made in the past regarding the creation of low vegetation buffers in areas of the Town where there is a greater potential for brushfires.

Public Education – The Fire Department provides public education on fire prevention on their website at https://www.belmont-ma.gov/fire.

Statewide Fire Mobilization Plan – Belmont participates in the State's fire mobilization plan for brush fires.

5.7 Existing Town-Wide Mitigation for Extreme Temperature-Related Hazards

Tree Maintenance by the Town – The Town's and the Town's Tree Warden work with a contractor to address hazard tree concerns, which can be exasperated by extreme temperatures.

Tree Maintenance by Energy Utilities (Belmont Municipal Light Department) – Utilities trim trees along the power lines. Increased preventative maintenance of trees along the power lines would be beneficial.

Emergency Shelters –Emergency Shelters can be used as heating and cooling centers during times of extreme temperatures.

5.8 Existing Town-Wide Mitigation for Geologic Hazards

Massachusetts State Building Code – The State Building Code contains a section on designing for earthquake loads (780 CMR 1612.0). Section 1612.1 states that the purpose of these provisions is "to minimize the hazard to life to occupants of all buildings and non-building structures, to increase the expected performance of higher occupancy structures as compared to ordinary structures, and to improve the capability of essential facilities to function during and after an earthquake". This section goes on to state that due to the complexity of seismic design, the criteria presented are the minimum considered to be "prudent and economically justified" for the protection of life safety. The code also states that absolute safety and prevention of damage, even in an earthquake event with a reasonable probability of occurrence, is not economically achievable for most buildings.

Section 1612.2.5 establishes seismic hazard exposure groups and assigns all buildings to one of these groups according to Section 1612.2.5. Group II includes buildings which have a substantial public hazard due to occupancy or use and Group III are those buildings having essential facilities which are required for post-earthquake recovery, including fire, rescue and police stations, emergency rooms, power-generating facilities, and communications facilities.

5.9 Summary of Existing Mitigation Measures

There are numerous existing natural hazard mitigation measures already in place in Belmont. These were identified through feedback from the Core Team, CRB Workshop participants, and other stakeholders and are summarized in Table 5-2 below. The existing hazard mitigation measures are described in more in the previous sections.

Table 5-2. Existing Mitigation Measures

Type of Existing Mitigation Measures	Improvement Considerations
MULTIPLE HAZARDS	
Comprehensive Emergency Management Plan (CEMP)	Needs to be periodically updated
Community Emergency Response Team (CERT)	Expand participation
Communications Equipment (Stable)	None
Massachusetts State Building Code	None
Zoning By-Laws	None
Multi-Department Review of Developments	None
Local Emergency Management Planning Committee (LEPC)	None

Table 5-2. Existing Mitigation Measures

Type of Existing Mitigation Measures	Improvement Considerations
Backup Generators	Add a generator at the Senior Center and consider solar power, battery backup at other facilities to keep facilities online longer than a generator
Emergency Shelters	Maintain, periodically review capacity, and check functionality of equipment
Tree Maintenance by the Town	Increase financial resources for tree maintenance and planting more trees
Tree Maintenance by Electric Utilities (Belmont Municipal Light)	Increase proactive maintenance of trees along power lines
Buried Utilities	Continue to expand implementation
Reverse 911	Increase participation
Public Education	Continue to expand outreach
FEMA Deployment	None
Green Infrastructure Projects	Identify new projects on municipal properties
FLOOD HAZARDS	
Participation in the NFIP. The Town actively enforces the floodplain regulations.	Encourage all eligible homeowners to obtain insurance
Stormwater System and Outfalls Mapped in GIS	Update periodically
IDDE Program Implementation	Continue implementation
Street sweeping	None
Catch basin cleaning	None
Drainage system maintenance	None
Ongoing Drainage Improvement Program	None
Floodplain District	None
Stormwater By-Law and Regulations	Require consideration of climate change.
Tri-Community Group	None
Wetlands Protection Act	Adopt a Town specific by-law.
Massachusetts Stormwater Regulations	Support update of regulations to include climate projections
Belmont Open Space and Recreation Plan (2008)	Update the plan
Review and Inspection of New Development Drainage	None
NPDES Phase II Stormwater Program	None
Trash Trap on Wellington Brook	None
Yard Waste Clean Up	None
Maintain Up-To-Date Flood Maps	Update FEMA Flood maps
DAM HAZARDS	
DCR Dam Safety Regulations and Permitting	None
Permits required for construction.	None
WINTER HAZARDS	
Snow-Plowing Operations	None

Table 5-2. Existing Mitigation Measures

Type of Existing Mitigation Measures	Improvement Considerations
Snow Removal Requirements in Bylaws	Educate the public about snow removal on public sidewalks and salt use on sidewalks and driveways
Roadway Treatments	None
FIRE-RELATED HAZARDS	
No Outdoor Burning	None
Public Education on Fire	Develop a FireWise Program to help educate residents on fire prevention and hazardous materials
Statewide Fire Mobilization Plan	None
Brush Fire Response Equipment	Purchase additional brush fire response equipment
Fire Department Site Plan Review	None

5.10 Mitigation Capabilities and Local Capacity for Implementation

Under the Massachusetts system of "Home Rule," the Town of Belmont is authorized to adopt and from time to time amend several local by-laws and regulations that support the Town's capabilities to mitigate natural hazards. These include the Zoning By-Laws, Stormwater Management and Erosion Control By-Law, and local enforcement of the State Building Code. Local regulations and by-laws may be amended by the Town Board of Selectmen, annual Town Meeting, and through other regulatory bodies to improve the Town's capabilities. The Town of Belmont has recognized several existing mitigation measures that require implementation or improvements and has the capacity based on these Home Rule powers within its local boards and departments to address them. The Town also can expand on and improve the existing policies and programs listed above.

6.0 STATUS OF MITIGATION MEASURES FROM THE 2013 DRAFT PLAN

6.1 Implementation Progress on the Previous Plan

At a meeting of the Belmont Core Team, Town staff reviewed the mitigation measures identified in the draft 2013 Belmont Hazard Mitigation Plan. The Core Committee felt it was important to determine which mitigation measures were still relevant and whether each measure had been implemented or deferred. Of those measures that had been deferred, the committee evaluated whether the measure should be deleted or carried forward into this 2020 HMP-MVP Plan. The decision on whether to delete or retain a particular measure was based on the committee's assessment of the continued relevance or effectiveness of the measure and whether the deferral of action on the measure was due to the inability of the Town to take action on the measure. Table 6-1 summarizes the status of the mitigation measures.

Table 6-1. 2020 Status of Mitigation Measures from the 2013 Plan

2013 Mitigation Topic	Description	2020 Status	Include in 2020 Plan?
High Priority			
A) Claypit Pond Flooding	Claypit Pond: Study possible solutions to flooding related to Claypit Pond. Historically, flooding has been a significant issue near Claypit Pond. Recent improvements have ameliorated this condition, but additional work could further protect the Town buildings and homes in this area. This study would primarily consider the costs and benefits of two possible solutions; pumping down water levels in advance of predicted large storm events or enlarging the pond outlet to Wellington Brook. The first solution was a recommendation of the 2004 Tri- Community report but has potential environmental impacts that must be considered. The second solution has the potential to create additional flooding on the remainder of the Alewife Brook system downstream during large storms.	In Progress—The trash trap on Wellington Brook has alleviated much of the flooding, but a study would still be beneficial	Yes

Table 6-1. 2020 Status of Mitigation Measures from the 2013 Plan

2013 Mitigation Topic	Description	2020 Status	Include in 2020 Plan?
B) Trapelo Road Culvert	Trapelo Road Culvert: Enlarge culvert and elevate road.	Not Completed-Culvert is being replaced in partnership with the City of Waltham	Yes
C) Stormwater Management Program	Stormwater Management program: Adopt storm water regulations and management program to reduce the amount of rainwater entering Belmont's waterways and contributing to flood events.	Completed	No
D) Generators	Purchase mobile, long-running generators and/or install or upgrade fixed, multi-fuel generators in designated emergency shelters.	Completed	No
E) Brush Fire Maintenance Program	Develop a brush fire prevention maintenance program for Town owned conservation properties including fire road maintenance, field mowing, and brush clearing.	Not Completed	Yes
F) Brush Fire Firefighting Equipment	Acquire additional brush fire firefighting equipment including a "drop-in unit" that can be fitted onto an existing Town owned four-wheel drive vehicle.	Have converted a Town vehicle into a makeshift mobile brush firefighting equipment	Yes
G) GPS Units and Communications	Purchase hand-held GPS units and upgrade or replace mobile radio communications equipment, as necessary.	Not Completed	No
H) Radio Repeater	Purchase a radio repeater so as to allow handheld radio communications to the western side of Belmont Hill.	Not Completed-Simulcast Transmitter needed on west side of Belmont Hill	Yes
I) Upgrade Generators	Upgrade all generators as needed; provide alternative fuel sources and generator power source flexibility	In Progress	Yes

Table 6-1. 2020 Status of Mitigation Measures from the 2013 Plan

2013 Mitigation Topic	Description	2020 Status	Include in 2020 Plan?
J) FIRM Mapping and Bylaws	FIRM mapping and bylaws: Update Town Flood Information Rate Maps (FIRM) maps information and update town bylaw.	Not Completed	No
K) Land Protection	Acquire priority open space parcels for many uses including maintaining flood storage and water infiltration capacity	In Progress	Yes
Medium Priority			
L) Maintenance of Drainage Facilities	Dedicate more resources for more frequent maintenance of town- owned drainage facilities, such as more frequent removal of sediment.	Not Completed	No
M) Tri-Community Working Group Flood Mitigation Measures	The Tri-Community Working Group identified a number of potential flood mitigation measures in their 2004 report. The three communities should consider following up on some of the additional studies identified.	Not Completed	Yes
N) High Groundwater Tables	Study the causes and potential solutions to groundwater sourced flooding related to high groundwater tables. This flooding is found in scattered locations throughout Belmont and neighboring localities within the Alewife Brook watershed and mostly impacts basements during severe storms. If possible, create a map and GIS shapefile of the areas where this flooding is most likely to occur.	Not Completed	Yes
O) Stormwater Utility Creation	Begin to study the feasibility of creating a stormwater utility to help pay for drainage system maintenance and improvements.	Not completed	Yes, amend to look at other alternative sources of revenue

Table 6-1. 2020 Status of Mitigation Measures from the 2013 Plan

2013 Mitigation Topic	Description	2020 Status	Include in 2020 Plan?
P) Web Based GIS for Wetlands	Develop a web-based GIS wetlands mapping capacity.	In Progress	No
Q) Emergency Flood Preparation	Develop more efficient emergency flood preparation and emergency response capacity.	In Progress	Yes
R) Tree Maintenance	Increase contract labor for tree maintenance program.	Not Completed	Yes
S) Earthquake Resistance	Investigate options to make all public buildings earthquake resistant.	Not Completed	Yes
T) FireWise Program	FireWise Program to help educate residents on fire prevention and hazardous materials	Not Completed	Yes
Low Priority			
U) Acorn Park Road	Acorn Park Road: The Belmont portion of this road floods only during very severe storm events. With development of the Belmont Uplands area, the Town will consider whether elevation of this road is necessary in the future, working with the City of Cambridge.	Completed	No
V) Storm Drains and Catch Basins into GIS	Complete locating of all storm drains and catch basins into town GIS database	Completed	No
W) Stormwater and Erosion Control Education	Stormwater and Erosion Control Outreach and Education: Develop a stronger wetland, erosion control, and stormwater education outreach program for town residents and builders	Completed	No

As indicated in Table 6-1, the Town completed several mitigation measures including:

- Adopting stormwater regulations and management program
- Purchasing a mobile emergency generator
- Acquiring additional brushfire fighting equipment
- Minimizing flooding on Acorn Park Road
- Locating all storm drains and catch basins and putting them in GIS

- Developing a better wetland, erosion control, and stormwater education outreach program for town residents and builders

Additionally, several mitigation measures from the 2013 HMP were identified as ongoing, high priority action items, including:

- Minimizing flooding in the Clay Pit Pond area
- Upsize the Trapelo Road Culvert
- Increasing contract labor for tree maintenance and hazard tree removal
- Developing better emergency flood preparation and response
- Upgrading generators in emergency shelters and Town facilities.

As the Town moves forward into the next five-year plan implementation period; identifying and incorporating hazard mitigation into the Town's decision-making process will be a high priority. Limited staffing and financial resources are the biggest challenges the Town faces in implementing the mitigations measure identified in this plan. The plan is intended to assist the Town in prioritizing the proposed measures, which will assist in allocating available grant or funding sources.

7.0 HAZARD MITIGATION AND CLIMATE ADAPTATION STRATEGY

7.1 Identification of Hazard Mitigation and Climate Adaptation Strategies

The Town developed a list of priority hazard mitigation and climate adaptation strategies through multi-faceted approach. Strategies were discussed and developed upon review of the:

- Hazard and climate change risk assessment.
- Existing measures and the capacity to mitigate and respond to hazardous events.
- Progress on the previous plan.
- Input from stakeholders.

Stakeholders were engaged through Core Team meetings, the CRB Workshop, and the public input session. The full list of action items from the CRB Workshop are available in Appendix C. Hazard mitigation strategies often provide protection against more than one natural or climatic hazard.

Each mitigation measure is paired with an estimated cost, timeframe, and implementation responsibility. These considerations also informed the prioritization of the mitigation measures. A description of the prioritization categories used in Table 7-1 is included below.

General Objective – An overarching aim related to one or several mitigation actions. The general objective may be achieved through a variety or combination of mitigation actions.

Specific Action - A description of a hazard mitigation or climate adaption measure with details, such a specific location, strategy or technique to be used to work towards fulfilling the general objective.

Implementation Responsibility – Most hazard mitigation and climate adaptation measures will require a multi-department approach where several Town departments share responsibility. This determination is at the discretion of the governing body of the community. The designation of implementation responsibility in the table was assigned based on general knowledge of the responsibilities of each municipal department. Departments names in bold will be the lead.

Time Frame – The time frames represented below are assigned based on the complexity of the measure, the overall priority of the measure, and generally reflect when the mitigation measure is planned to initiate. The identification of time frames is not meant to prevent a community from actively seeking out and taking advantage of funding opportunities as they arise. The time frames are divided into the categories below.

- >1 year
- 1-3 years
- 3-5 years
- 5-10 years
- 10+ years
- Ongoing

Estimated Cost – The estimated cost is provided using the breakdown below. All costs are estimates and would need to be updated at the time of design and construction. When applicable, costs have been divided between preliminary assessments and cost of construction.

- $: >$10,000
- $$: $10,000-$100,000
- $$$: $100,000-$250,000
- $$$$: $250,000-$500,000
- $$$$$: $500,000+

Priority – Designation of high, medium, or low priority was based on overall potential benefits, areas affected, and estimated project costs. A High Priority action is very likely to have political and public support and necessary maintenance can occur following the project, and the costs seem reasonable considering likely benefits from the measure. A Medium Priority action may have political and public support and necessary maintenance had potential to occur following the project. A Low Priority action may not have political and public support for implementation or the necessary maintenance support following the project.

Residents were asked how Belmont should prioritize climate adaptation and hazard mitigation measures. Over forty percent of residents felt the impact to public safety should be considered followed by funding and time frame (see Appendix D for more details).

Table 7-1. Priority Hazard Mitigation and Climate Adaptation Actions

General Objective	Specific Actions	Implementation Responsibility	Time Frame (years)	Cost	Priority
Culvert replacements and upgrades using climate projection design standards	*Upsize the Trapelo Road Culvert	• DPW • Community Development • City of Waltham	0-1	$$$$	H
	Identify roadways vulnerable to flooding and perform a culvert right-sizing and priority study	• Community Development	1-3	$$$- Study	H
	Upgrade culvert sizes to accommodate more stormwater runoff, particularly at Concord Avenue/Wellington Brook culvert, intersection of Clifton St and Hickory Ln, intersection of Belmont St and Lexington St, and near Spy Pond	• Community Development	1-3	$$$$ - per Culvert	H
Sewer infrastructure	Implement a sewer lining program and repair failing infrastructure	• Community Development	Ongoing	$$$- per year	H
Decrease potential leaching hazard from former incinerator and develop site into beneficial use ★ Voted as a top priority by residents	As required by DEP, place cap on incinerator site to prevent leaching into the Charles River during heavy precipitation events and utilize wetland vegetation to improve water quality. Implement Select Board approved post closure uses of Belmont Light Department sustainability projects.	• DPW • Community Development	1-3	$$$$$	H

Table 7-1. Priority Hazard Mitigation and Climate Adaptation Actions

General Objective	Specific Actions	Implementation Responsibility	Time Frame (years)	Cost	Priority
Stormwater computer modelling	Model existing drainage system utilizing updated rainfall data to evaluate flooding conditions under projected climate change conditions. Data will be combined with City of Cambridge data to create a regional look at flooding impacts.	• Community Development	0-1	$	H
Low Impact Development (LID) stormwater management opportunities analysis	Identify low impact development stormwater management opportunities (like rain gardens) on municipal properties and roadways. Investigate de-paving large parking lots and investigate using permeable pavement on sidewalks. Create swales and stormwater detention areas.	• DPW • Community Development • Facilities	3-5	$$ - Study $$$ - Design/ Construction	M
Implement measure identified in planning efforts that intersection with hazard mitigation and climate resilience	*Implement the flood mitigation measures from the 2004 The Tri-Community Working Group report.	• DPW • City of Cambridge • Town of Arlington	3-5	Varies	M
Identify a stable and reliable funding source for stormwater management	Develop a stormwater enterprise fee or a building permit fee for stormwater and impermeable surface.	• DPW • Community Development	5-10	$$- setup, future would be self-sustaining	M
Develop a comprehensive emergency response plan and ongoing communication program	Develop an Emergency Response Plan that has tailored sections addressing how to support people at greater risk, a database of vulnerable residents, and a plan to provide wellness checks.	• Police • Fire	1-3	$$	H
	Increase registrations for the Reverse 911 system, possibly by developing the option to sign ups at any public office	• Police • Fire	1-3	$	H
	Create more transit options to get people to shelters during emergencies	• Police • Fire	5-10	$$$	M

Table 7-1. Priority Hazard Mitigation and Climate Adaptation Actions

General Objective	Specific Actions	Implementation Responsibility	Time Frame (years)	Cost	Priority
	Develop a recurring protocol for examining shelter capacity, functionality, and essential equipment and goods. Develop a shelter in place guide or toolkit for private, multi-unit facilities.	• Police • Fire	1-3	$	M
	Improve emergency preparedness outreach and education for vulnerable and isolated populations, including the elderly, youth, non-English speakers, low income individuals, and disabled individuals.	• Police • Fire	1-3	$	M
	*Document emergency flood preparation and emergency response capacity.	• DPW • Police • Fire	1-3	$	M
	Partner with neighborhood groups and worship communities to spread awareness of the available community resources and document how these organizations can support hazard mitigation and climate adaptation efforts.	• Police • Fire	1-3	$	L
	Increase public education and engagement in pest prevention and vector borne diseases, such as encouraging residents to reduce the amount of standing water in residential areas and install signage in recreation areas about mosquitos and ticks.	• Health Department • Conservation Commission	1-3	$	L
	Educate the public about snow removal on public sidewalks and salt use on sidewalks and driveways.	• DPW • Community Development	1-3	$	L
Decrease fossil fuel usage and decrease energy demand	Increase participation in the HeatSmart Program, which encourages heat pump usage and reduces energy demand.	• DPW	3-5	$	M

Table 7-1. Priority Hazard Mitigation and Climate Adaptation Actions

General Objective	Specific Actions	Implementation Responsibility	Time Frame (years)	Cost	Priority
Cost-benefit analysis of flood management projects ★ Voted as a top priority by residents	*Develop a cost-benefit analysis of the possible flood mitigation solutions at areas such as Claypit Pond, Little Pond, and Mill Pond. This study would primarily consider the costs and benefits of pumping down water levels in advance of predicted large storm events, investigating overflow protection, and enlarging pond outlets (particularly at Wellington Brook).	• Community Development	3-5	$$$	M
Develop a fire prevention program and purchase more equipment	*Develop a brush fire prevention maintenance program for Town owned conservation properties including fire road maintenance, field mowing, and brush clearing.	• Fire Department	5-10	$$$	M
	FireWise Program to help educate residents on fire prevention and hazardous materials.	• Fire Department	1-3	$	M
	Protect the existing green spaces by purchasing a side-by side UTV with water tank to combat brush fires away from roadways.	• Fire Department	3-5	$$	L
Improve the resilience of natural features	Install low impact development and green infrastructure in parks.	• Community Development • Conservation Commission	3-5	$$$	M
	Adopt the wetlands bylaw.	• Community Development • Conservation Commission	3-5	$$	M
	Restore wetlands impact by poor water quality and development.	• Community Development • Conservation Commission	3-5	$$$	M
Purchase strategic land acquisitions	*Acquire priority parcels for many uses including flood storage, stormwater infiltration, and conservation.	• Community Development • Conservation Commission	5-10	$$$$$	M

Table 7-1. Priority Hazard Mitigation and Climate Adaptation Actions

General Objective	Specific Actions	Implementation Responsibility	Time Frame (years)	Cost	Priority
Improve resilience of communications equipment	*Install a Simulcast Transmitter on the west side of Belmont Hill to improve communications in the area.	• Police • Fire	5-10	$$$$	M
	*Upgrade or replace mobile radio communications equipment, as necessary.	• Police • Fire	5-10	$$$$	M
Design and construction more complete streets	Increase access to cooling shelters and parks through a complete streets network. For example, examine the feasibility of installing bike lanes to Grove Park.	• DPW • Community Development	3-5	$$$	
	Complete the bike path that connects to Cambridge.	• DPW • Community Development	5-10	$$$	M
	Create more transit options to get people to shelters in an emergency.	• Police • Fire	5-10	$$$	M
	Maintain and build more sidewalks.	• DPW • Community Development	5-10	$$$	M
Improve the resilience of municipal buildings	*Investigate options to make all public buildings earthquake resistant.	• Facilities Department	10+	$$-Evaluation	L
	Implement the municipal building plan that involved climate resilience measures (fortifying roofing tiles, weatherizing windows, elevating mechanical systems above flood level, and strengthen HVAC systems).	• Facilities Department	1-3	Varies	L
	Install a generator at the Senior Center.	• DPW • Council on Aging	1-3	$$	M
	Upgrade backup power systems with new generators, renewable microgrids, or solar power redundancy at critical facilities, possibly the Winthrop L Chenery Middle School (emergency shelter), Senior Center, new police station, and data centers.	• DPW • Police • Fire	3-5	$$ per facility	H

Table 7-1. Priority Hazard Mitigation and Climate Adaptation Actions

General Objective	Specific Actions	Implementation Responsibility	Time Frame (years)	Cost	Priority
High groundwater tables	*Study the causes and potential solutions to flooding (in mostly basements) related to high groundwater tables primarily in the Alewife Brook watershed. If possible, create a map and GIS shapefile of the areas where this flooding is most likely to occur.	• Community Development	5-10	$$-study	L
Tree management	*Increase tree maintenance efforts and funding for tree maintenance contractor.	• DPW	1-3	$$$	M
	Develop a comprehensive tree management plan, which could include planting appropriate species by taking into consideration local air quality, proximity to dense housing and roadways, drought, extreme temperatures, and wind.	• DPW	1-3	$$	M

7.2 Regional Partnerships

Mitigating natural hazards is not confined to a local issue. The communities are often complex systems of storm drains, roadway infrastructure, pump stations, dams, and other facilities owned and operated by a wide variety of agencies, including Massachusetts Department of Transportation (MassDOT), the Massachusetts Water Resources Authority (MWRA), and the Department of Conservation and Recreation (DCR). The planning, construction, operation, and maintenance of these structures are integral to the hazard mitigation and climate adaptation efforts of communities. These agencies also operate under the same constraints as communities do including budgetary and staffing limitations. And as all communities do, they must make decisions about numerous competing priorities. In order to implement many of these mitigation measures, all parties will need to work together towards a mutually beneficial solution.

The Town will also work with other groups, such as the Mystic River Watershed Association and the Tri-Community Working Group to complete regionally focused action items. The surrounding communities will be additional partners on specific projects, for example, the upsizing of the Trapelo Road culvert. Local businesses and private entities, like the McLean Hospital, will play a role in implementing best practices beyond municipally controlled parcels.

7.3 Potential Funding Sources

There is a great variety of funding available for Massachusetts municipalities, both through the state and federal governments. A full list of funding opportunities can be found on the [Community Grant Finder webpage]. The Community Grant finder provides a streamlined interface where municipalities can easily learn about grant opportunities. Specific funding options related to action items developed by Belmont are listed below.

Table 7-2: Funding Opportunities for Resiliency Projects

Category	Grant	Description	Limitations & Stipulations
Community Development	MassWorks Infrastructure Program	Provides grants to communities to help them prepare for success and contribute to the long-term strength and sustainability of the Commonwealth.	None
Emergency Management and Planning	Flood Mitigation Assistance Grant Program (FMA)	Implement cost-effective measures that reduce or eliminate the long-term risk of flood damage	building and other structures insured under the National Flood Insurance Program (NFIP).
Emergency Management and Planning	Hazard Mitigation Grant Program	Provides funding after a disaster to significantly reduce or permanently eliminate future risk to lives and property from natural hazards	None
Emergency Management and Planning	Pre-Disaster Mitigation (PDM) Grant Program	Provides funds for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event	None
Energy	DOER	The DOER provides grant funding for clean energy-related programs	None
Energy	Green Communities Designation and Grant Program	Provides a road map along with financial and technical support to municipalities that pledge to cut municipal energy and meet other criteria	None
Environment	Community Forest Grant Program	Funding to establish community forests	None
Environment	Culvert Replacement Municipal Assistance Grant Program	Grant to replace undersized, perched, and/or degraded culverts located in an area of high ecological value	None
Environment	604b Grant Program	Water quality assessment and management planning	None

Table 7-2: Funding Opportunities for Resiliency Projects

Category	Grant	Description	Limitations & Stipulations
Environment	Land Use Planning Grants	Support effort to plan, regulate, and act to conserve and develop land consistent with the Massachusetts' Sustainable Development Principles	None
Environment	LAND Grant Program	Helps cities and towns acquire land for conservation and passive recreation	Reimbursement rate: 52-70%
Environment	Federal Land & Water Conservation Fund	Funding for the acquisition, development, and renovation of parks, trails, and conservation areas.	Municipality must have an OSRP
Environment	MassTrails Program	Trail protection, construction, and stewardship projects	None
Environment	Municipal Vulnerability Preparedness (MVP) Program	Provides support implement climate change resiliency priority projects	None
Environment	Natural Resource Damages Program	Funding for restoration projects. Funding comes from settlements, so it is does not follow a set schedule.	None
Environment	MS4 Grant Program	Meeting the requirements of the 2016 MS4 permit and reduce stormwater pollution through partnerships	Two or more municipalities subject to the 2016 Small MS4 General Permit (must apply together)
Public Safety	Emergency Management Performance Grant (EMPG)	Reimbursable grant program to assist local emergency management departments to build and maintain an all-hazards emergency preparedness system	Reimbursable
Public Safety	Public Assistance Program	The state reimburses governments and other applicants for disaster related costs	75% reimbursable
Public Safety	Senior SAFE	Supports fire and life safety education for seniors	None
Public Safety	Student Awareness of Fire Education (S.A.F.E.)	Grants for local fire departments to teach fire and life safety to schools	None

Table 7-2: Funding Opportunities for Resiliency Projects

Category	Grant	Description	Limitations & Stipulations
Public Works and Transportation	Chapter 90 Program	Reimbursable grants on approved projects	None
Public Works and Transportation	Community Transit Grant Program	Funding to meet the transportation and mobility needs of seniors and people with disabilities	Depends on project type
Public Works and Transportation	Complete Streets Funding Program	Technical assistance and construction funding	Eligible communities must pass a Complete Streets Policy and develop a Prioritization Plan
Public Works and Transportation	Municipal Small Bridge Program	Funding for small bridge replacement, preservation and rehab projects	Bridges with spans between 10’ and 20’

8.0 PLAN ADOPTION AND MAINTENANCE

8.1 Plan Adoption

The Town of Belmont 2020 HMP-MVP Plan was adopted by the Select Board on *May 17th, 2021*. See Appendix D for documentation. The plan was approved by FEMA on June 02,2021 for a five-year period through May 31, 2026.

8.2 Plan Implementation

The Core Team will use Table 7.1 as a guide for taking action to mitigate hazards and improve the Town's climate resilience. The time frame, responsible department, and funding mechanisms in Table 7.2 layout out an implementation plan for the Core Team. The Core Team will be held accountable through the tracking mechanisms explained in the following sections. The HMP-MVP Plan will also inform future planning and budgeting processes.

8.3 Plan Maintenance

8.3.1 Tracking Progress and Updates

FEMA's initial approval of this plan is valid for five years. During that time the Town will need to continue to track progress, document hazards, and identify future mitigation efforts. The Core Team, coordinated by the Community Development Director and Fire Chief, will meet annually or on an as-needed basis, whichever is most frequent, to monitor plan implementation. The Core Team will be amended as needed. The meetings will assist in determining any necessary changes or revisions to the plan that may be needed. The coordinators of Core Team will prepare and distribute materials, such as a survey or excel document, for the annual meeting to track the progress of the actions in Table 7.1. In addition, the Core Team document the effects of hazards or problem areas that have been identified since the plan drafting. The Core Team will regularly review and update the Town's capacity to mitigate, prepare, and respond using Chapter 5 as a base. The information collected will be used to formulate a report and/or addendum to the plan.

8.3.1 Continuing Public Participation

The adopted plan will be posted on the Town's website. The posting of the plan on the Town's web site will provide a mechanism for citizen feedback, such as an e-mail address for interested parties to send comments. The Town will encourage local participation whenever possible during the next five-year planning and implementation cycle. The Core Team will incorporate engagement into the implementation of the priority action items. All updates to the plan, including implementation progress, will be placed on the Town's website. All public meetings related to the HMP-MVP Plan will be publicly noticed in accordance with Town and State open meeting laws.

8.3.2 Integration of the Plans with Other Planning Initiatives

Upon approval of the Town of Belmont 2020 HMP-MVP Plan by FEMA, the Core Team will make the plan available to all interested parties and all departments with an implementation responsibility. The group will initiate a discussion with those various departments regarding how the plan can be integrated into their ongoing work. At a minimum, the plan will be reviewed and discussed with the following departments:

• Community and Economic Development	• Facilities Department • Health Board

• Department of Public Work • Parks and Recreation Department • Conservation Commission	• Fire Department • Police Department

Appropriate sections of the HMP-MVP Plan will be integrated into other plans, policies and documents as those are updated and renewed, including the writing of, or updates to, the Town's next update to the Master Plan, Open Space Plan, Comprehensive Emergency Management Plan, and Capital Investment Program. Coordination with the Metropolitan Area Planning Council, local organizations, businesses, watershed groups, and state agencies will be required for successful implementation and continued updating.

8.4 Process of Updating

By maintaining the Town of Belmont 2020 HMP-MVP Plan, the Town will have a competitive application when applying to FEMA for funding to update the plan. Once the resources have been secured to update the plan, the Core Team will need to determine whether to undertake the update itself or hire a consultant. If the Core Team decides to update the plan itself, the group will need to review the current FEMA hazard mitigation plan guidelines for any change in the requirements. The update to the Town of Belmont 2020 HMP-MVP Plan will be forwarded to MEMA for review and to FEMA for ultimate approval. The Core Team will begin drafting the full update of the plan in four years. This will help the Town avoid a lapse in its approved plan status and grant eligibility when the current plan expires at the end of year five.

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APPENDIX A

Core Team Materials

Municipal Vulnerability Preparedness Planning Grant and Hazard Mitigation Planning Grant Update

Core Team Meeting, Town Hall Conference Room 2
Tuesday, October 15, 2019 9:00 am – 10:30 am

8 Core team members in attendance

Introductions — 5 minutes

Project Overview — 15 minutes

1. MVP Program Overview
    a. Brief Introduction to Climate Change in Belmont
    b. MVP Planning Process
    c. MVP Action Grants
    d. Hazard Mitigation Plan Overlap
    e. Master Plan Chapter

Core Team Role — 2 minutes

1. Develop/approve list of stakeholders
2. Active participants in the Community Resilience Building Workshop
3. Promote the listening session/attend listening session
4. Inform community priorities/Determine how decisions from Workshop will be used

Goal Setting and Endorsement — 15 minutes

1. Large group activity on what a successful hazard mitigation and climate preparedness plan means to them.
2. Presentation of goals and large group discussion on how to incorporate comments

Community Resilience Building Workshop and Review of Materials — 35 minutes

1. MVP Risk Matrix
    a. Discuss hazards and key features (infrastructure, society, environment)
2. Review map of key resources/assets
3. Prioritization Process MVP Key Actions
4. Workshop Schedule
    b. One 8-hour or two 4-hour meetings
    c. Weekday or weekend
    d. Day or evening
    e. A Monday from 11:30-7:30 was decided as preferable
5. Presentation Feedback

W&S Action Item: Finalize Workshop materials based on Core Team input
Belmont Action Item: Help to fill mapping and PowerPoint gaps

Data Sources 3 minutes

1. Interviews with municipal officials
2. Applicable reports and materials
3. Ask:
    a. Other ongoing efforts?
    b. Local hazards/experiences to highlight? - previous flood events, issue areas

W&S Action Item: Review materials and incorporate into Workshop and Report(s)
Belmont Action Item: Identify and provide any additional resources

Workshop Participants 10 minutes

1. Respond to a list of workshop invitees

W&S Action Item: Draft invitation to stakeholders
Belmont Action Item: Finalize list of invitees; send invitation and track RSVPs, assign participants to tables

Initial additions suggested for the draft list of invitees (additional feedback pending):
Steve Pinkerton
Adjacent towns: Watertown

Wrap Up and Next Steps 5 minutes

1. Confirm draft schedule

TOWN OF BELMONT

Community Resilience Building Workshop

Wednesday, October 15, 2019

WELCOME CORE TEAM

Jon Marshall	Wayne Haley
Jay Marcotte	James MacIsaac
Mary Trudeau	Glenn Clancy
Steve Dorrance	Diana Ekman
Wesley Chin	

CORE TEAM

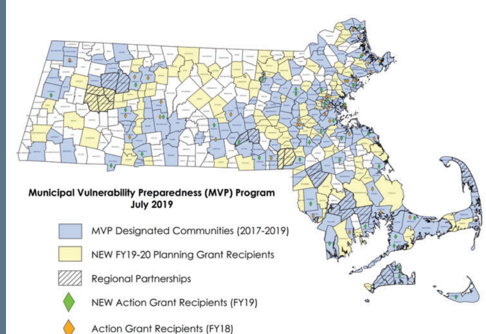
ROLE

- Confirm framework for process
- Provide data and local expertise
- Participate in the stakeholder workshop
- Finalize priority actions for the final report

TODAY'S OBJECTIVES

- Review Process
- Set Goals
- Prepare for Stakeholder Meeting

MUNICIPAL VULNERABILITY PREPAREDNESS PROGRAM (MVP)



Planning Grant	CRB Workshop	Listening Session	MVP Plan	Action Grant
Summer 2019	Nov 2019	Dec 2019	March 2020	Spring 2020

HAZARD MITIGATION PLAN UPDATE

- Aligns with MVP Process
- Extended hazard profiles and vulnerability assessment
- Update to previous mitigation measures table

MVP/HMP GOALS IN BELMONT

- Prevent and reduce loss and damages
- Identify and seek funding for mitigation
- Integrate hazard mitigation planning into all departments and boards
- Encourage collaboration with businesses, institutions, and non-profits, surrounding communities, and state, regional, and federal agencies
- Ensure that future development meets standards for hazard mitigation
- Take advantage of resources from FEMA and MEMA to educate Town staff and the public about mitigation

MVP in Belmont: Collaboration, Planning, Education, Mitigation

HAZARDS IN BELMONT

- Flooding
- Winter Storms
- Hurricanes
- Earthquakes
- Tornadoes
- Landslides
- Brush Fires

EXTREME TEMPERATURES

WARMER ANNUAL AIR TEMPERATURES
UP 0.5°F PER DECADE SINCE 1970, ON AVERAGE

WARMER WINTERS
UP 1.3°F PER DECADE SINCE 1970, ON AVERAGE

EXTREME TEMPERATURES IN MASSACHUSETTS

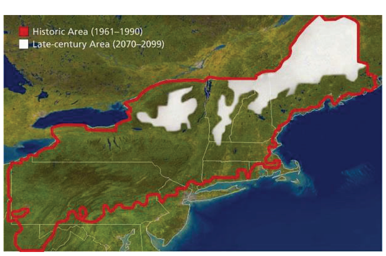
DAYS WITH TEMPERATURES ABOVE 90°F

2005 OBSERVED ANNUAL AVERAGE	MID-CENTURY PROJECTED ANNUAL AVERAGE	END-OF-CENTURY PROJECTED ANNUAL AVERAGE
6	24	35

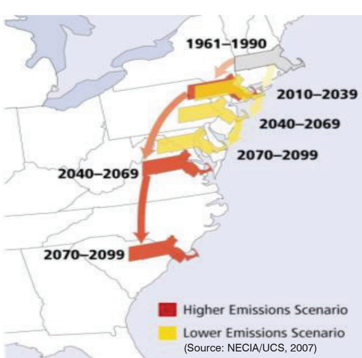
DAYS WITH TEMPERATURES BELOW 32°F

2005 OBSERVED ANNUAL AVERAGE	MID-CENTURY PROJECTED ANNUAL AVERAGE	END-OF-CENTURY PROJECTED ANNUAL AVERAGE
145	114	101

Massachusetts Executive Office of Energy & Environmental Affairs. 2019. "ResilientMA Datagrapher." Massachusetts Climate Change Clearinghouse. Resilientma.org/datagrapher/?c=Temp/state/tx90/ANN/MA/
Notes: Mid-century projected annual averages use a 2040-2069 time range. End-of-century project annual averages use a 2080-2097 time range.



(Source: UCSUSA "Confronting Climate Change in the U.S. Northeast")

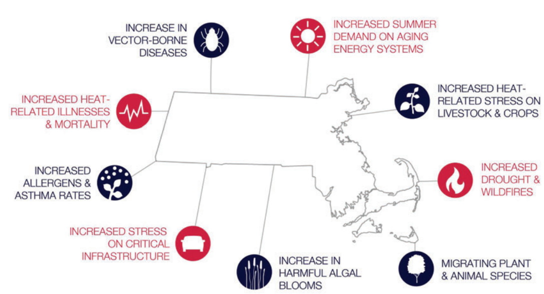


(Source: NECIA/UCS, 2007)

IMPACTS OF RISING TEMPERATURES

WARMER ANNUAL AIR TEMPERATURES
UP 0.5°F PER DECADE SINCE 1970, ON AVERAGE

WARMER WINTERS
UP 1.3°F PER DECADE SINCE 1970, ON AVERAGE



Massachusetts Executive Office of Energy & Environmental Affairs. 2019. "Rising Temperatures." Massachusetts Climate Change Clearinghouse. http://www.resilientma.org/changes/rising-temperatures

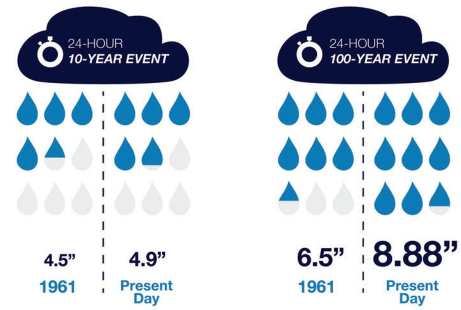
CHANGES IN PRECIPITATION

MORE **INTENSE & FREQUENT** EXTREME RAIN EVENTS

PRECIPITATION DURING **HEAVY EVENTS** IN THE NORTHEAST **INCREASED BY MORE THAN 70%** BETWEEN 1958-2010

Massachusetts Executive Office of Energy & Environmental Affairs. 2019. "Changes in Precipitation." Massachusetts Climate Change Clearinghouse. Resilientma.org/changes/changes-in-precipitation

CHANGES IN **PRECIPITATION**



1961 Data: NOAA TP-40
Present Day Data: Cornell University Northeast Regional Climate Center (NRCC) and Natural Resource Conservation Services (NRCS). Extreme Precipitation in New York and New England: Precipitation Frequency Duration Graphs. 1 hr- 24hr (100 yr and 500 yr reoccurrence). http://precip.eas.cornell.edu/

EXTREME PRECIPITATION

8%
Increase in extreme precipitation events by midcentury

13%
Increase in extreme precipitation events by 2100

Source: Executive Office of Energy and Environmental Affairs, Adaptation Advisory Committee. 2011. "Massachusetts Climate Change Adaptation Report," 19.

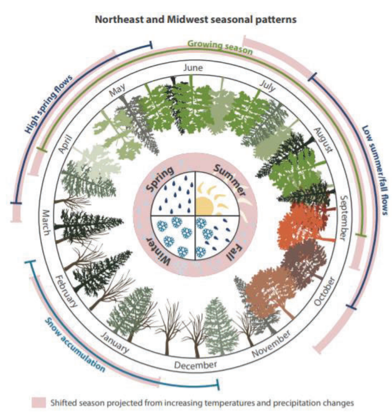


Image credit: Northeast Climate Science Center, University of Maryland Center for Environmental Science

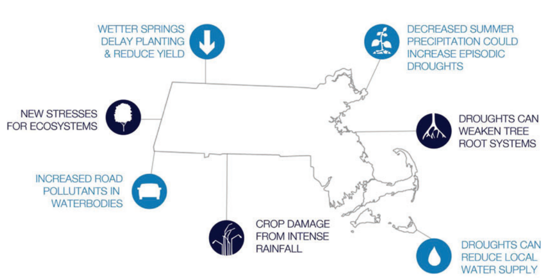
2016
The most notable recent drought event was in

The occurrence of droughts lasting 1 to 3 months could go up by as much as 75% over existing conditions by the end of the century, under the high emissions scenario

Source: Executive Office of Energy and Environmental Affairs, Adaptation Advisory Committee. 2011. "Massachusetts Climate Change Adaptation Report," 17.

IMPACTS OF CHANGING **PRECIPITATION**

HIGHER AVERAGE ANNUAL PRECIPITATION
INCREASED BY ABOUT 10% IN THE NORTHEAST INTHE LAST 50 YEARS



Massachusetts Executive Office of Energy & Environmental Affairs. 2019. "Changes in Precipitation." Massachusetts Climate Change Clearinghouse. http://www.resilientma.org/changes/changes-in-precipitation

FLOODING

ZONE	ANNUAL CHANCE	FLOODPLAIN
A, AE, A1-A30	1% ANNUAL CHANCE	100-YEAR FLOODPLAIN
X	0.2% ANNUAL CHANCE	500-YEAR FLOODPLAIN

"By 2050, Boston could experience the current 100- year riverine flood every two to three years on average"

Source: Executive Office of Energy and Environmental Affairs, Adaptation Advisory Committee. 2011. "Massachusetts Climate Change Adaptation Report," 19.

FLOODING


Above: a portion of the FEMA Flood Insurance Rate Map (FIRM) for Belmont

LOCALLY IDENTIFIED AREAS OF FLOODING[2]

Claypit Pond

Trapelo Road @ Mill Rd.

Acorn Park Road—addressed!

REPETITIVE FLOOD LOSS STRUCTURES

1

repetitive loss structure

Defined as an NFIP-insured structure that has had at least 2 paid flood losses of more than $1,000 each in any 10-year period since 1978[1]

1. Federal Emergency Management Agency (FEMA). 2019. "Definitions." Accessed August 29, 2019. Fema.gov/national-flood-insurance-program/definitions#R
2. Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 14.

STORMWATER FLOODING


New walkway and drainage improvements near the Belmond Center Commuter Rail on Concord Ave. Photo credit: Town of Belmont, 2018, via Twitter.

Areas with:

- Poor drainage
- High amounts of impervious surface
- Undersized culverts

WINTER STORMS

- The blizzard of 2013 left nearly **400,000 Massachusetts residents without power[1]**
- "Heavy blizzards are among the **most costly and disruptive** weather events for Massachusetts communities."[1]
- The average annual snowfall for most of Belmont is **48-72 inches.[2]**

1: Resilient MA Climate Change Clearinghouse for the Commonwealth. "Extreme Weather," 2017.
2: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 15.

WIND-RELATED HAZARDS


Downed tree and power lines. Photo by Belmont Light, 2019, via Twitter.

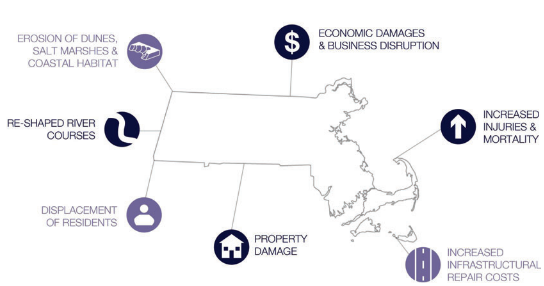
- These hazards include hurricanes, tornadoes, and high winds during severe storms
- Falling trees and downed power lines causing power outages are an issue
- The last tropical storm in Belmont was in **1861**
- There have been no recorded tornadoes in Belmont.
- The Town's 100-year wind speed is **110 mph**

Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 14.

Weston & Sampson

IMPACTS OF **EXTREME WEATHER**

STORMS ARE BECOMING MORE INTENSE AND DAMAGING



Massachusetts Executive Office of Energy & Environmental Affairs. 2019. "Extreme Weather." Massachusetts Climate Change Clearinghouse. http://www.resilientma.org/changes/extreme-weather

GEOLOGIC HAZARDS

- These hazards include earthquakes, landslides, subsidence and unstable soils.
- Many structures pre-date the most recent building code, which includes seismic standards.
- There have been no recorded earthquake epicenters in Belmont.
- The Town has a low risk for landslides.

Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 15-16, 26.

BRUSH FIRE

Belmont Fire Fighters Local 1637 battle a vehicle fire started by mechanical issues. Photo by the Belmont Police, 2018, via Twitter.

- 12+ brush fires can occur in Belmont each year
- Brush fires are relatively frequent in the western part of Town.
- The areas with the highest incidences include:
  - Mclean Open Space
  - Beaver Brook Reservation
  - Belmont Hill
  - Rock Meadow

Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 15.

As an FYI: Boston Sea Level Rise Projections (ft)

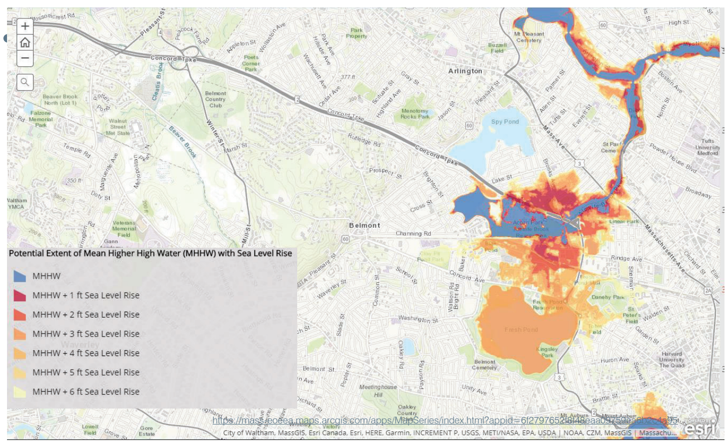
Increased coastal flooding

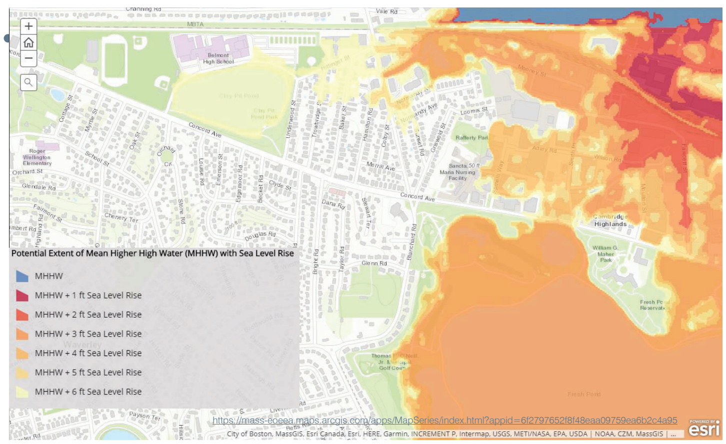
Permanently inundated low-lying coastal areas

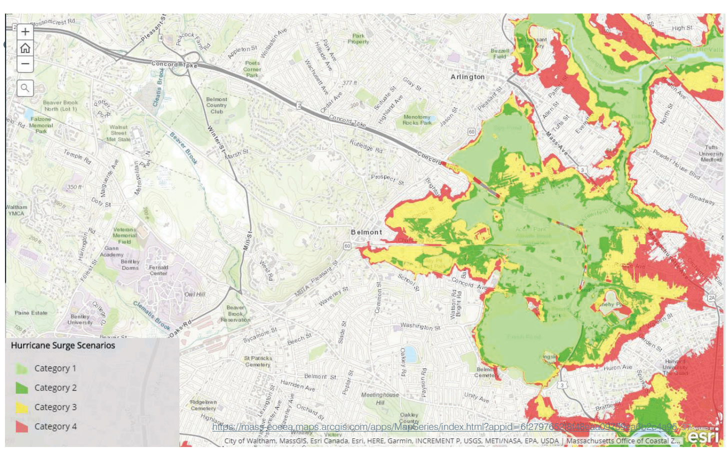
Increased shoreline erosion

Emission Scenario	2030	2050	2070	2100
Intermediate	0.7	1.4	2.3	4.0
Intermediate-High	0.8	1.7	2.9	5.0
High	1.2	2.4	4.2	7.6
Extreme	1.4	3.1	5.4	10.2

(Source: Northeast Climate Adaption Science Center)







RISK MATRIX

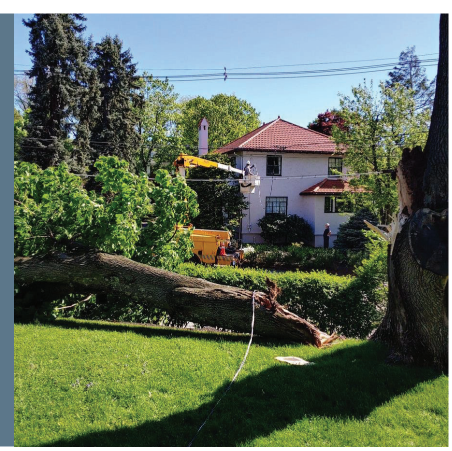


Photo: Downed tree and power line at School Street and Bow Road. Photo by Belmont Light, 2019, via Twitter.

IDENTIFY HAZARDS

Photo: Downed tree and power line on Hurd Road. Photo by Belmont Light, 2018, via Twitter.

HAZARDS IN BELMONT

CHOOSE 4 FOR THE MVP ACTION PLAN

Weston & Sampson

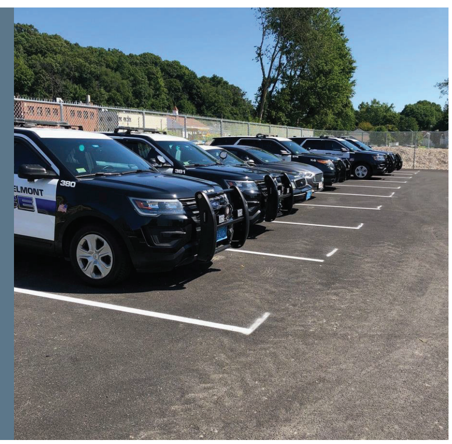
Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 11.

15 MINUTE BREAK!

Photo: "Touch a Truck" at Wellington School. Photo by Belmont EMA, 2019, via Twitter.

FEATURES IN BELMONT

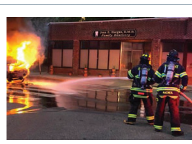
Photo: Police station at 40 Woodland Street. Photo by Belmont Police, 2019, via Twitter.



INFRASTRUCTURAL FEATURES

Police Department

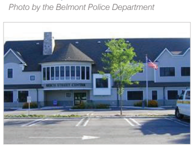
Photo by the Belmont Police Department



Fire Department

Photo by the Belmont Police Department

Wastewater Treatment & Collection

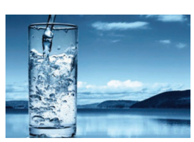


Community Centers

Photo by the Belmont Police Department.

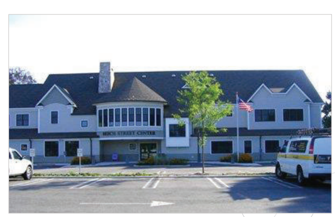
Roadways

Photo by the Belmont Police Department



Water Supply

INFRASTRUCTURAL FEATURES



Beech Street Center, used as a cooling center. Photo by the Belmont Police Department.

Critical Infrastructure includes:

- Facilities important for disaster response and evacuation.
  - Emergency operations centers
  - Fire stations
  - Water pump stations
- Facilities where additional assistance might be needed during an emergency.
  - Nursing homes
  - Elderly housing
  - Day care centers

Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 16.

INFRASTRUCTURAL FEATURES: CRITICAL INFRASTRUCTURE IN BELMONT

Table 5: Relationship of Critical Infrastructure to Hazard Areas

ID	NAME	TYPE	Landslide Risk	FEMA Flood Zone	Locally-Identified Flood Area
1	McLean Hospital	Hospital	No	No	No
2	Belmont Manor	Nursing Home	No	No	No
3	Belmont Town Hall	Municipal Office	No	No	No
4	McLean Child Care Center	Day Care	No	No	No
5	Adventures Preschool Children's Center	Day Care	No	No	No
6	A Place to Grow	Day Care	No	No	No
7	Belmont Cooperative Nursery School	Day Care	No	No	No
8	Christ Lutheran Child Care & Nursery School	Day Care	No	No	No
9	The Kendall School	Day Care	No	No	No
10	Plymouth Nursery School	Day Care	No	No	No
11	Kids on the Hill Child Care Center	Day Care	No	No	No
12	Payson Park Nursery School	Day Care	No	No	No
13	Wellington PTA Child Care Program	Day Care	No	No	No
14	Burbank Before & After School Program	Day Care	No	No	No
15	Butler Extended Day Program	Day Care	No	No	No

Table 5: Relationship of Critical Infrastructure to Hazard Areas

ID	NAME	TYPE	Landslide Risk	FEMA Flood Zone	Locally-Identified Flood Area
16	Winn Brook PTA After School Child Care Programs	Day Care	No	No	No
17	Large Family Day Care	Day Care	No	No	No
18	Chenery Extended Program (CHENEX)	Day Care	No	No	No
19	Belmont Fire Department	Fire Station	No	No	No
20	Belmont Fire Department	Fire Station	No	No	No
21	Belmont Police Department	Police Station	No	No	No
22	Belmont Town Hall Annex (Homer Building)	Municipal Office	No	No	No
23	Daniel Butler Elementary School	School	No	No	No
24	Winthrop L Chenery Middle School	School	No	No	No
25	Mary Lee Burbank Elementary School	School	No	No	No
26	Roger E. Wellington Elementary School	School	No	No	No
27	CNS/Pathways Academy	School	No	No	No
28	Belmont High School	School	No	No	No

Table 5: Relationship of Critical Infrastructure to Hazard Areas

ID	NAME	TYPE	Landslide Risk	FEMA Flood Zone	Locally-Identified Flood Area
29	LABBB Collaborative	School	No	No	No
30	Belmont Day School	School	No	No	No
31	Arlington School	School	No	No	No
32	Winn Brook Elementary School	School	No	No	No
33	Belmont Hill School	School	No	No	No
34	Crossroads Evangelical Church	Place of Worship	No	No	No
35	Boston Temple	Place of Worship	No	No	No
36	St. Joseph's Church	Place of Worship	No	No	No
37	Payson Park Church	Place of Worship	No	No	No
38	Methodist Church	Place of Worship	No	No	No
39	First Baptist Church	Place of Worship	No	No	No
40	First Church of Christ Scientist	Place of Worship	No	No	No
41	St. Lukes Church	Place of Worship	No	No	No
42	First Congregational Church	Place of Worship	No	No	No
43	First Unitarian Church	Place of Worship	No	No	No
44	First Armenian Church	Place of Worship	No	No	No
45	Beth El Temple Center	Place of Worship	No	No	No

Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 15-23.

SOCIETAL FEATURES

Population	
2010: 24,330 residents	
2018: 26,330 residents	
Age	
Under 18 years: 24.6%	
65+ years: 16.6%	
Education	
Bachelor's degree or higher: 72.7%	
Additional Information	
Median household income: $118,370	
Persons in poverty: 5.5%	
With a disability: 3.8%	
Language other than English spoken at home: 28.5%	

Source: U.S. Census Bureau, 2019

ENVIRONMENTAL FEATURES

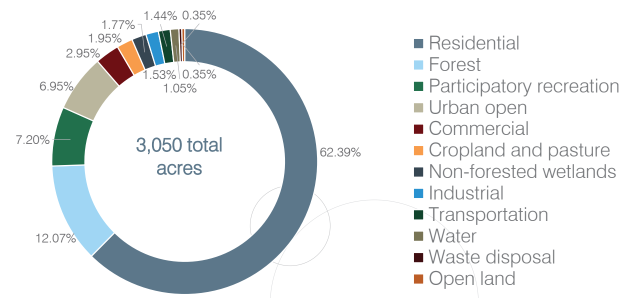
Photo credit: Franklin Tucker, Patch Staff

Belmont's Open Space[1]

- 2/3rd of open space is publicly-accessible
- The largest open space areas are:
  - Beaver Brook Reservation (313 acres)
  - Town Conservation land at McLean (140 acres)
  - Habitat Education Center and Wildlife Sanctuary (88 acres)
  - Rock Meadow Open Space (70 acres)

1. Belmont Planning Board, Belmont Office of Community Development. 2010. "A Vision for Belmont: Mapping a Sustainable Future." 35.

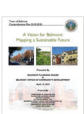
Belmont's Land Use



Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 4.

DATA RESOURCES






In Belmont and Massachusetts

- Massachusetts Climate Change Projections (NECSC, 2018)
- Town of Belmont Hazard Mitigation Plan, 2011
- A Working Vision for Belmont's Future: Priorities and Progress, 2015
- Massachusetts Climate Change Adaptation Report (MA EEA, 2011)
- A Vision for Belmont: Mapping a Sustainable Future, 2010
- Rock Meadow: A Conservation Master Plan, 2018
- Input from Municipal Officials
- Town of Belmont Climate Action Plan, 2009

EXISTING HAZARD PROTECTION

- Comprehensive Emergency Management Plan (CEMP)
- Communications equipment
- Emergency power generators
- Local Emergency Management Planning Committee (LEPC)
- Massachusetts State Building Code
- Participation in the National Flood Insurance Program (NFIP)
- Street sweeping
- Catch basin cleaning
- Roadway treatments
- Drainage infrastructure maintenance
- Zoning regulations
- Stormwater Program
- Tri-Community Group
- Trash trap on Wellington Brook
- Tree-trimming and removal program
- Snow removal and disposal
- Brushfire response equipment
- Outdoor burning
- Site plan review
- Middlesex Mosquito Control District

Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 30-35.

LUNCH

Photo: Routine pole and transformer replacement on Beech Street. Photo by Belmont Light, 2018, via Twitter.

ADAPTATION STRATEGIES

Photo: the LimeBike Bike Share program in Belmont. Photo by the Town of Belmont, 2018, via Twitter.

15 MINUTE BREAK!

Photo: Routine pole and transformer replacement on Beech Street. Photo by Belmont Light, 2018, via Twitter.

DEFINE COMMUNITY ACTIONS

Photo: Summer movie night. Photo by Belmont Recreation, 2018, via Twitter.

IDENTIFY PRIORITY ACTIONS

Photo: Upgrading electric service in Belmont Center. Photo by Belmont Light, 2019, via Twitter.

WRAP-UP & CLOSING REMARKS

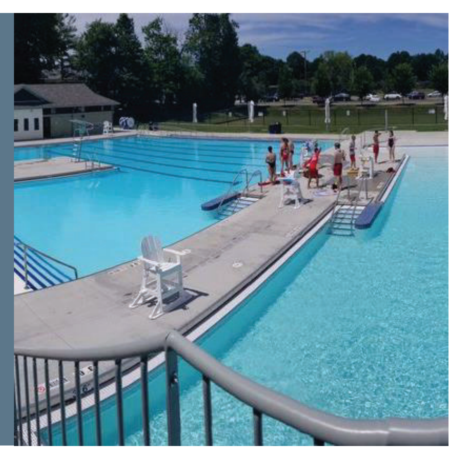


Photo: Underwood Pool. Photo by Belmont Recreation, 2018, via Twitter.

THANK YOU

Weston & Sampson

APPENDIX B

Additional Hazard Data

Hazus: Hurricane Global Risk Report

Region Name: Belmont_HMP

Hurricane Scenario: Probabilistic 100-year Return Period

Print Date: Tuesday, February 18, 2020

Table of Contents

General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 4.72 square miles and contains 8 census tracts. There are over 9 thousand households in the region and a total population of 24,729 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 8 thousand buildings in the region with a total building replacement value (excluding contents) of 3,878 million dollars (2014 dollars). Approximately 90% of the buildings (and 78% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 8,088 buildings in the region which have an aggregate total replacement value of 3,878 million (2014 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Building Exposure by Occupancy Type

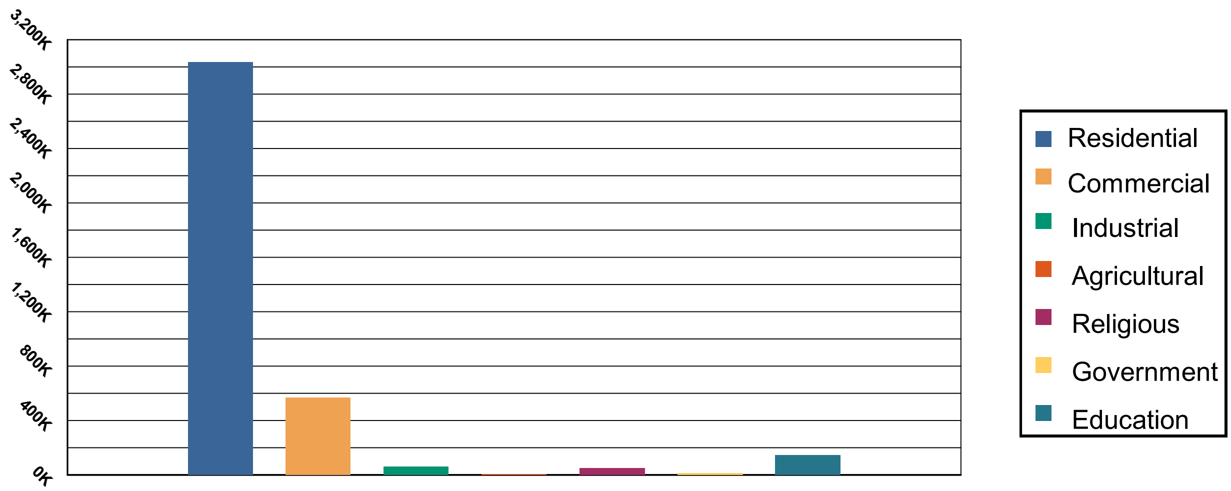


Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	3,035,146	78.26 %
Commercial	569,384	14.68%
Industrial	61,115	1.58%
Agricultural	6,320	0.16%
Religious	49,120	1.27%
Government	13,142	0.34%
Education	144,271	3.72%
Total	**3,878,498**	**100.00%**

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 160 beds. There are 10 schools, 1 fire stations, 1 police stations and no emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 19 buildings will be at least moderately damaged. This is over 0% of the total number of buildings in the region. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

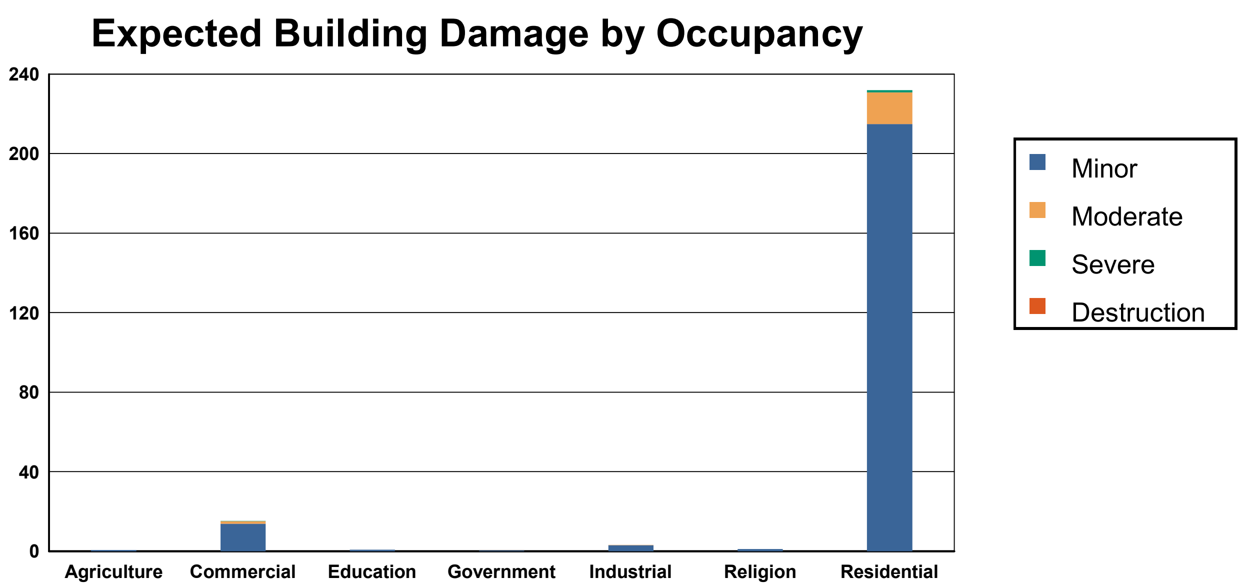


Table 2: Expected Building Damage by Occupancy : 100 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	18.39	96.77	0.52	2.73	0.07	0.37	0.02	0.12	0.00	0.00
Commercial	571.82	97.41	13.75	2.34	1.36	0.23	0.06	0.01	0.00	0.00
Education	32.25	97.73	0.73	2.20	0.02	0.07	0.00	0.00	0.00	0.00
Government	10.75	97.76	0.24	2.18	0.01	0.06	0.00	0.00	0.00	0.00
Industrial	123.88	97.54	2.95	2.32	0.15	0.12	0.03	0.02	0.00	0.00
Religion	44.93	97.68	1.03	2.23	0.04	0.09	0.00	0.00	0.00	0.00
Residential	7,033.15	96.81	214.78	2.96	15.99	0.22	1.08	0.01	0.00	0.00
Total	**7,835.17**		**233.99**		**17.64**		**1.19**		**0.00**	

Table 3: Expected Building Damage by Building Type : 100 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	85	97.41	2	2.51	0	0.08	0	0.00	0	0.00
Masonry	786	96.21	25	3.08	5	0.65	0	0.06	0	0.00
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	342	97.56	8	2.26	1	0.17	0	0.01	0	0.00
Wood	6,234	97.01	184	2.86	8	0.12	0	0.01	0	0.00

Essential Facility Damage

Before the hurricane, the region had 160 hospital beds available for use. On the day of the hurricane, the model estimates that 160 hospital beds (only 100.00%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Thematic Map of Essential Facilities with greater than 50% moderate

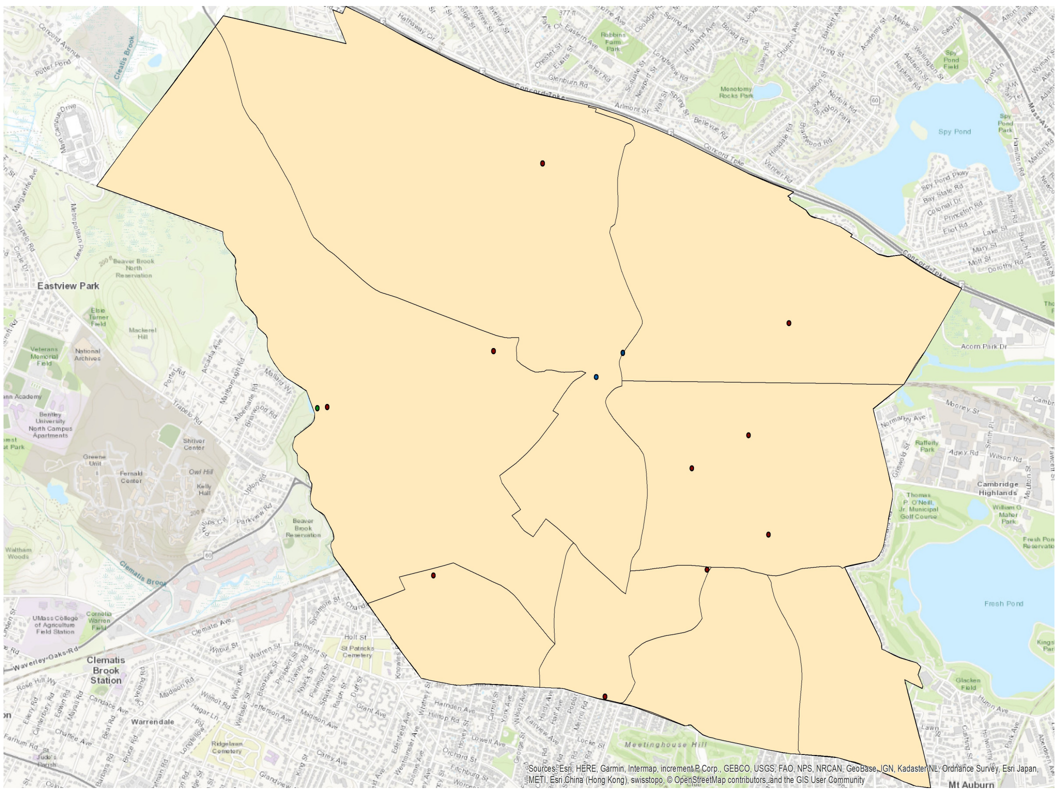
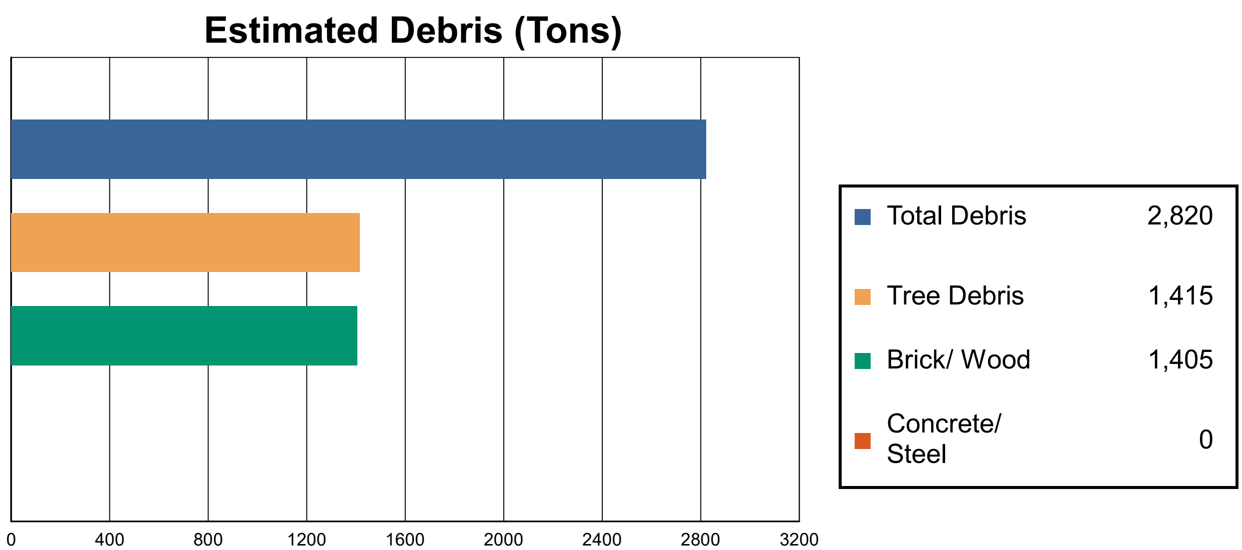


Table 4: Expected Damage to Essential Facilities

Classification	Total	# Facilities: Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day
Fire Stations	1	0	0	1
Hospitals	1	0	0	1
Police Stations	1	0	0	1
Schools	10	0	0	10

Induced Hurricane Damage

Debris Generation

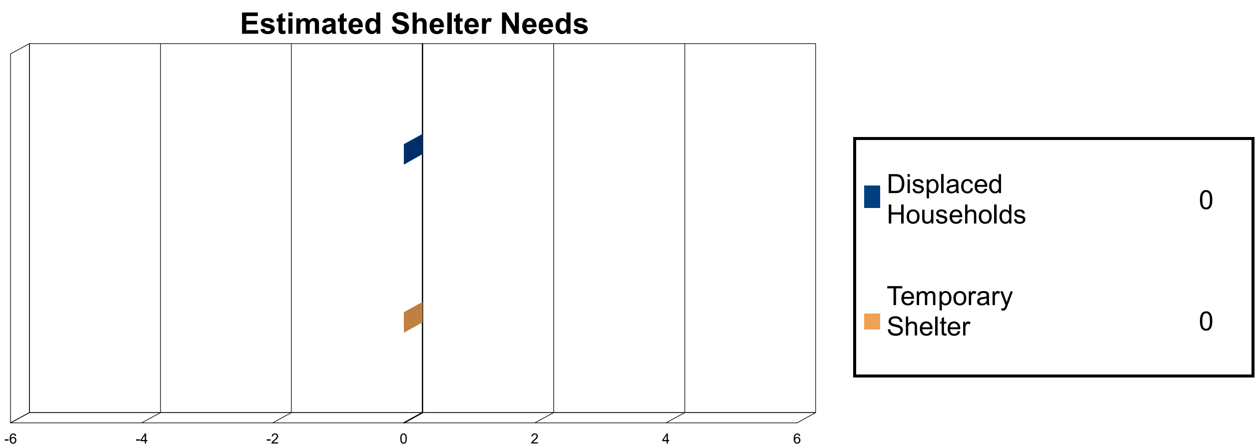


Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 2,820 tons of debris will be generated. Of the total amount, 363 tons (13%) is Other Tree Debris. Of the remaining 2,457 tons, Brick/Wood comprises 57% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 56 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 1,052 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 0 households to be displaced due to the hurricane. Of these, 0 people (out of a total population of 24,729) will seek temporary shelter in public shelters.

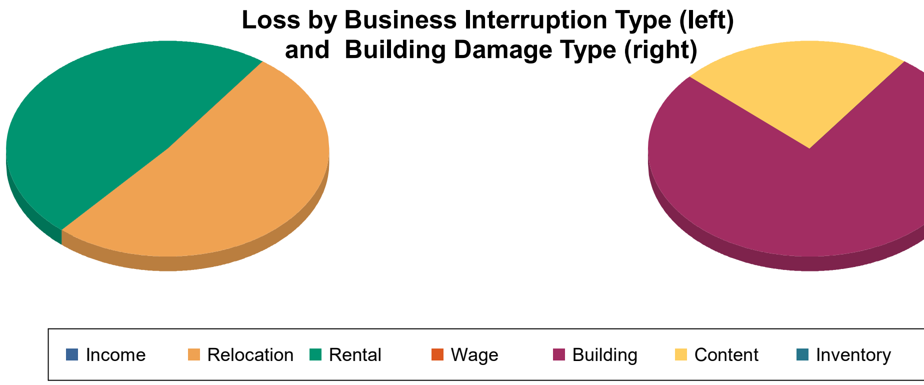
Economic Loss

The total economic loss estimated for the hurricane is 22.5 million dollars, which represents 0.58 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 23 million dollars. 3% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 97% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.



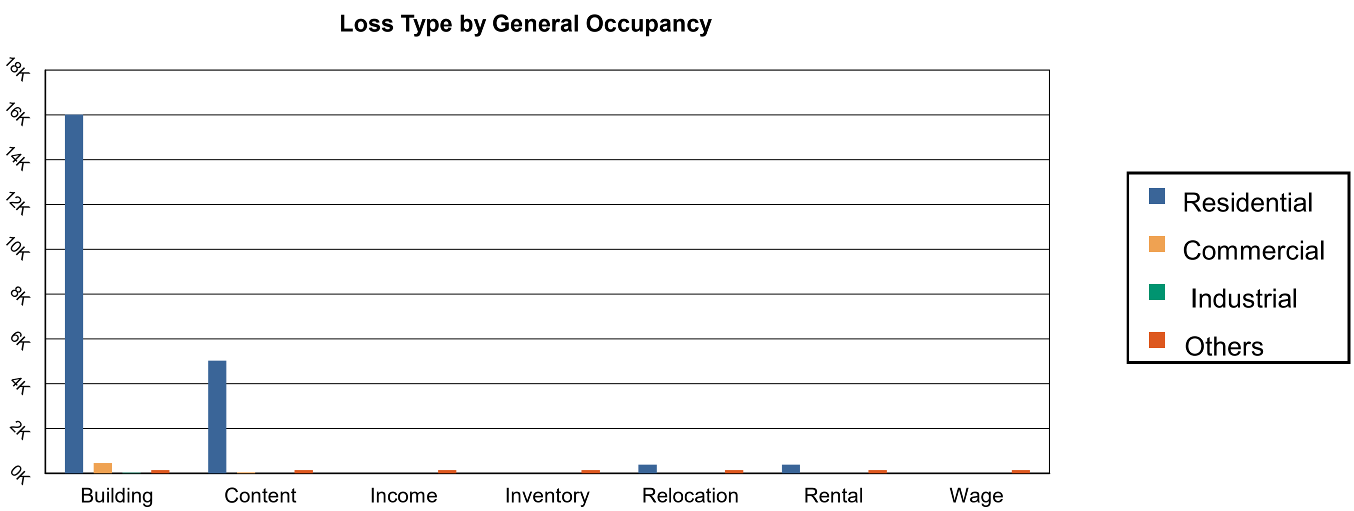


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	16,018.32	454.94	37.34	136.95	16,647.55
	Content	5,026.54	39.21	7.20	1.66	5,074.61
	Inventory	0.00	0.47	1.13	0.15	1.75
	Subtotal	**21,044.86**	**494.62**	**45.67**	**138.76**	**21,723.91**
Business Interruption Loss						
	Income	0.00	0.59	0.00	0.00	0.59
	Relocation	393.15	8.45	0.32	0.94	402.86
	Rental	382.59	0.27	0.00	0.00	382.86
	Wage	0.00	0.21	0.00	0.00	0.21
	Subtotal	**775.75**	**9.52**	**0.32**	**0.94**	**786.52**

Total

Total	**21,820.61**	**504.13**	**45.98**	**139.70**	**22,510.43**

Appendix A: County Listing for the Region

Massachusetts
- Middlesex

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Massachusetts				
Middlesex	24,729	3,035,146	843,352	3,878,498
Total	**24,729**	**3,035,146**	**843,352**	**3,878,498**
Study Region Total	**24,729**	**3,035,146**	**843,352**	**3,878,498**

Hazus: Hurricane Global Risk Report

Region Name: Belmont_HMP

Hurricane Scenario: Probabilistic 500-year Return Period

Print Date: Tuesday, February 18, 2020

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

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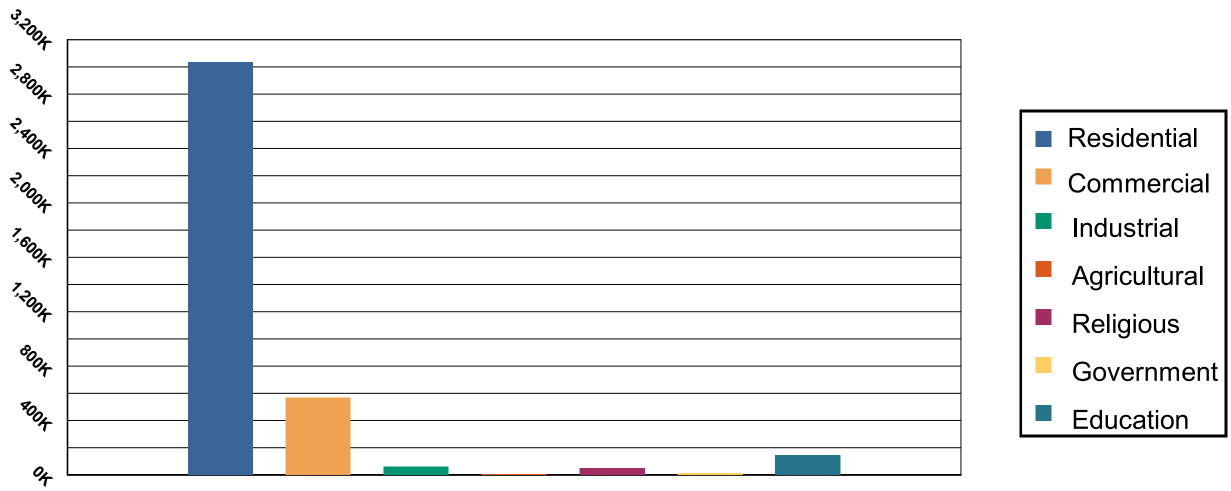

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Hurricane Scenario

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Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 242 buildings will be at least moderately damaged. This is over 3% of the total number of buildings in the region. There are an estimated 5 buildings that will be completely destroyed. The definition of the 'damage states' is provided in the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

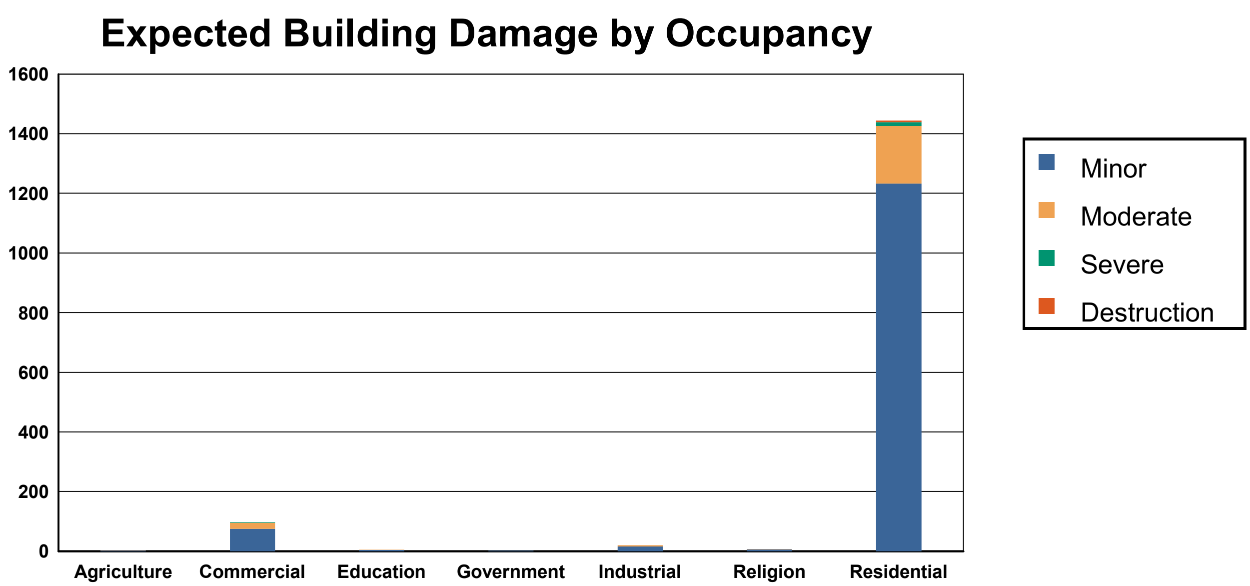


Table 2: Expected Building Damage by Occupancy : 500 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	14.98	78.83	2.84	14.93	0.78	4.09	0.37	1.94	0.04	0.22
Commercial	489.71	83.43	75.01	12.78	19.87	3.38	2.39	0.41	0.01	0.00
Education	28.03	84.95	4.04	12.24	0.87	2.65	0.06	0.17	0.00	0.00
Government	9.37	85.21	1.32	12.01	0.29	2.63	0.02	0.15	0.00	0.00
Industrial	106.66	83.99	15.55	12.25	4.09	3.22	0.65	0.51	0.04	0.03
Religion	38.44	83.56	6.34	13.78	1.15	2.50	0.07	0.16	0.00	0.00
Residential	5,820.70	80.12	1,232.91	16.97	192.84	2.65	13.16	0.18	5.40	0.07
Total	**6,507.89**		**1,338.02**		**219.89**		**16.72**		**5.49**	

Table 3: Expected Building Damage by Building Type : 500 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	73	83.92	11	12.54	3	3.37	0	0.17	0	0.00
Masonry	664	81.22	111	13.56	39	4.74	4	0.46	0	0.02
MH	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	297	84.48	41	11.59	12	3.44	2	0.49	0	0.00
Wood	5,150	80.14	1,123	17.47	139	2.17	9	0.14	5	0.08

Essential Facility Damage

Before the hurricane, the region had 160 hospital beds available for use. On the day of the hurricane, the model estimates that 160 hospital beds (only 100.00%) are available for use by patients already in the hospital and those injured by the hurricane. After one week, 100.00% of the beds will be in service. By 30 days, 100.00% will be operational.

Thematic Map of Essential Facilities with greater than 50% moderate

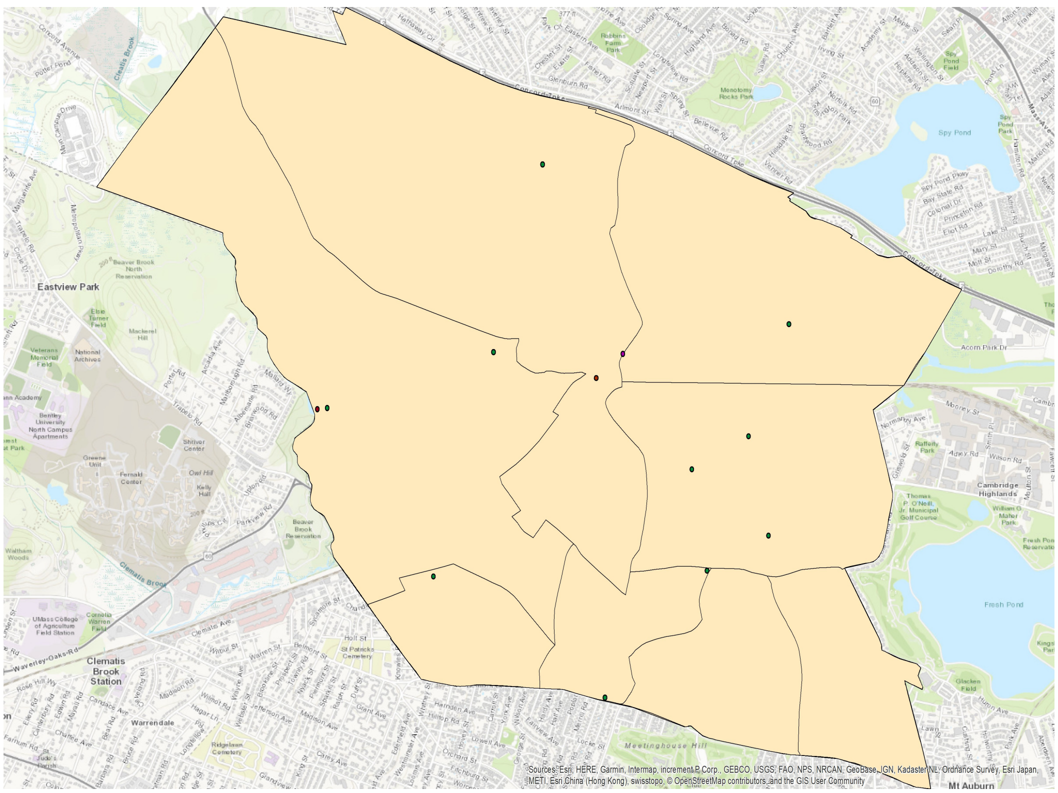
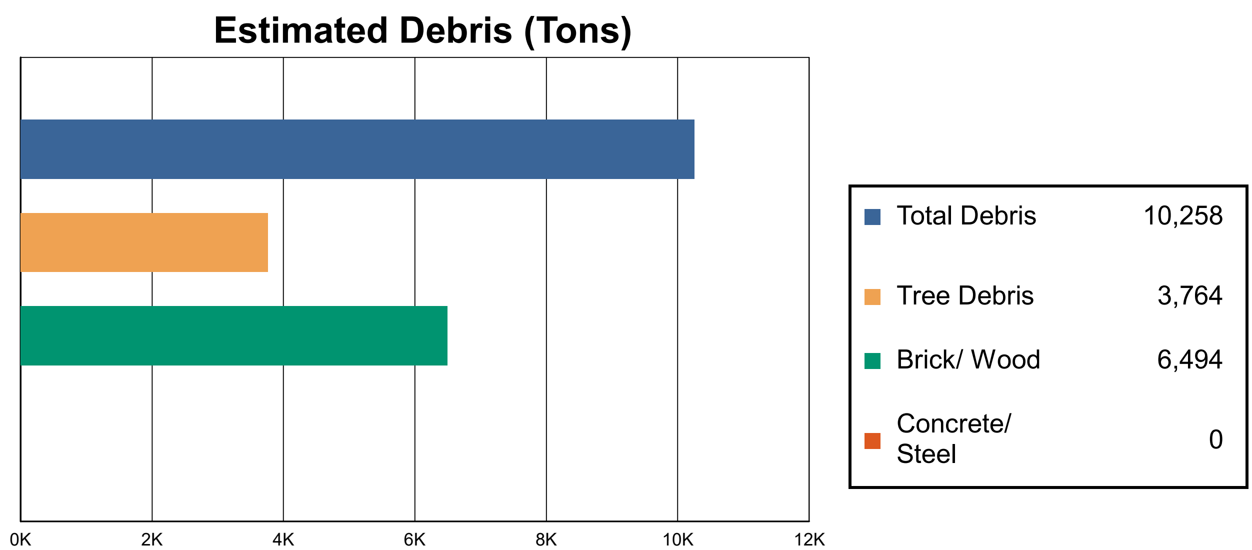


Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
Fire Stations	1	0	0	1
Hospitals	1	0	0	1
Police Stations	1	0	0	1
Schools	10	0	0	4

Induced Hurricane Damage

Debris Generation

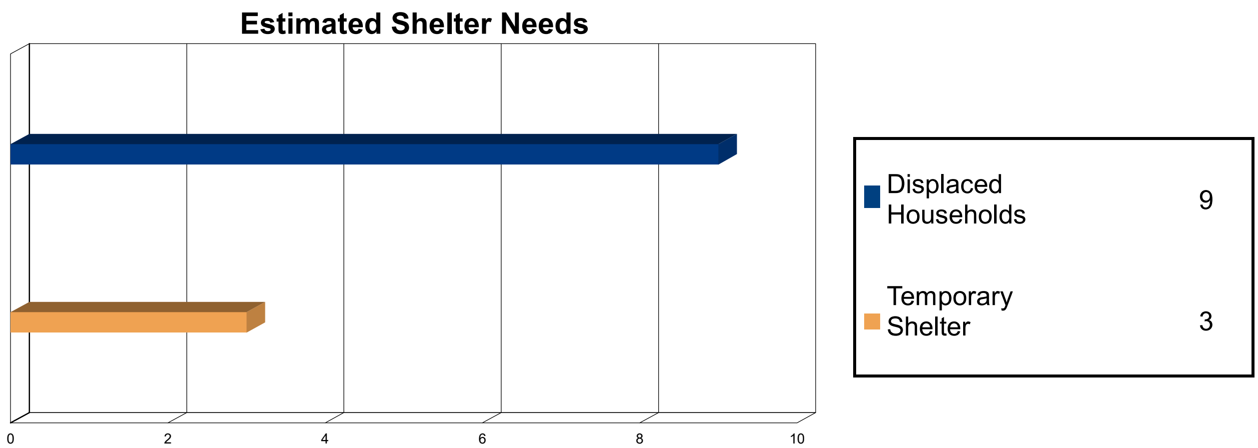


Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 10,258 tons of debris will be generated. Of the total amount, 944 tons (9%) is Other Tree Debris. Of the remaining 9,314 tons, Brick/Wood comprises 70% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 260 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 2,820 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement



Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 9 households to be displaced due to the hurricane. Of these, 3 people (out of a total population of 24,729) will seek temporary shelter in public shelters.

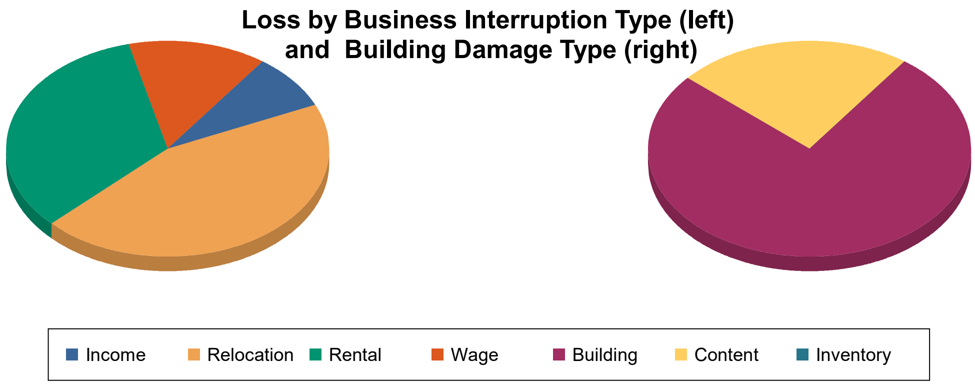
Economic Loss

The total economic loss estimated for the hurricane is 89.4 million dollars, which represents 2.31 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 89 million dollars. 7% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 91% of the total loss. Table 5 below provides a summary of the losses associated with the building damage.



Loss Type by General Occupancy

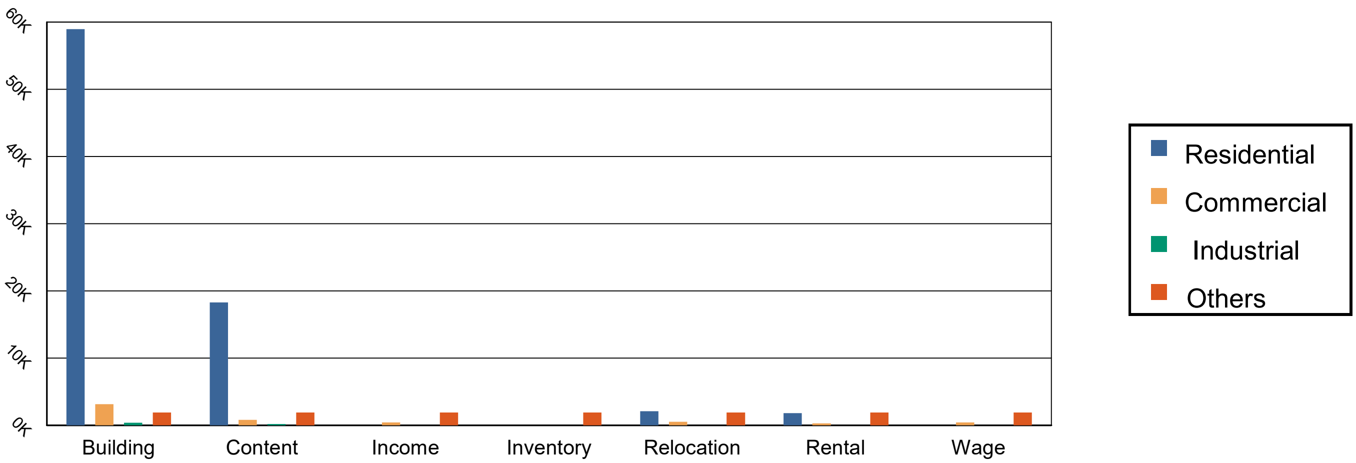


Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	58,926.74	3,159.44	379.73	990.35	63,456.25
	Content	18,306.23	826.99	203.93	214.70	19,551.86
	Inventory	0.00	14.43	28.15	2.91	45.49
	Subtotal	**77,232.97**	**4,000.87**	**611.81**	**1,207.96**	**83,053.60**
Business Interruption Loss						
	Income	0.00	419.04	4.69	113.80	537.53
	Relocation	2,115.55	524.25	25.40	156.14	2,821.34
	Rental	1,823.84	274.03	3.65	11.26	2,112.78
	Wage	0.00	459.44	8.02	408.57	876.03
	Subtotal	**3,939.40**	**1,676.75**	**41.76**	**689.77**	**6,347.68**

Total

Total	**81,172.36**	**5,677.62**	**653.57**	**1,897.73**	**89,401.28**

Appendix A: County Listing for the Region

Massachusetts
- Middlesex

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Massachusetts				
Middlesex	24,729	3,035,146	843,352	3,878,498
Total	**24,729**	**3,035,146**	**843,352**	**3,878,498**
Study Region Total	**24,729**	**3,035,146**	**843,352**	**3,878,498**

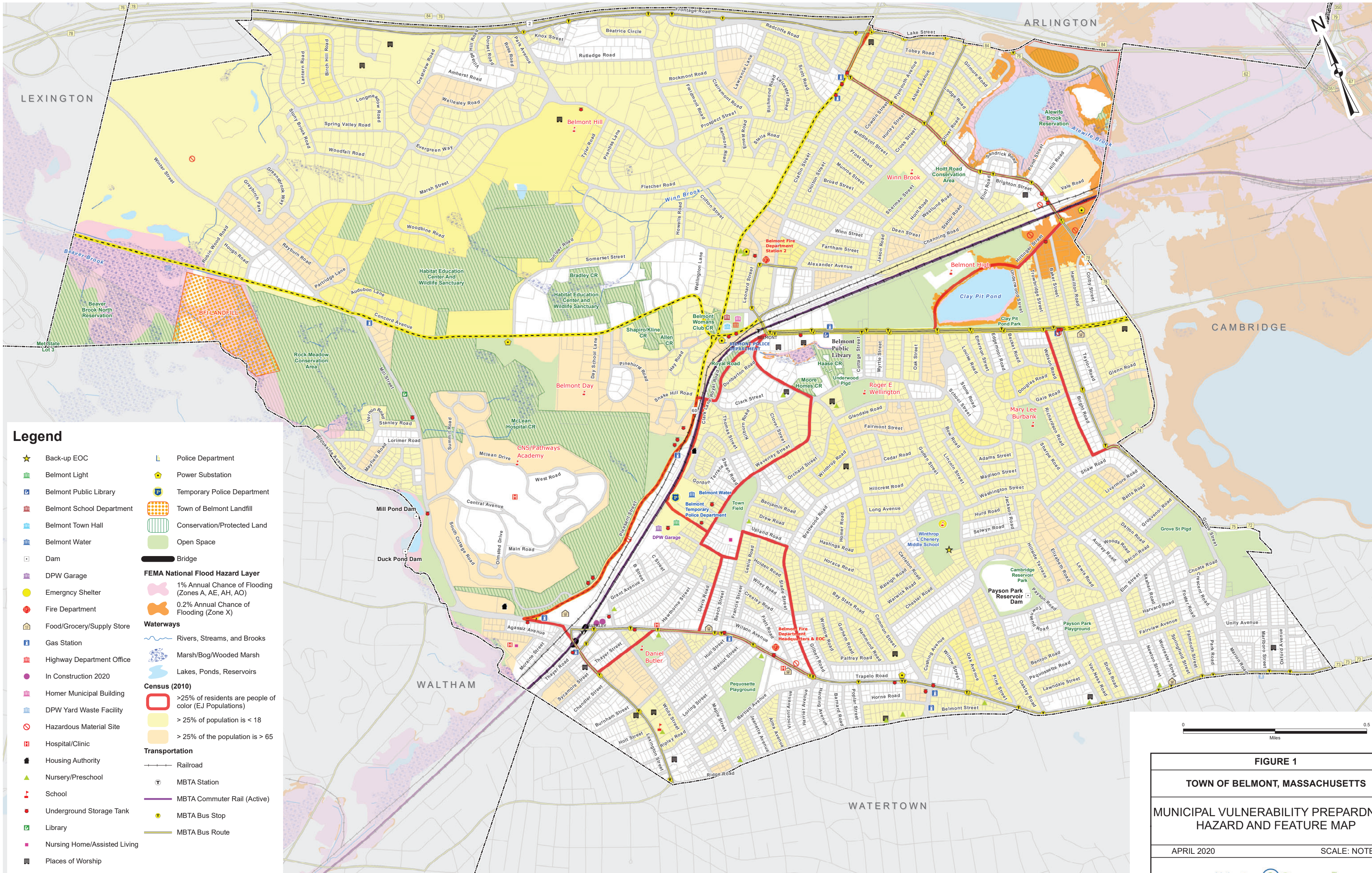


FIGURE 1

TOWN OF BELMONT, MASSACHUSETTS

MUNICIPAL VULNERABILITY PREPARDNESS
HAZARD AND FEATURE MAP

APRIL 2020 SCALE: NOTED

Weston & Sampson

Hazus: Earthquake Global Risk Report

Region Name Belmont_HMP

Earthquake Scenario: Belmont Magnitude 5 Earthquake

Print Date: February 14, 2020

Disclaimer:

This version of Hazus utilizes 2010 Census Data.

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

General Description of the Region

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 4.72 square miles and contains 8 census tracts. There are over 9 thousand households in the region which has a total population of 24,729 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 8 thousand buildings in the region with a total building replacement value (excluding contents) of 3,878 (millions of dollars). Approximately 90.00 % of the buildings (and 78.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 899 and 9 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 8 thousand buildings in the region which have an aggregate total replacement value of 3,878 (millions of dollars) . Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 80% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 160 beds. There are 10 schools, 1 fire stations, 1 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 3 hazardous material sites, no military installations and no nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 908.00 (millions of dollars). This inventory includes over 66.49 miles of highways, 5 bridges, 290.18 miles of pipes.

Table 1: Transportation System Lifeline Inventory

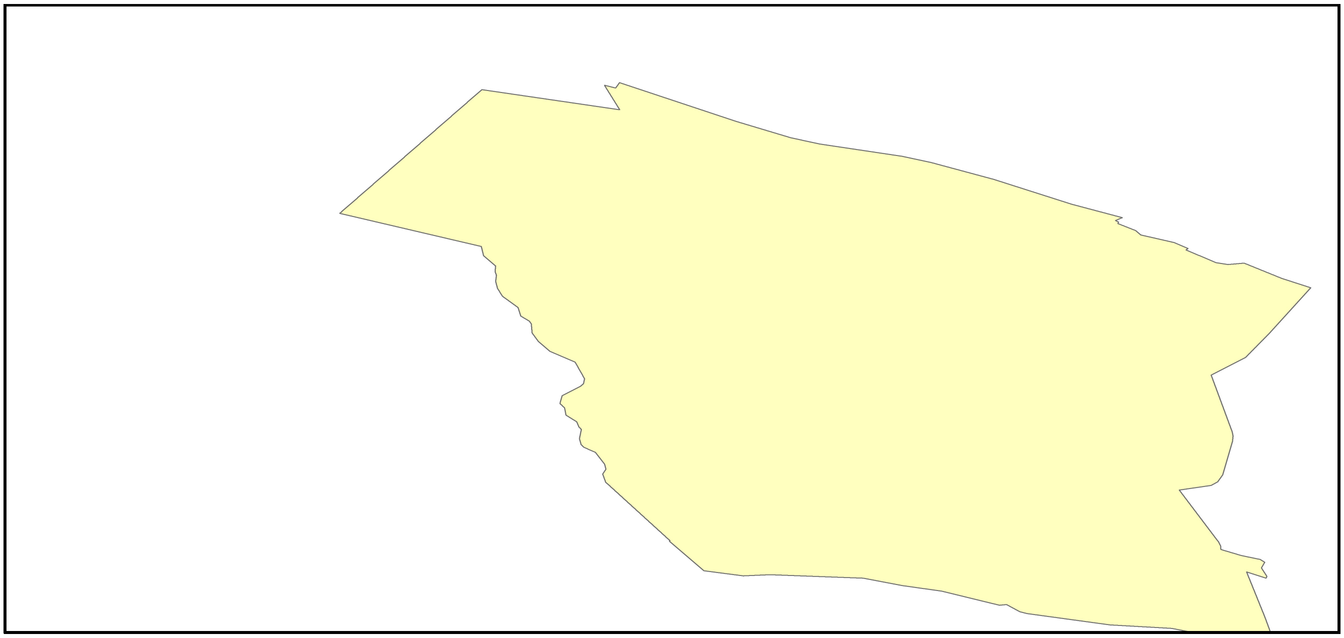
System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	5	114.7751
	Segments	91	710.2160
	Tunnels	0	0.0000
		Subtotal	**824.9911**
Railways	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	20	45.7351
	Tunnels	0	0.0000
		Subtotal	**45.7351**
Light Rail	Bridges	0	0.0000
	Facilities	2	5.3260
	Segments	8	23.1443
	Tunnels	0	0.0000
		Subtotal	**28.4703**
Bus	Facilities	0	0.0000
		Subtotal	**0.0000**
Ferry	Facilities	0	0.0000
		Subtotal	**0.0000**
Port	Facilities	0	0.0000
		Subtotal	**0.0000**
Airport	Facilities	0	0.0000
	Runways	0	0.0000
		Subtotal	**0.0000**
		Total	**899.20**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	4.6718
	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**4.6718**
Waste Water	Distribution Lines	NA	2.8031
	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**2.8031**
Natural Gas	Distribution Lines	NA	1.8687
	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**1.8687**
Oil Systems	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**0.0000**
Electrical Power	Facilities	0	0.0000
		Subtotal	**0.0000**
Communication	Facilities	0	0.0000
		Subtotal	**0.0000**
		Total	**9.30**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.



Scenario Name	Belmont Magnitude 5 Earthquake
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-71.18
Latitude of Epicenter	42.40
Earthquake Magnitude	5.00
Depth (km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Direct Earthquake Damage

Building Damage

Hazus estimates that about 1,917 buildings will be at least moderately damaged. This is over 24.00 % of the buildings in the region. There are an estimated 118 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Damage Categories by General Occupancy Type

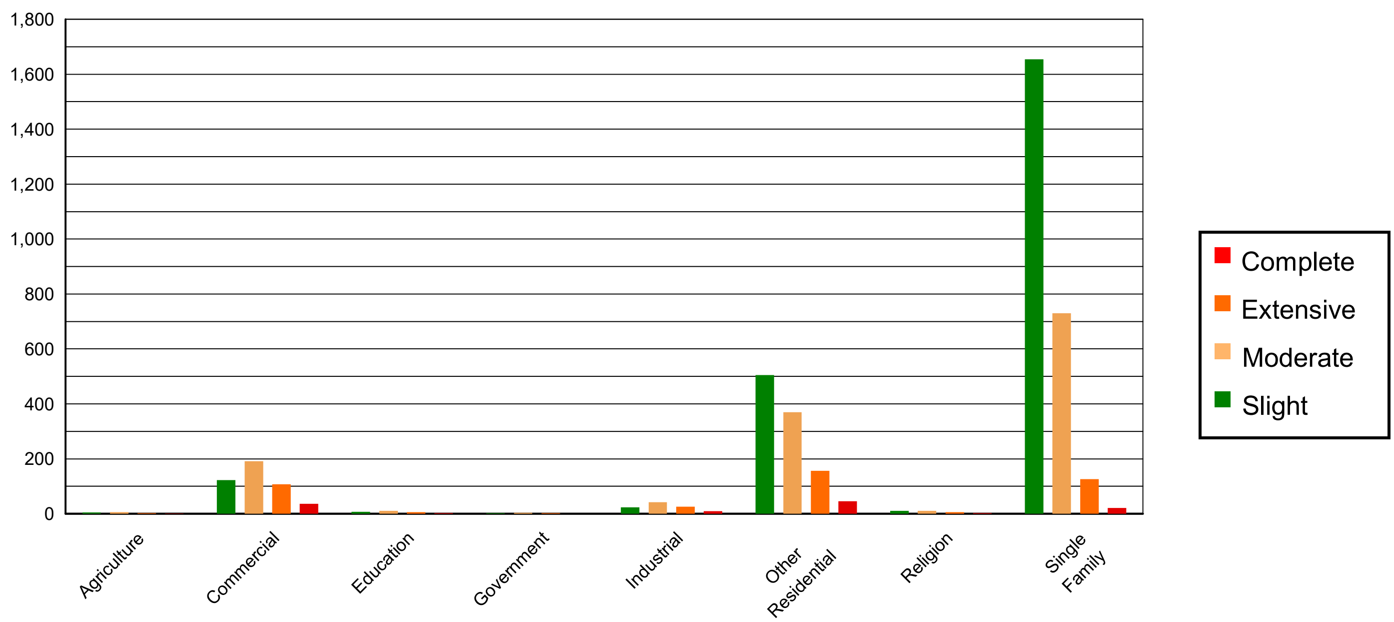


Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	4.08	0.11	4.59	0.20	6.37	0.47	2.96	0.68	1.01	0.85
Commercial	128.76	3.35	122.19	5.25	191.82	14.04	107.30	24.80	36.93	31.18
Education	7.65	0.20	6.67	0.29	10.78	0.79	5.91	1.37	1.98	1.67
Government	2.29	0.06	2.03	0.09	3.67	0.27	2.24	0.52	0.77	0.65
Industrial	26.28	0.68	23.50	1.01	42.17	3.09	26.06	6.02	9.00	7.60
Other Residential	816.67	21.26	504.57	21.67	370.20	27.09	156.48	36.17	46.08	38.91
Religion	16.11	0.42	10.88	0.47	11.05	0.81	5.98	1.38	1.98	1.68
Single Family	2840.23	73.92	1654.02	71.04	730.40	53.45	125.68	29.05	20.67	17.46
Total	**3,842**		**2,328**		**1,366**		**433**		**118**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	3457.63	89.99	2017.47	86.64	873.51	63.92	122.58	28.33	9.67	8.17
Steel	77.44	2.02	65.63	2.82	142.45	10.42	90.69	20.96	32.43	27.39
Concrete	21.39	0.56	19.65	0.84	46.23	3.38	30.91	7.15	9.26	7.82
Precast	4.14	0.11	3.10	0.13	8.05	0.59	8.22	1.90	2.63	2.22
RM	73.08	1.90	34.13	1.47	69.38	5.08	54.26	12.54	9.59	8.10
URM	207.36	5.40	187.04	8.03	223.88	16.38	123.90	28.64	54.31	45.87
MH	1.03	0.03	1.44	0.06	2.96	0.22	2.05	0.47	0.52	0.44
Total	**3,842**		**2,328**		**1,366**		**433**		**118**	

*Note:
RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 160 hospital beds available for use. On the day of the earthquake, the model estimates that only 36 hospital beds (23.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 45.00% of the beds will be back in service. By 30 days, 74.00% will be operational.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	1	1	0	0
Schools	10	10	0	0
EOCs	0	0	0	0
PoliceStations	1	0	0	1
FireStations	1	1	0	0

Transportation Lifeline Damage

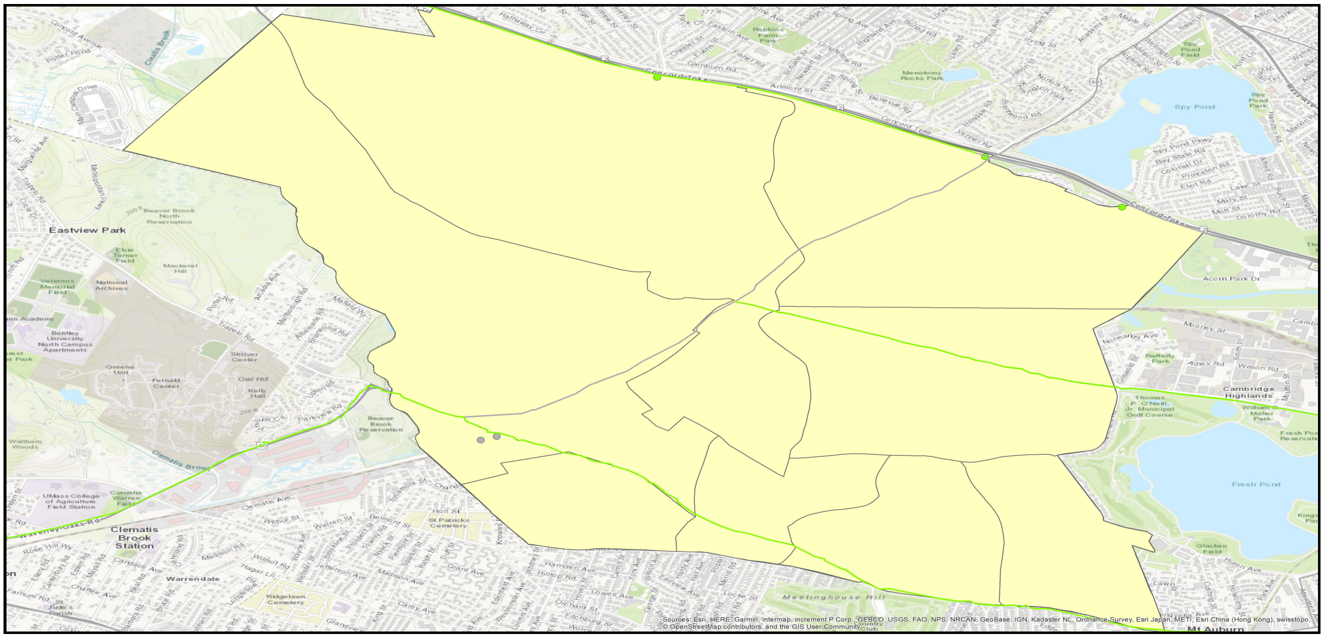


Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	With Functionality > 50 % After Day 7
Highway	Segments	91	0	0	86	86
	Bridges	5	3	0	2	5
	Tunnels	0	0	0	0	0
Railways	Segments	20	0	0	18	18
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	8	0	0	8	8
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	2	1	0	2	2
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	0	0	0	0	0
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	0	0	0	0	0

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	145	38	10
Waste Water	87	19	5
Natural Gas	58	7	2
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	9,651	0	0	0	0	0
Electric Power		8,146	5,450	2,307	418	10

Induced Earthquake Damage

Fire Following Earthquake

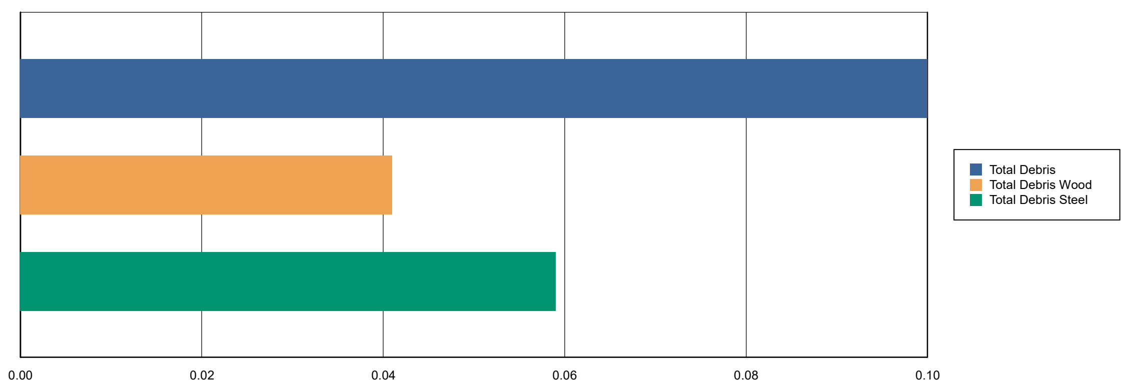
Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 100,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 41.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 4,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Earthquake Debris (millions of tons)



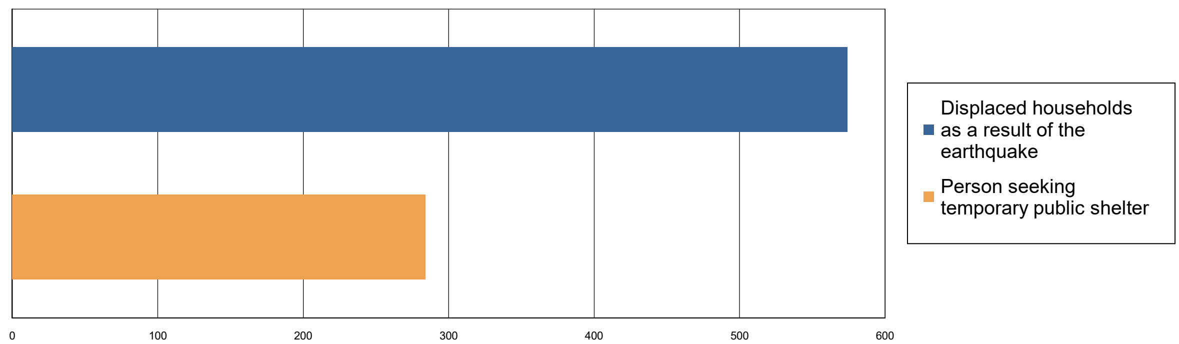
Brick/ Wood	Reinforced Concrete/Steel	Total Debris	Truck Load
0.04	0.06	0.10	4,000 (@25 tons/truck)

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 574 households to be displaced due to the earthquake. Of these, 284 people (out of a total population of 24,729) will seek temporary shelter in public shelters.

Displaced Households/ Persons Seeking Short Term Public Shelter



Displaced households as a result of the earthquake	Persons seeking temporary public shelter
574	284

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- · Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- · Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- · Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- · Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	1.69	0.42	0.06	0.11
	Commuting	0.01	0.01	0.02	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	1.22	0.31	0.04	0.08
	Other-Residential	47.94	11.72	1.70	3.34
	Single Family	18.33	3.16	0.33	0.64
	Total	**69**	**16**	**2**	**4**
2 PM	Commercial	96.13	23.89	3.34	6.50
	Commuting	0.09	0.11	0.20	0.04
	Educational	32.59	8.33	1.24	2.41
	Hotels	0.00	0.00	0.00	0.00
	Industrial	9.03	2.27	0.32	0.62
	Other-Residential	9.69	2.41	0.36	0.68
	Single Family	3.64	0.65	0.07	0.13
	Total	**151**	**38**	**6**	**10**
5 PM	Commercial	67.97	16.95	2.39	4.60
	Commuting	1.66	2.00	3.64	0.69
	Educational	2.65	0.68	0.10	0.20
	Hotels	0.00	0.00	0.00	0.00
	Industrial	5.64	1.42	0.20	0.39
	Other-Residential	19.03	4.73	0.70	1.33
	Single Family	7.21	1.29	0.14	0.26
	Total	**104**	**27**	**7**	**7**

Economic Loss

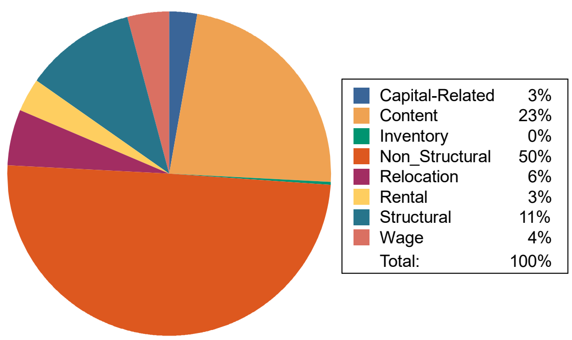
The total economic loss estimated for the earthquake is 578.21 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 555.75 (millions of dollars); 16 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 57 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Earthquake Losses by Loss Type ($ millions)



Earthquake Losses by Occupancy Type ($ millions)

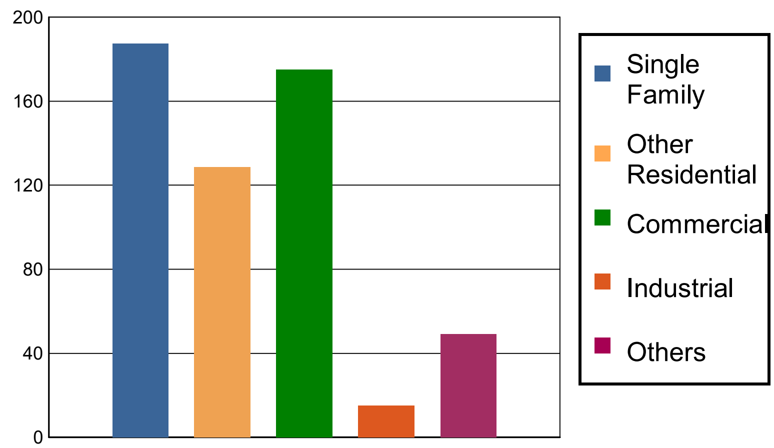


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	3.8780	18.4598	0.2744	1.2064	23.8186
	Capital-Related	0.0000	1.6508	13.7119	0.1581	0.3625	15.8833
	Rental	1.9230	8.8593	7.3526	0.0816	0.4271	18.6436
	Relocation	6.8897	5.0748	14.0621	0.5305	5.1075	31.6646
	Subtotal	**8.8127**	**19.4629**	**53.5864**	**1.0446**	**7.1035**	**90.0101**
Capital Stock Losses							
	Structural	17.9086	12.1878	21.3592	2.0287	7.3880	60.8723
	Non_Structural	108.4014	74.0498	63.2493	6.9683	22.5846	275.2534
	Content	52.3847	23.0419	36.2853	4.5181	12.0158	128.2458
	Inventory	0.0000	0.0000	0.6045	0.7190	0.0421	1.3656
	Subtotal	**178.6947**	**109.2795**	**121.4983**	**14.2341**	**42.0305**	**465.7371**
	Total	**187.51**	**128.74**	**175.08**	**15.28**	**49.13**	**555.75**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Table 12: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	710.2160	0.0000	0.00
	Bridges	114.7751	20.8076	18.13
	Tunnels	0.0000	0.0000	0.00
	Subtotal	**824.9911**	**20.8076**	
Railways	Segments	45.7351	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**45.7351**	**0.0000**	
Light Rail	Segments	23.1443	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	5.3260	1.3688	25.70
	Subtotal	**28.4703**	**1.3688**	
Bus	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Port	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Airport	Facilities	0.0000	0.0000	0.00
	Runways	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
	Total	**899.20**	**22.18**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Line	4.6718	0.1730	3.70
	Subtotal	**4.6718**	**0.1730**	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Line	2.8031	0.0869	3.10
	Subtotal	**2.8031**	**0.0869**	
Natural Gas	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Line	1.8687	0.0298	1.59
	Subtotal	**1.8687**	**0.0298**	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Electrical Power	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Communication	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
	Total	**9.34**	**0.29**	

Appendix A: County Listing for the Region

Middlesex,MA

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Massachusetts					
	Middlesex	24,729	3,035	843	3,878
Total Region		**24,729**	**3,035**	**843**	**3,878**

Hazus: Earthquake Global Risk Report

Region Name Belmont_HMP

Earthquake Scenario: Belmont Magnitude 7.0 Earthquake

Print Date: February 14, 2020

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

Table of Contents

General Description of the Region

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Massachusetts

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 4.72 square miles and contains 8 census tracts. There are over 9 thousand households in the region which has a total population of 24,729 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 8 thousand buildings in the region with a total building replacement value (excluding contents) of 3,878 (millions of dollars). Approximately 90.00 % of the buildings (and 78.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 899 and 9 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 8 thousand buildings in the region which have an aggregate total replacement value of 3,878 (millions of dollars) . Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 80% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 160 beds. There are 10 schools, 1 fire stations, 1 police stations and 0 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 3 hazardous material sites, no military installations and no nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 908.00 (millions of dollars). This inventory includes over 66.49 miles of highways, 5 bridges, 290.18 miles of pipes.

Table 1: Transportation System Lifeline Inventory

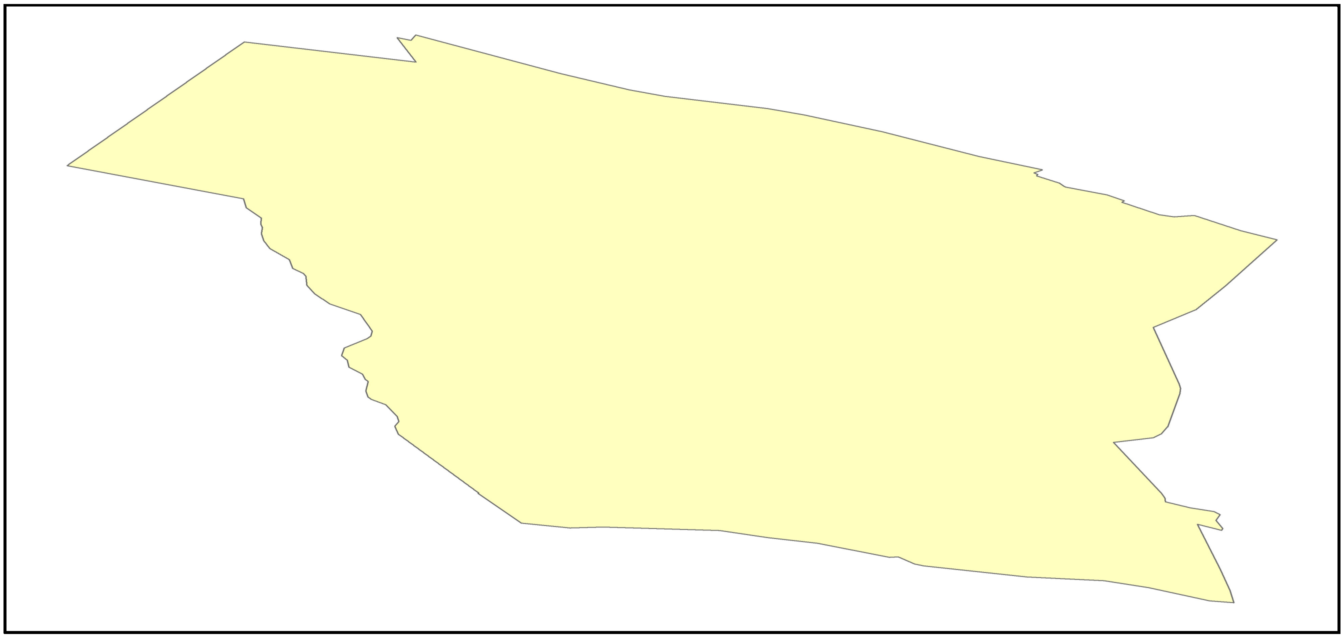
System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	5	114.7751
	Segments	91	710.2160
	Tunnels	0	0.0000
		Subtotal	**824.9911**
Railways	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	20	45.7351
	Tunnels	0	0.0000
		Subtotal	**45.7351**
Light Rail	Bridges	0	0.0000
	Facilities	2	5.3260
	Segments	8	23.1443
	Tunnels	0	0.0000
		Subtotal	**28.4703**
Bus	Facilities	0	0.0000
		Subtotal	**0.0000**
Ferry	Facilities	0	0.0000
		Subtotal	**0.0000**
Port	Facilities	0	0.0000
		Subtotal	**0.0000**
Airport	Facilities	0	0.0000
	Runways	0	0.0000
		Subtotal	**0.0000**
		Total	**899.20**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	4.6718
	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**4.6718**
Waste Water	Distribution Lines	NA	2.8031
	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**2.8031**
Natural Gas	Distribution Lines	NA	1.8687
	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**1.8687**
Oil Systems	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**0.0000**
Electrical Power	Facilities	0	0.0000
		Subtotal	**0.0000**
Communication	Facilities	0	0.0000
		Subtotal	**0.0000**
		Total	**9.30**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.



Scenario Name	Belmont Magnitude 7.0 Earthquake
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-71.18
Latitude of Epicenter	42.40
Earthquake Magnitude	7.00
Depth (km)	12.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Direct Earthquake Damage

Building Damage

Hazus estimates that about 7,845 buildings will be at least moderately damaged. This is over 97.00 % of the buildings in the region. There are an estimated 4,332 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Damage Categories by General Occupancy Type

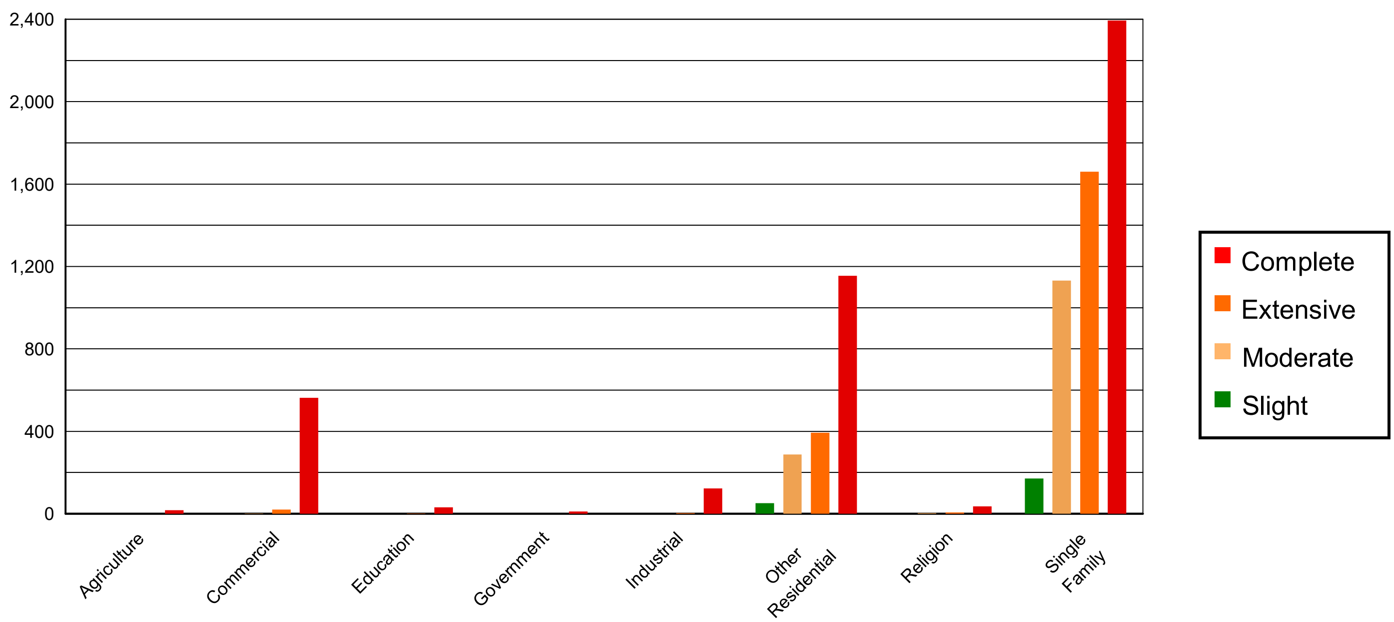


Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	0.00	0.00	0.01	0.00	0.10	0.01	1.02	0.05	17.87	0.41
Commercial	0.03	0.14	0.16	0.07	2.38	0.17	21.21	1.02	563.22	13.00
Education	0.00	0.01	0.01	0.00	0.12	0.01	1.05	0.05	31.82	0.73
Government	0.00	0.00	0.00	0.00	0.03	0.00	0.26	0.01	10.71	0.25
Industrial	0.01	0.03	0.02	0.01	0.35	0.02	3.40	0.16	123.21	2.84
Other Residential	5.07	25.86	51.29	23.00	288.49	20.23	394.21	18.89	1154.94	26.66
Religion	0.04	0.21	0.52	0.23	3.66	0.26	5.98	0.29	35.79	0.83
Single Family	14.46	73.74	170.95	76.67	1131.22	79.31	1659.88	79.53	2394.49	55.27
Total	**20**		**223**		**1,426**		**2,087**		**4,332**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Wood	19.52	99.55	222.37	99.73	1419.35	99.51	2047.72	98.12	2771.89	63.99
Steel	0.02	0.10	0.02	0.01	0.36	0.03	7.18	0.34	401.06	9.26
Concrete	0.00	0.01	0.01	0.01	0.15	0.01	1.59	0.08	125.68	2.90
Precast	0.00	0.00	0.01	0.00	0.05	0.00	0.19	0.01	25.88	0.60
RM	0.05	0.24	0.08	0.04	1.17	0.08	3.78	0.18	235.36	5.43
URM	0.02	0.10	0.48	0.22	5.23	0.37	26.36	1.26	764.40	17.65
MH	0.00	0.00	0.00	0.00	0.02	0.00	0.20	0.01	7.78	0.18
Total	**20**		**223**		**1,426**		**2,087**		**4,332**	

*Note:
RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 160 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 0.00% of the beds will be back in service. By 30 days, 1.00% will be operational.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	1	1	1	0
Schools	10	10	10	0
EOCs	0	0	0	0
PoliceStations	1	1	1	0
FireStations	1	1	1	0

Transportation Lifeline Damage

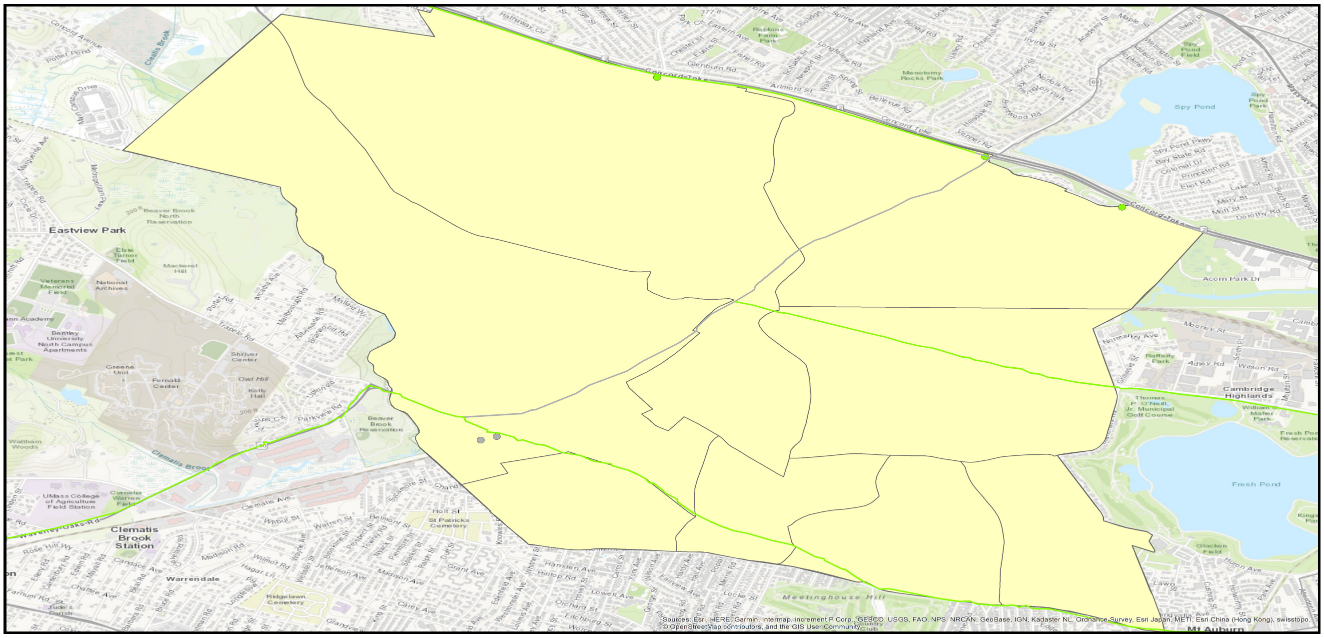


Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	91	0	0	86	86
	Bridges	5	5	5	0	0
	Tunnels	0	0	0	0	0
Railways	Segments	20	0	0	18	18
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	8	0	0	8	8
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	2	2	1	0	1
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	0	0	0	0	0
	Runways	0	0	0	0	0

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	0	0	0	0	0
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	0	0	0	0	0

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	145	1214	304
Waste Water	87	610	152
Natural Gas	58	209	52
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	9,651	9,633	9,615	9,434	0	0
Electric Power		9,298	8,768	7,224	3,053	10

Induced Earthquake Damage

Fire Following Earthquake

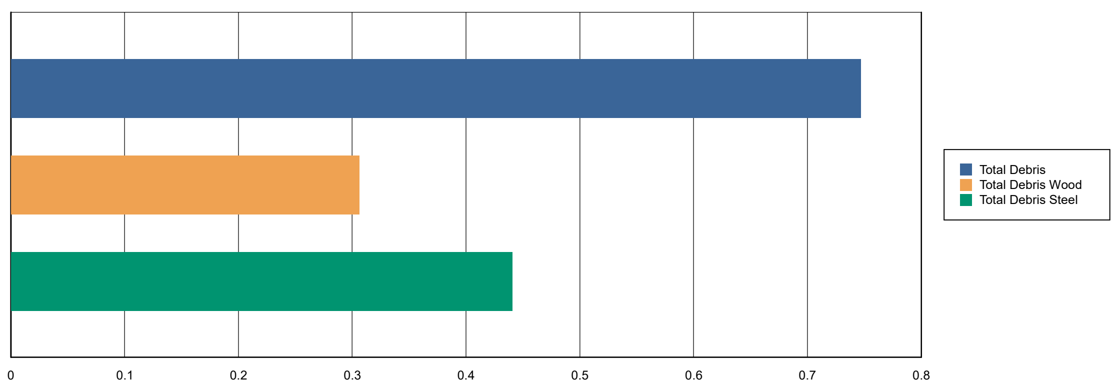
Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 2 ignitions that will burn about 0.01 sq. mi 0.21 % of the region's total area.) The model also estimates that the fires will displace about 88 people and burn about 10 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 747,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 41.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 29,880 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Earthquake Debris (millions of tons)



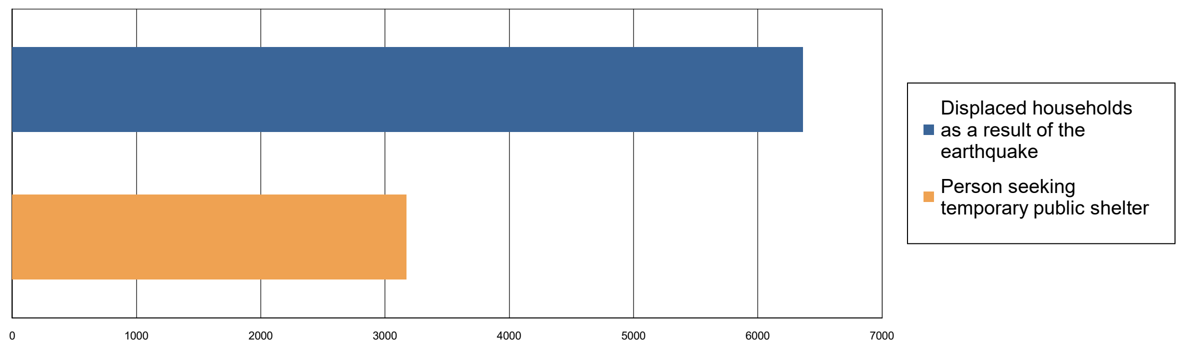
Brick/ Wood	Reinforced Concrete/Steel	Total Debris	Truck Load
0.31	0.44	0.75	29,880 (@25 tons/truck)

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 6,362 households to be displaced due to the earthquake. Of these, 3,171 people (out of a total population of 24,729) will seek temporary shelter in public shelters.

Displaced Households/ Persons Seeking Short Term Public Shelter



Displaced households as a result of the earthquake	Persons seeking temporary public shelter
6,362	3,171

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	16.86	5.39	0.86	1.69
	Commuting	0.07	0.11	0.16	0.03
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	11.29	3.66	0.59	1.17
	Other-Residential	609.30	188.49	28.14	54.87
	Single Family	492.66	124.80	10.24	17.96
	Total	**1,130**	**322**	**40**	**76**
2 PM	Commercial	961.59	307.50	49.09	96.11
	Commuting	0.63	0.95	1.48	0.29
	Educational	330.74	108.26	18.12	35.31
	Hotels	0.00	0.00	0.00	0.00
	Industrial	83.82	27.16	4.43	8.64
	Other-Residential	123.08	38.37	5.97	11.00
	Single Family	99.62	25.34	2.44	3.67
	Total	**1,599**	**508**	**82**	**155**
5 PM	Commercial	683.25	218.65	35.25	67.83
	Commuting	11.51	17.22	26.81	5.31
	Educational	26.79	8.77	1.47	2.86
	Hotels	0.00	0.00	0.00	0.00
	Industrial	52.39	16.97	2.77	5.40
	Other-Residential	243.86	75.92	11.78	21.69
	Single Family	198.79	50.57	4.86	7.31
	Total	**1,217**	**388**	**83**	**110**

Economic Loss

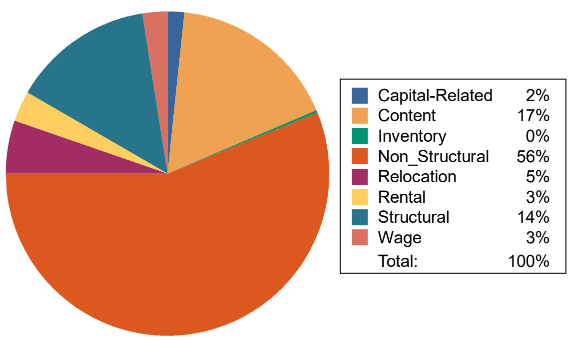
The total economic loss estimated for the earthquake is 4,070.43 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 3,964.41 (millions of dollars); 12 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 67 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Earthquake Losses by Loss Type ($ millions)



Earthquake Losses by Occupancy Type ($ millions)

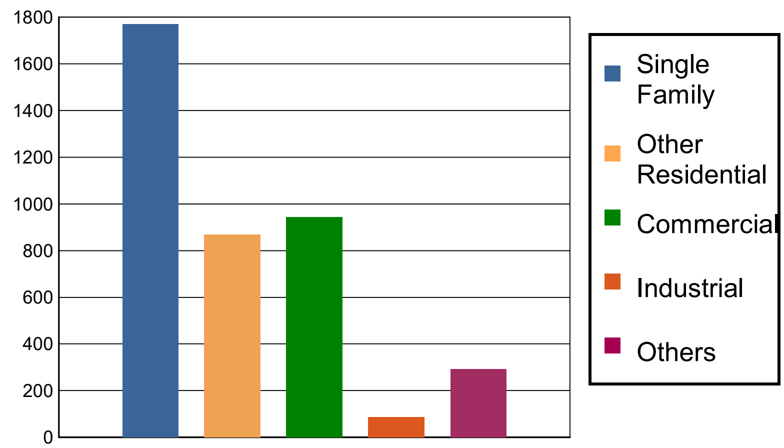


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	19.8464	74.7390	1.2389	5.1080	100.9323
	Capital-Related	0.0000	8.4468	59.3916	0.7066	1.6701	70.2151
	Rental	30.3024	60.8333	26.8087	0.2891	1.8614	120.0949
	Relocation	99.3108	32.4010	47.7704	1.5039	21.0082	201.9943
	Subtotal	**129.6132**	**121.5275**	**208.7097**	**3.7385**	**29.6477**	**493.2366**
Capital Stock Losses							
	Structural	314.3637	91.0436	107.8933	9.4420	40.0885	562.8311
	Non_Structural	1082.1553	540.7071	413.4648	44.8928	153.1685	2,234.3885
	Content	244.0748	115.1246	211.0309	25.9841	69.7981	666.0125
	Inventory	0.0000	0.0000	3.5322	4.1516	0.2553	7.9391
	Subtotal	**1640.5938**	**746.8753**	**735.9212**	**84.4705**	**263.3104**	**3471.1712**
	Total	**1770.21**	**868.40**	**944.63**	**88.21**	**292.96**	**3964.41**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Table 12: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	710.2160	0.0000	0.00
	Bridges	114.7751	93.0732	81.09
	Tunnels	0.0000	0.0000	0.00
	Subtotal	**824.9911**	**93.0732**	
Railways	Segments	45.7351	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**45.7351**	**0.0000**	
Light Rail	Segments	23.1443	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	5.3260	3.8031	71.41
	Subtotal	**28.4703**	**3.8031**	
Bus	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Port	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Airport	Facilities	0.0000	0.0000	0.00
	Runways	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
	Total	**899.20**	**96.88**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Line	4.6718	5.4635	116.95
	Subtotal	**4.6718**	**5.4635**	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Line	2.8031	2.7444	97.91
	Subtotal	**2.8031**	**2.7444**	
Natural Gas	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Line	1.8687	0.9402	50.31
	Subtotal	**1.8687**	**0.9402**	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Electrical Power	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Communication	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
	Total	**9.34**	**9.15**	

Appendix A: County Listing for the Region

Middlesex,MA

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Massachusetts					
	Middlesex	24,729	3,035	843	3,878
Total Region		**24,729**	**3,035**	**843**	**3,878**

APPENDIX C

CRB Workshop

Belmont
MASSACHUSETTS
The Town of Homes

Municipal Vulnerability Preparedness Planning Grant and Hazard Mitigation Planning Grant Update

Community Resilience Building Workshop

19 Moore St, Gallery Room in the Homer Building
Monday, January 27th, 2020, 11:30AM – 7:30PM

11:30 am – 11:45 am	Registration - Grab Lunch
11:45 am – 12:00 pm	Welcome and Introductions
12:00 pm – 12:15 pm	MVP Workshop Purpose
12:15 pm – 1:00 pm	Overview Climate Science Risk Matrix
1:00 pm – 1:15 pm	Large Group Exercise #1 – Identify Climate Hazards
1:15 pm – 2:00 pm	Small Group Exercise #1- Identify Infrastructure Features
2:00 pm – 2:45 pm	Small Group Exercise #2 - Identify Societal Features
2:45 pm – 3:30 pm	Small Group Exercise #3 - Identify Environmental Features
3:30 pm – 3:45 pm	BREAK
3:45 pm – 4:00 pm	MVP Community Actions
4:00 pm – 4:45 pm	Small Group Exercise #4- Identify Infrastructure Actions
4:45 pm – 5:30 pm	Small Group Exercise #5- Identify Societal Actions
5:30 pm – 6:00 pm	Small Group Exercise #6- Identify Environmental Actions
6:00 pm – 6:15 pm	BREAK
6:15 pm – 7:15 pm	Large Group Exercise #2- Prioritization
7:15 pm – 7:30 pm	Wrap-up and Closing Remarks

Weston & Sampson

FIGURE 1

TOWN OF BELMONT, MASSACHUSETTS

MUNICIPAL VULNERABILITY PREPARDNESS HAZARD AND FEATURE MAP

OCTOBER 2019 SCALE: NOTED

Weston & Sampson

TOWN OF BELMONT

Community Resilience Building Workshop

Monday, January 27, 2019

Photo: Belmont Town Hall, Town of Belmont Facebook.

WELCOME W&S

Amanda Kohn

Lydia Kifner

Deanna Lambert

Alex Gaspar

Justin Gould

Mike Warner

Photo: Professional Development Day. Belmont Website, 2019.

WELCOME CORE TEAM

Jon Marshall

Jay Marcotte

Mary Trudeau

Steve Dorrance

Wesley Chin

Wayne Haley

James MacIsaac

Glenn Clancy

Diana Ekman

Photo: Professional Development Day. Belmont Website, 2019.

WELCOME PARTICIPANTS

Your name

Organization/Relationship to Belmont

Favorite thing about Belmont

Photo: Professional Development Day. Belmont Website, 2019.

WORKSHOP OUTLINE

- LUNCH -

PRESENTATION:

- Overview of Science & Data
- Characterization of Hazards

INDIVIDUAL TABLES:

- Identify Community Features

- BREAK-

INDIVIDUAL TABLES:

- Identify and Prioritize Actions

- BREAK -

LARGE GROUP DISCUSSION:

- Determine Overall Priority Actions

Photo: K9 Grim. Photo by Belmont Police, 2018, via Twitter.

Municipal Vulnerability Preparedness Program

Executive Office of Energy and Environmental Affairs

Carolyn Meklenburg
MVP Regional Coordinator, Greater Boston
MA Executive Office of Energy and Environmental Affairs

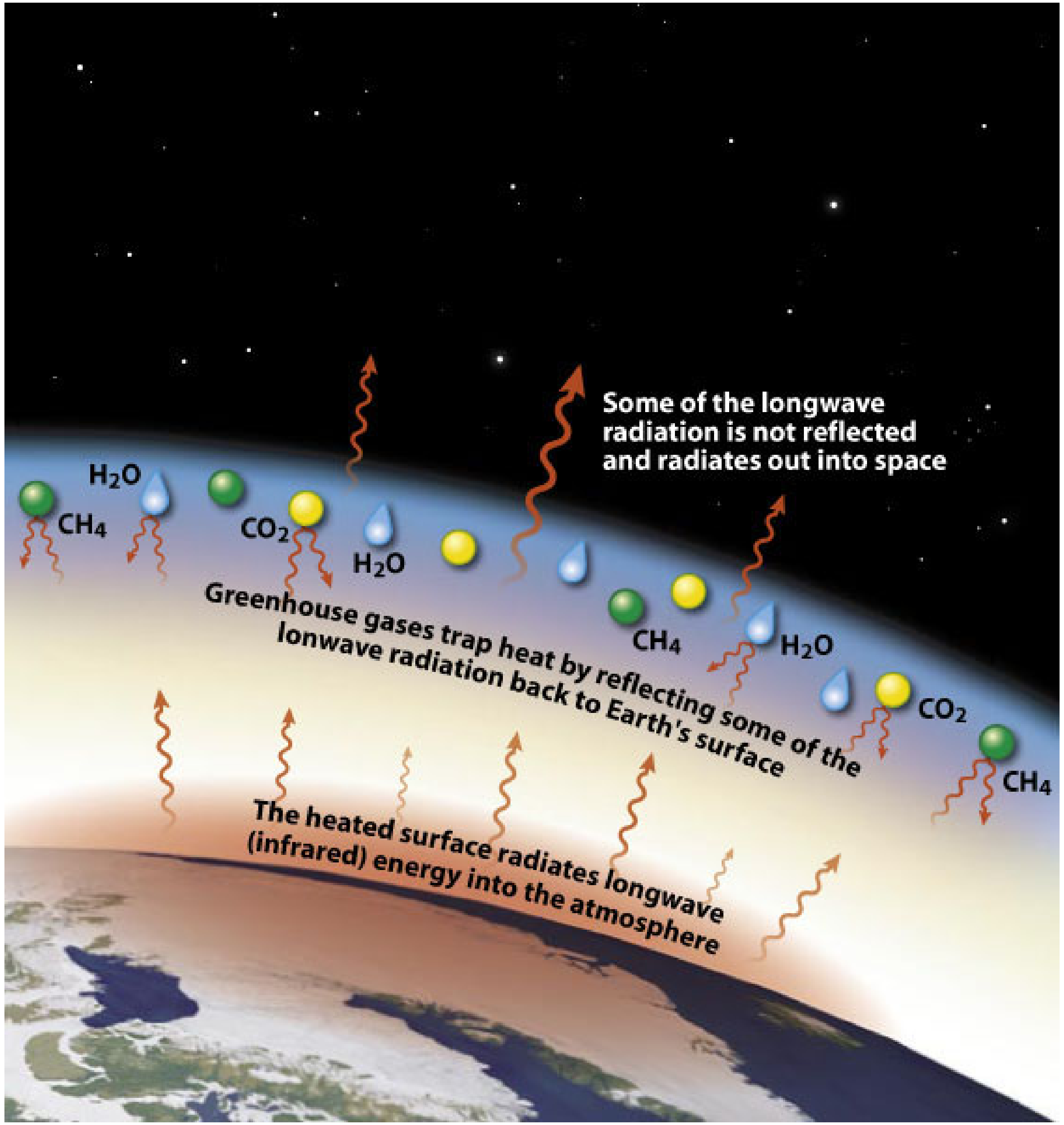
Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) - September 2018

- Acknowledges that climate change is already worsening natural hazards, integrating information and planning elements for 14 natural hazards that affect the Commonwealth
- Uses best scientific data and projections to assess risk and vulnerability
- Evaluates the Commonwealth's existing capabilities to implement agency-specific and statewide activities to reduce risk and increase resilience

GREENHOUSE GASES (GHG)

- Naturally occurring
- Act as a blanket
- Examples: carbon dioxide and methane

Climate mitigation ensures there is less to adapt to and is a key component of our community's resilience



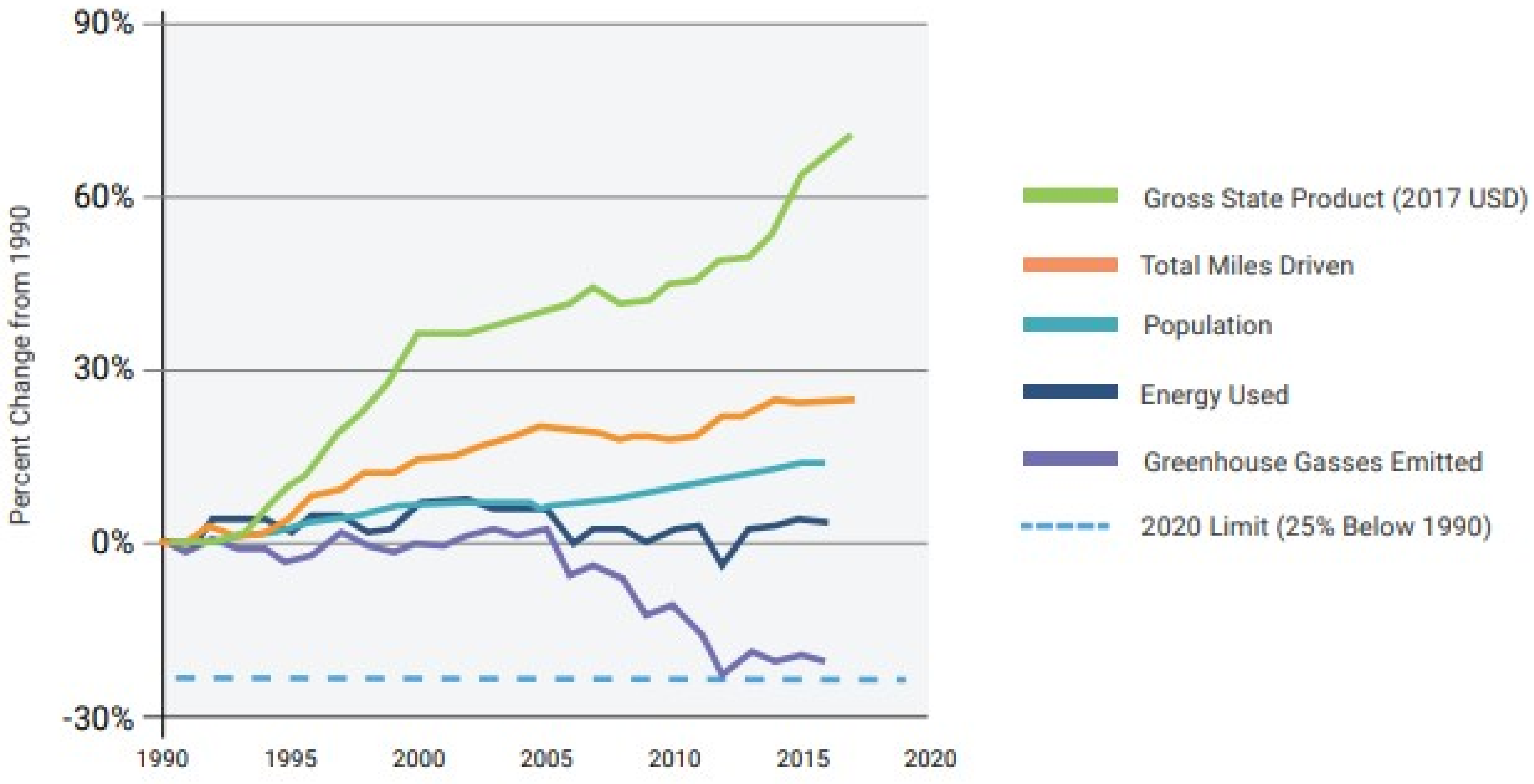
Smithsonian Environmental Research Center. "Too Much of a Good Thing."
http://forces.si.edu/atmosphere/02_04_07.html

MASSACHUSETTS GHG GOALS

- Established by the Global Warming Solutions Act (GWSA) of 2008
- 25% reduction in GHG emissions by 2020
- 80% reduction in GHG emissions by 2050
- 1990 is the baseline year

Source: Commonwealth of Massachusetts. 2019. “Global Warming Solutions Act 10-year Progress Report,” 10.

FIGURE 3 | TRENDS OF GROWTH IN GSP, VMT, AND POPULATION WHILE GHG EMISSIONS ARE DECREASING AND ENERGY USE HAS BEEN STABLE



Source: Commonwealth of Massachusetts. 2019. “Global Warming Solutions Act 10-year Progress Report,” 10.

MA 2050 Decarbonization Plan

Executive Office of Energy and Environmental Affairs

EEA is conducting an **80x50 Study** to identify the strategies, policies, and implementation pathways for MA to achieve at least 80% Greenhouse Gas reductions by 2050.

The results of that research will be published in a **2050 Roadmap report** and will inform the setting of a **2030 GHG emissions limit** and the development of the **Clean Energy and Climate Plan for 2030**.

More information and opportunities to get involved:

www.mass.gov/2050Roadmap

Massachusetts Global Warming Solutions

Bill S.10:

An Act for Climate Change Adaptation Infrastructure Investments in the Commonwealth

- Proposed new source of revenue for loans, grants, and technical assistance to municipalities and regional partnerships for priority adaptation projects
    - Proposed deeds excise increase → est. $137M annually ($1B in ten years)
    - Recurring, long-term revenue stream for multi-year project feasibility

RESILIENCE = MITIGATION + ADAPTATION

RESILIENCE

The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner.

=

MITIGATION

aims to reduce the causes of climate change

+

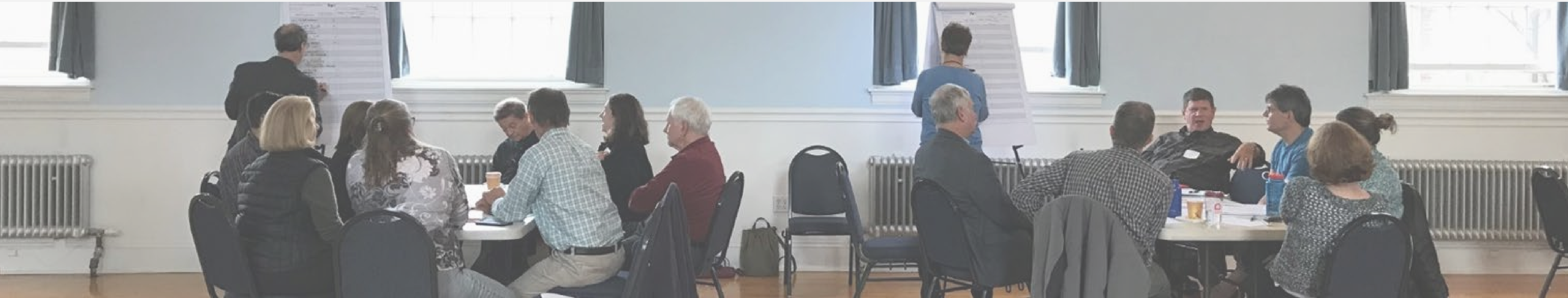
ADAPTATION

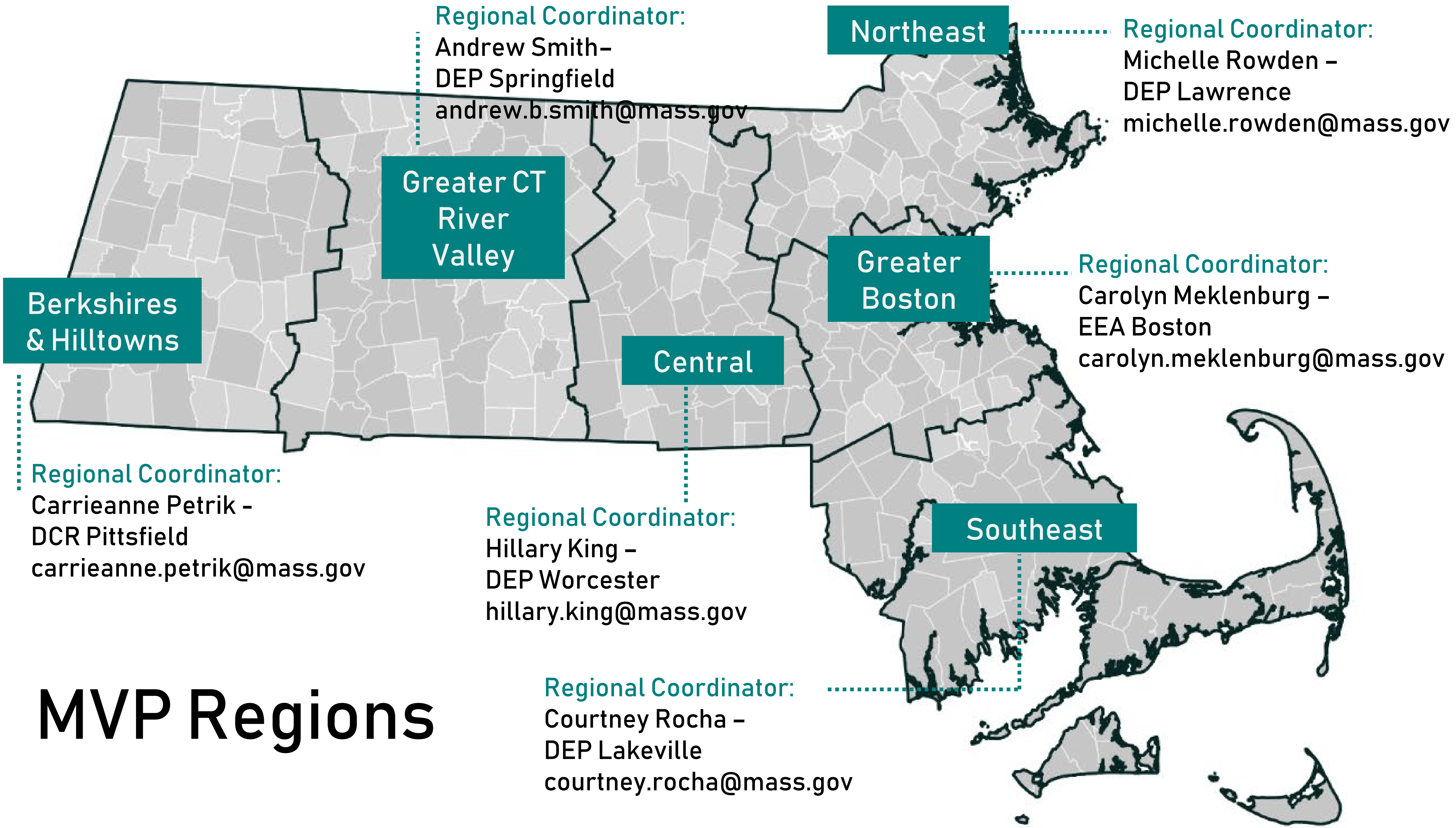
involves modifying our decisions, activities and ways of thinking to adjust to a changing climate

Definitions taken from the Massachusetts 2018 State Hazard Mitigation and Climate Adaptation Plan and Canada in a Changing Climate report (Adaptation.NRCan.gc.ca)

MVP is a ***community-led***, ***accessible*** process that:

- Employs local knowledge and buy-in
- Utilizes partnerships and leverages existing efforts
- Reaches and responds to risks faced by EJ communities and vulnerable populations
- Is based in best available climate projections and data
- Incorporates principles of nature-based solutions
- Demonstrates pilot potential and is proactive




Regional Coordinator:
Andrew Smith–
DEP Springfield
andrew.b.smith@mass.gov
Northeast
Regional Coordinator:
Michelle Rowden –
DEP Lawrence
michelle.rowden@mass.gov
Greater CT River Valley
Berkshires & Hilltowns
Greater Boston
Regional Coordinator:
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EEA Boston
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Regional Coordinator:
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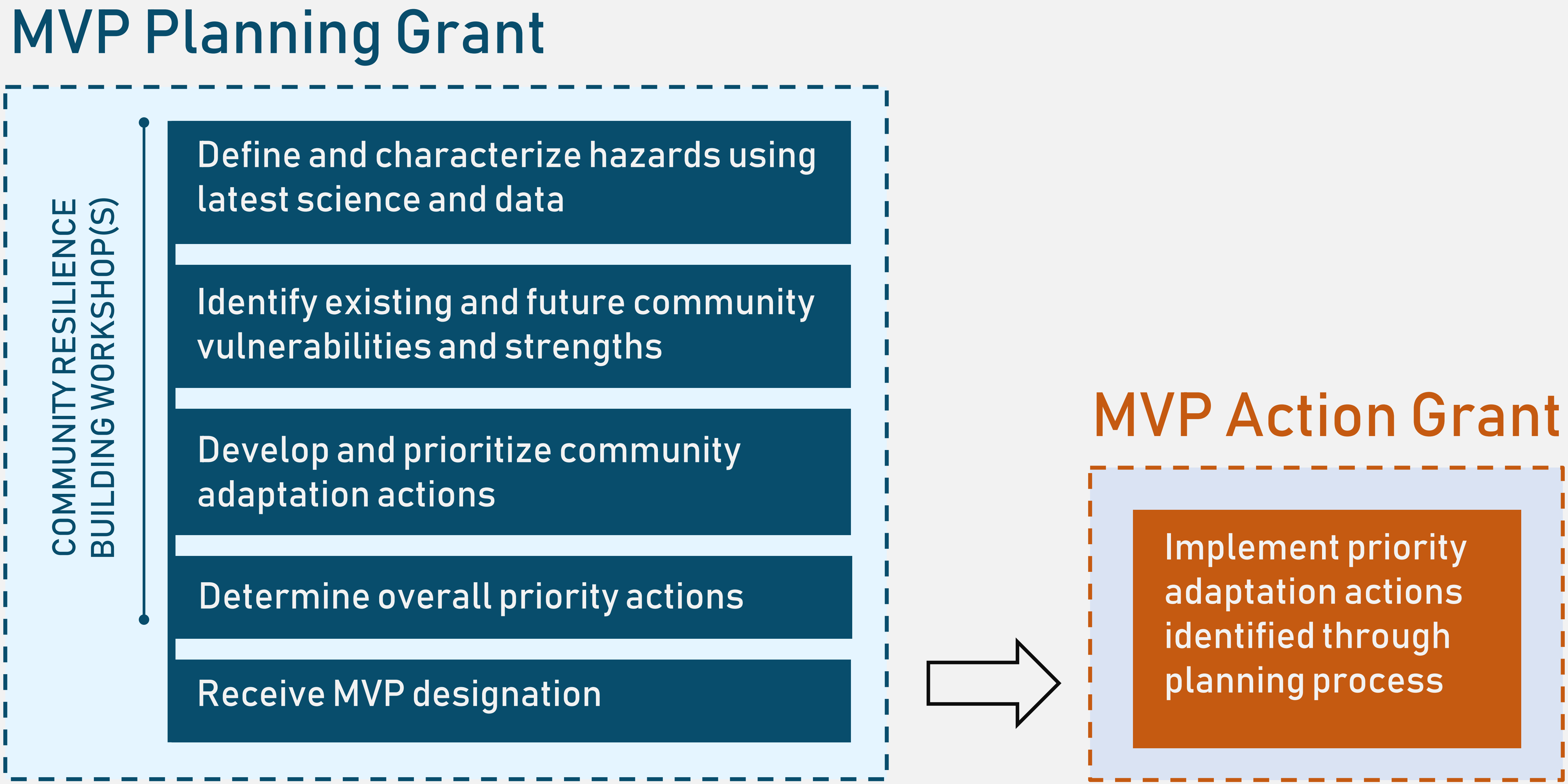
Southeast
MVP Regions
Regional Coordinator:
Courtney Rocha –
DEP Lakeville
courtney.rocha@mass.gov

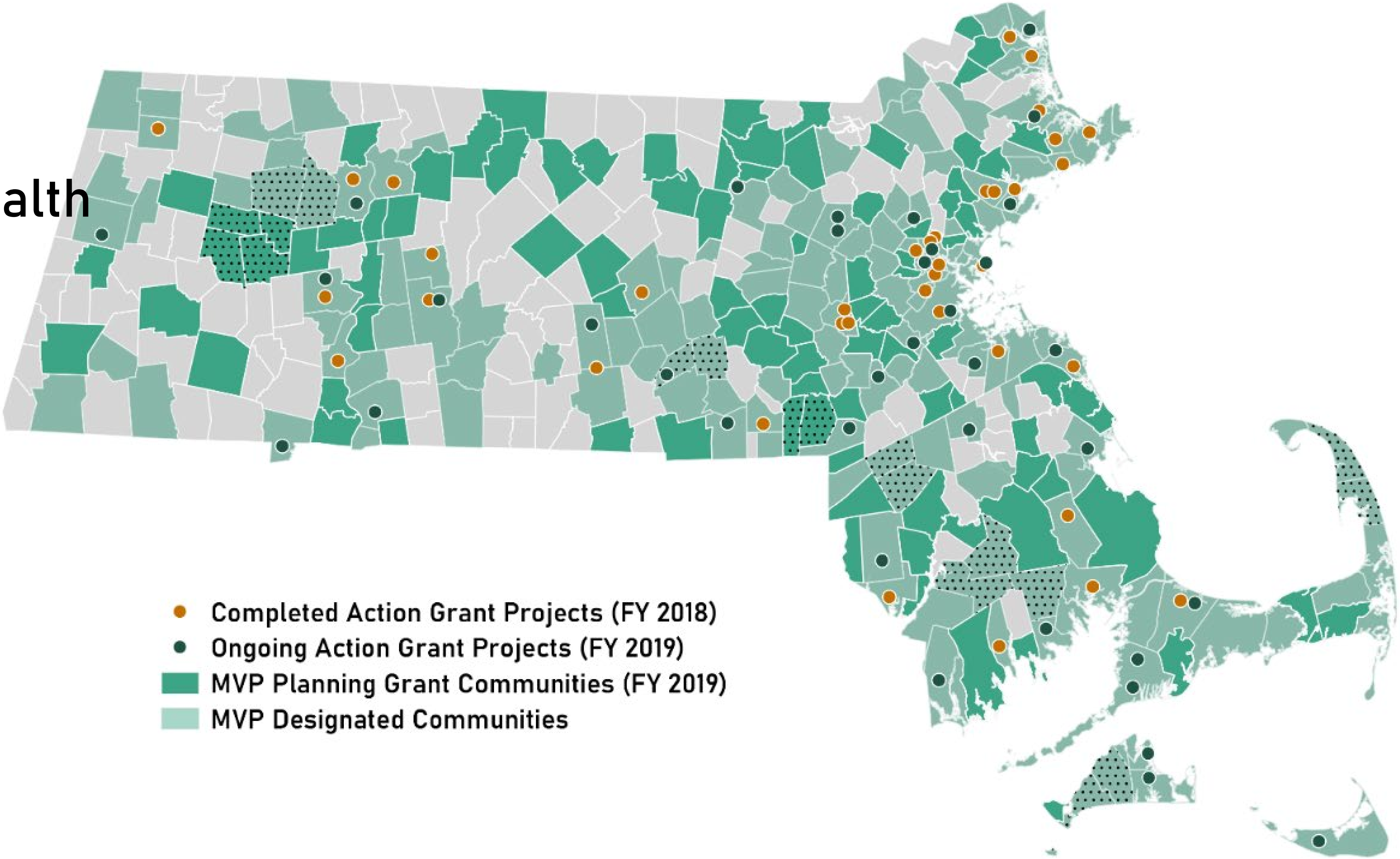

MVP Planning Grant
COMMUNITY RESILIENCE BUILDING WORKSHOP(S)
Define and characterize hazards using latest science and data
Identify existing and future community vulnerabilities and strengths
Develop and prioritize community adaptation actions
Determine overall priority actions
Receive MVP designation
MVP Action Grant
Implement priority adaptation actions identified through planning process

Three Years of MVP

MVP Designations
71% of the Commonwealth
249 communities

Action Grant Projects
FY 18: 37
FY 19: 36

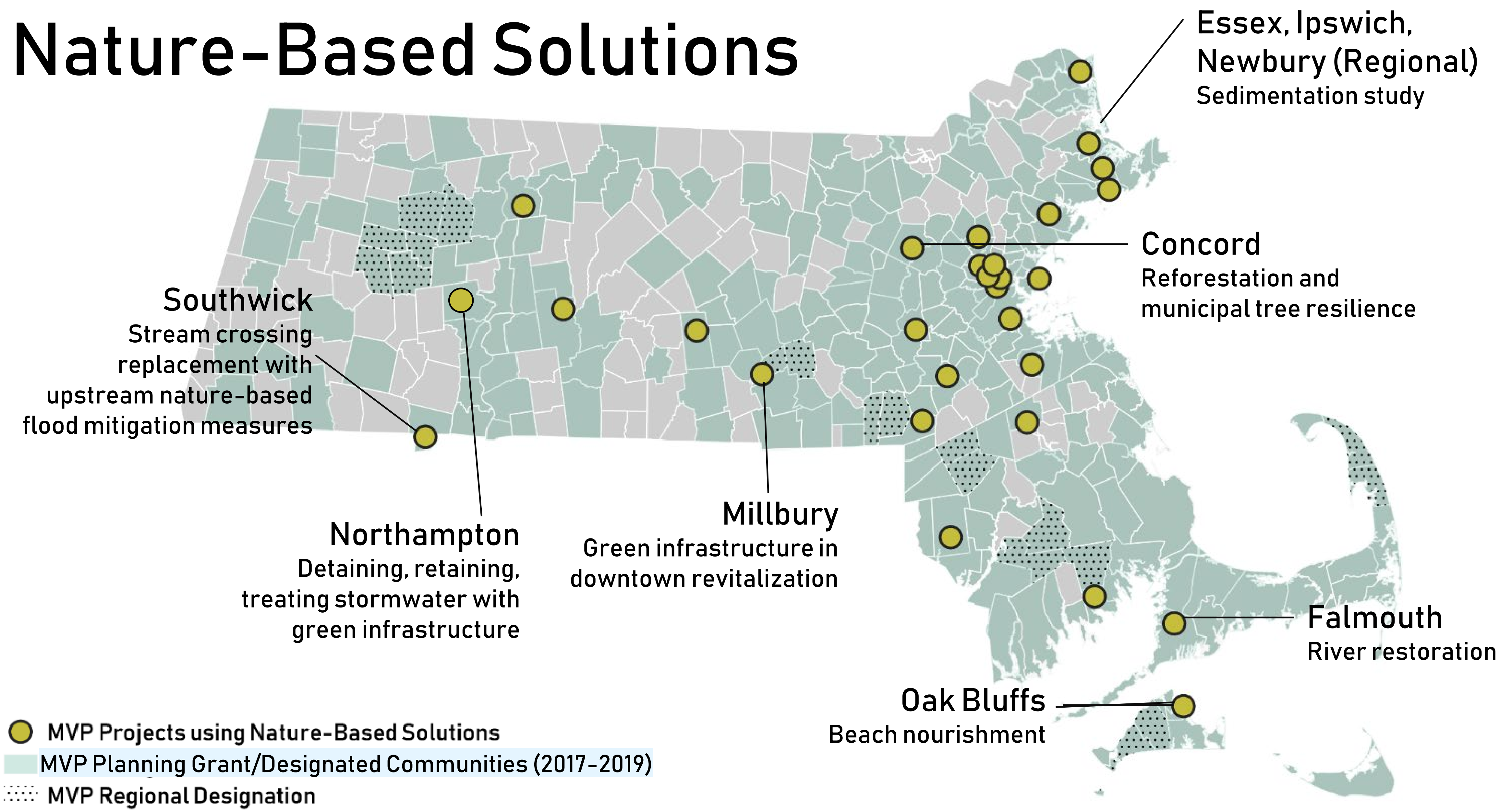
Total Awards
$17M+ in planning and action grants to date



MVP Action Grants: Project Types

- Vulnerability and Risk Assessment
- Community Outreach and Education
- Local Bylaws, Ordinances, Plans, and Other Management Measures
- Redesigns and Retrofits
- Nature-Based Flood Protection, Drought Mitigation, Water Quality, and Water Infiltration Techniques
- Nature-Based, Infrastructure and Technology Solutions to Reduce Vulnerability to Extreme Heat and Poor Air Quality
- Nature-Based Solutions to Reduce Vulnerability to other Climate Change Impacts
- Ecological Restoration and Habitat Management to Increase Resiliency
- Energy Resilience
- Chemical Safety
- Land Acquisition for Resilience
- Subsidized Low-Income Housing Resilience Strategies
- Mosquito Control Districts

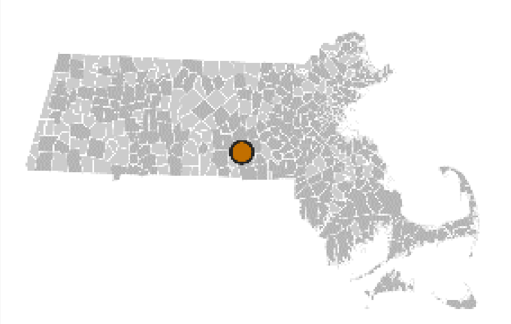
Nature-Based Solutions



Example Action Grant Projects

Nature-Based Flood Protection, Drought Prevention, Water Quality, and Water Infiltration Techniques

Millbury



Utilizing green infrastructure like stormwater planters, bioretention bump outs, rain gardens, and other measures like porous pavers and pervious pavement to reduce heat island effects and stormwater runoff into the Blackstone River.

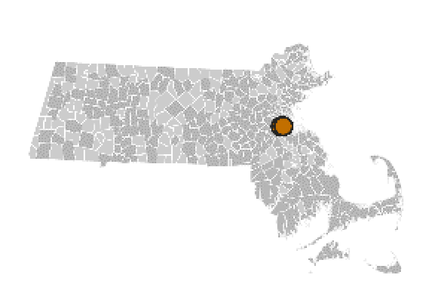
Nature-based solutions

Example Action Grant Projects

Local Bylaws, Ordinances, Plans, and Other Management Measures

Redesigns and Retrofits

Boston



Developing its first ever resilient building code so that development in the future floodplain is prepared for at least three feet of sea level rise, the likely scenario by late century.

Retrofitting a major waterfront park into a legacy park that uses nature-based solutions to address climate vulnerabilities while providing important access to recreation for residents.

Proactive

Pilot potential

Community co-benefits

Nature-based solutions

Example Action Grant Projects

Detailed Vulnerability and Risk Assessment, Further Planning

Holyoke

Conducted a detailed demographic analysis of individuals who arrived in Holyoke from Puerto Rico as a result of Hurricane Maria and develop recommendations for planning for future climate change migrants in Holyoke

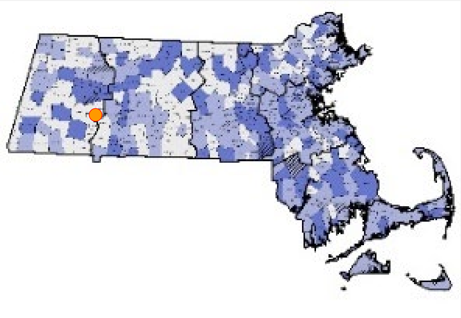
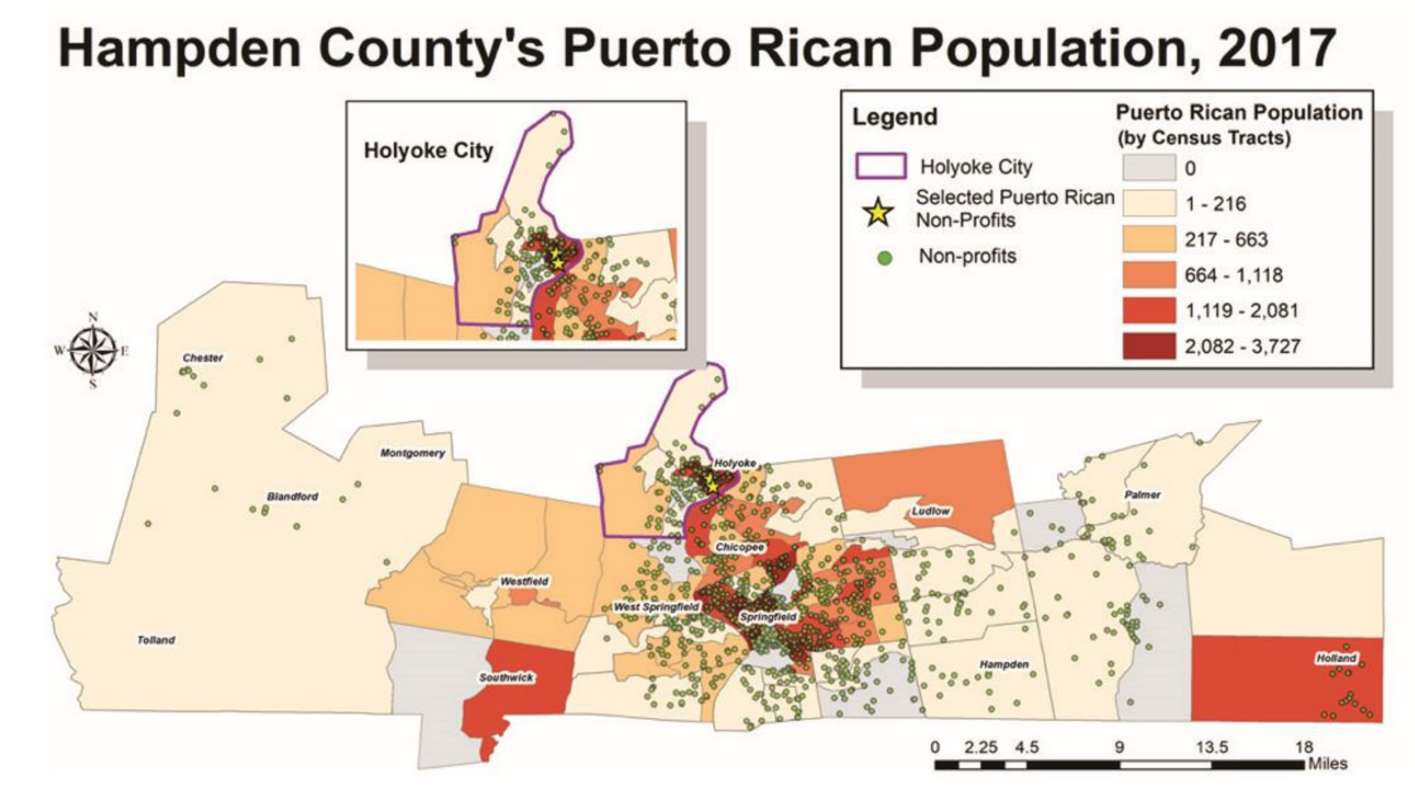


Table 12

How did the Holyoke municipal government respond to your needs? Was the response...	Freq.	Percent
Helpful	26	63.4
I don't know	7	17.1
Neither helpful nor unhelpful	2	4.9
There was no response from this resource	6	14.6
Total	**41**	**100**



Informational graphics from Holyoke's final report

Image credits: Town of Holyoke, Hunter College CUNY, El Instituto UCONN

carolyn.meklenburg@mass.gov
https://www.mass.gov/municipal-vulnerability-preparedness-program

Massachusetts Executive Office of Energy & Environmental Affairs (EOEEA)	Overlap	United States Federal Emergency Management Agency (FEMA)
Municipal Vulnerability Preparedness (MVP)		**Hazard Mitigation Planning (HMP)**
core team	municipal leadership	planning committee
	regional collaboration	
listening session	community engagement	public input events
	review existing information	
climate change hazards and projections	hazard impacts and vulnerability	natural hazards and in-depth hazard profile
opportunities to improve	existing policies/programs	document existing
risk matrix	identify strengths, vulnerabilities, and potential actions	background research
prioritize climate adaptation actions		implementation plan for hazard mitigation
summary of findings	report	hazard mitigation plan
state action grants	grant funding	federal grants

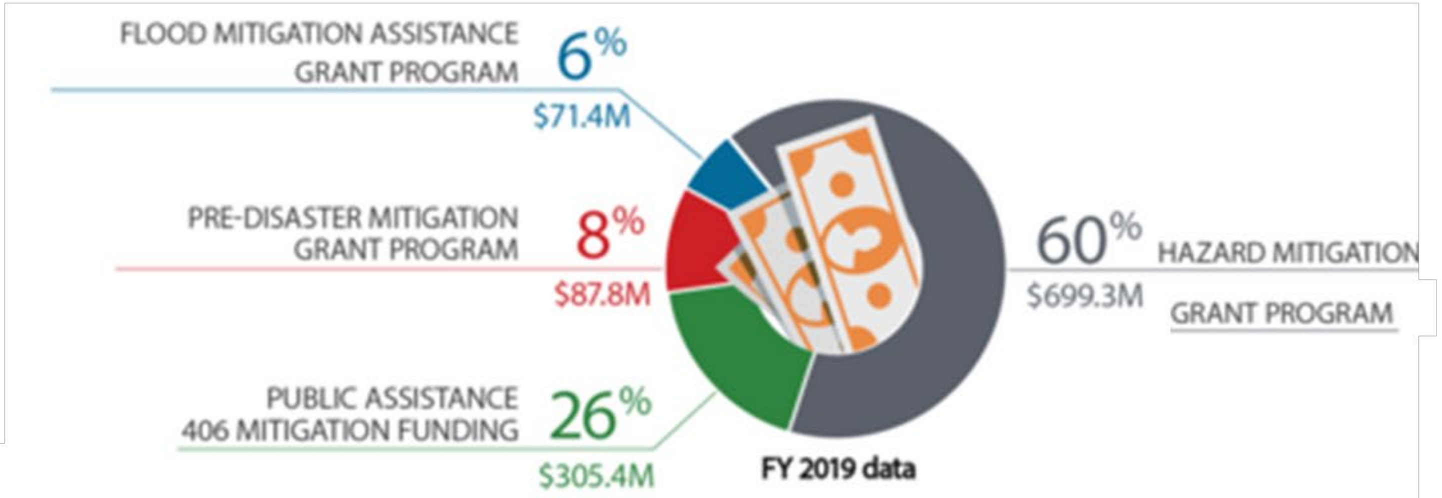
MVP:

- community resilience building workshop
- abbreviated time frame
- less competitive grants

HMP:

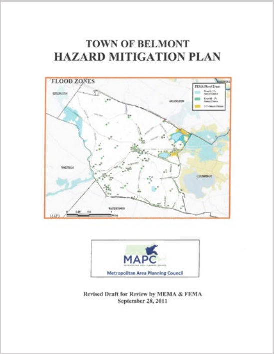
- provide updates on development changes
- document NFIP participation and compliance
- define the future update process
- address repetitively damaged structures
- document formal plan adoption

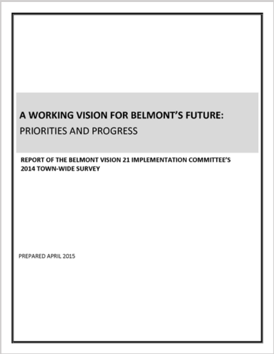
Weston & Sampson

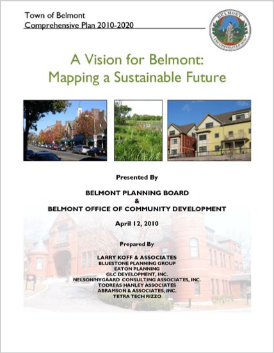


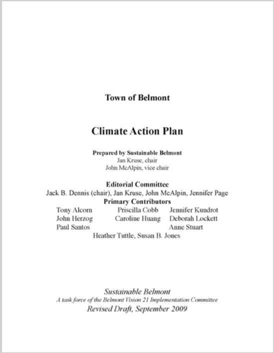
In FY 2019 more than $1.16B

DATA RESOURCES









In Belmont and Massachusetts

Massachusetts Climate Change Projections (NECSC, 2018)

Town of Belmont Hazard Mitigation Plan, 2011

A Working Vision for Belmont's Future: Priorities and Progress, 2015

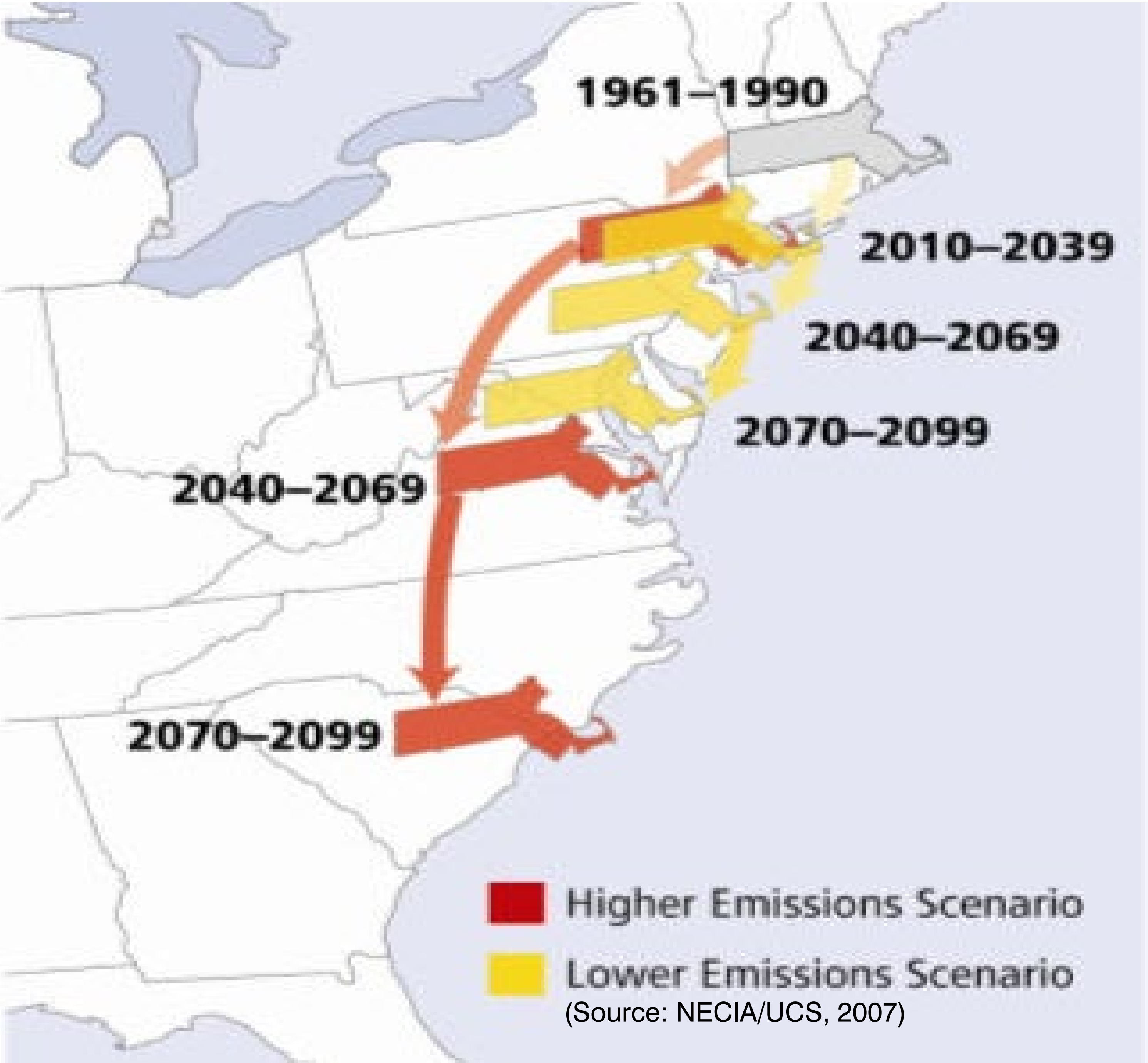
Massachusetts Climate Change Adaptation Report (MA EEA, 2011)

A Vision for Belmont: Mapping a Sustainable Future, 2010

Rock Meadow: A Conservation Master Plan, 2018

Input from Municipal Officials

Town of Belmont Climate Action Plan, 2009



(Source: NECIA/UCS, 2007)

EXTREME TEMPERATURES

WARMER ANNUAL AIR TEMPERATURES

UP 0.5°F PER DECADE SINCE 1970, ON AVERAGE

WARMER WINTERS

UP 1.3°F PER DECADE SINCE 1970, ON AVERAGE

Source: ResilientMA.org, "Rising Temperatures," 2017

EXTREME TEMPERATURES
IN MASSACHUSETTS

6	24	35
2005 OBSERVED ANNUAL AVERAGE	**MID-CENTURY** PROJECTED ANNUAL AVERAGE	**END-OF-CENTURY** PROJECTED ANNUAL AVERAGE

DAYS WITH TEMPERATURES ABOVE 90°F

145	114	101
2005 OBSERVED ANNUAL AVERAGE	**MID-CENTURY** PROJECTED ANNUAL AVERAGE	**END-OF-CENTURY** PROJECTED ANNUAL AVERAGE

DAYS WITH TEMPERATURES BELOW 32°F

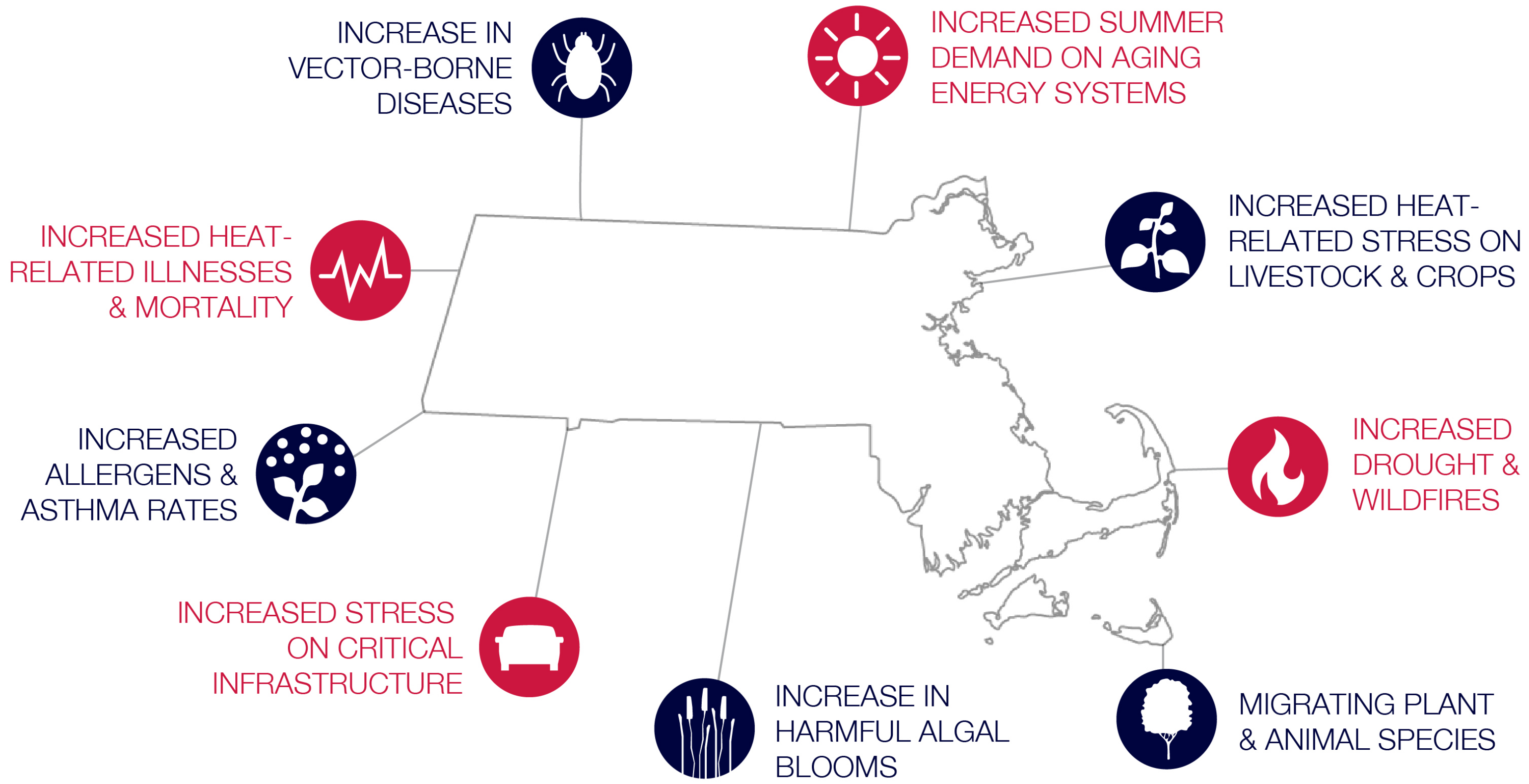
Massachusetts Executive Office of Energy & Environmental Affairs. 2019. “ResilientMA Datagrapher.” Massachusetts Climate Change Clearinghouse. Resilientma.org/datagrapher/?c=Temp/state/tx90/ANN/MA/
Notes: Mid-century projected annual averages use a 2040-2069 time range. End-of-century project annual averages use a 2080-2097 time range.

Weston & Sampson

IMPACTS OF **RISING TEMPERATURES**

WARMER ANNUAL AIR TEMPERATURES
UP 0.5°F PER DECADE SINCE 1970, ON AVERAGE

WARMER WINTERS
UP 1.3°F PER DECADE SINCE 1970, ON AVERAGE



Massachusetts Executive Office of Energy & Environmental Affairs. 2019. "Rising Temperatures." Massachusetts Climate Change Clearinghouse. http://www.resilientma.org/changes/rising-temperatures

http://belmontonian.com/news/with-heat-wave-coming-belmont-light-asks-customers-to-cut-energy-use/
https://patch.com/massachusetts/belmont/how-to-beat-this-heat-wave

With Heat Wave Coming, Belmont Light Asks Customers To Cut Energy Use

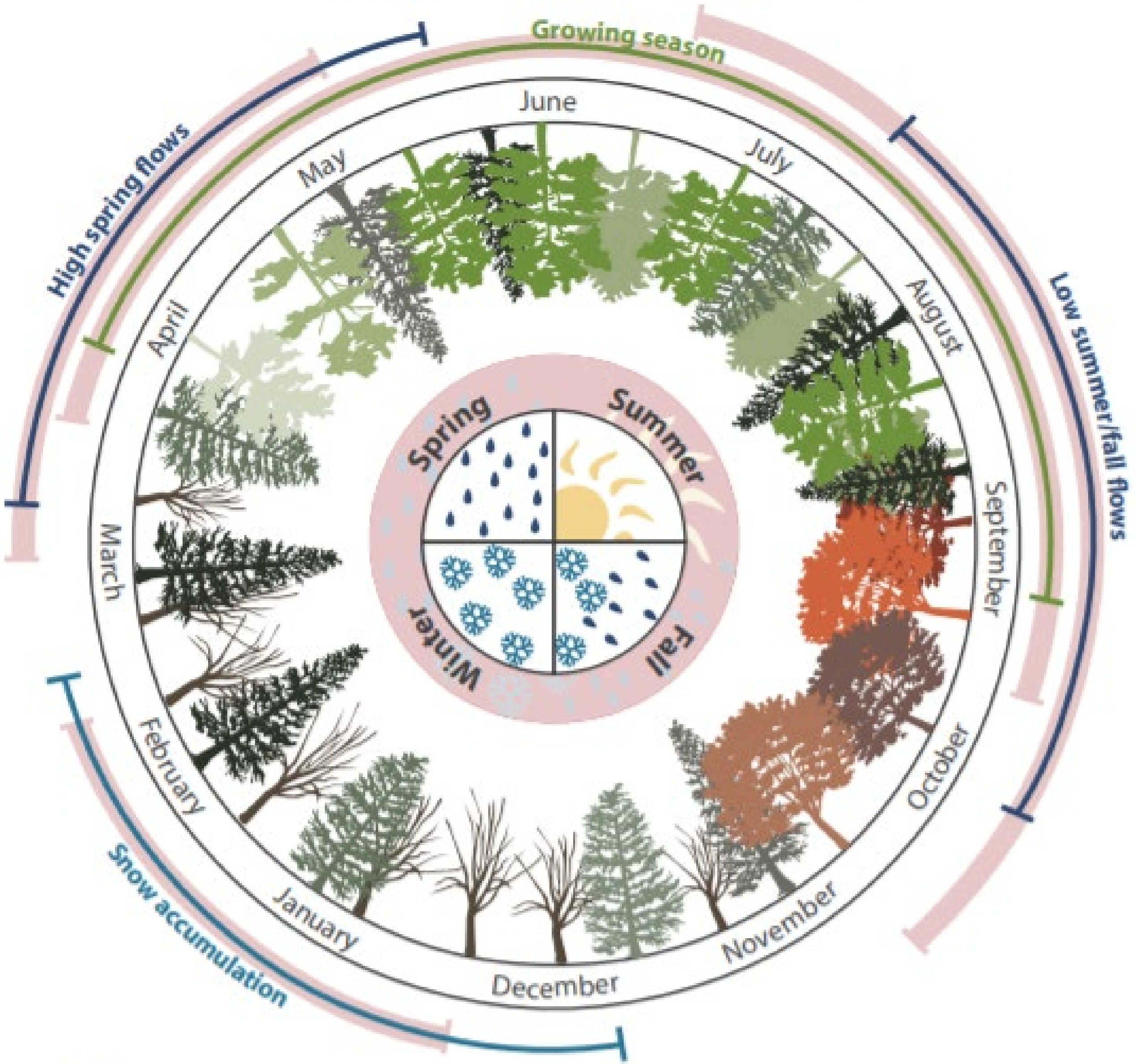
JULY 17, 2019 BY FRANKLIN B. TUCKER — LEAVE A COMMENT

How To Beat This Heat Wave

Belmont Studio Cinema and the public library are opened and air-conditioned.

By Franklin Tucker, Patch Staff
Jul 5, 2013 5:41 am ET

Northeast and Midwest seasonal patterns



Shifted season projected from increasing temperatures and precipitation changes

Image credit: Northeast Climate Science Center, University of Maryland Center for Environmental Science

CHANGES IN **PRECIPITATION**

MORE **INTENSE & FREQUENT** EXTREME RAIN EVENTS

PRECIPITATION DURING **HEAVY EVENTS** IN THE NORTHEAST

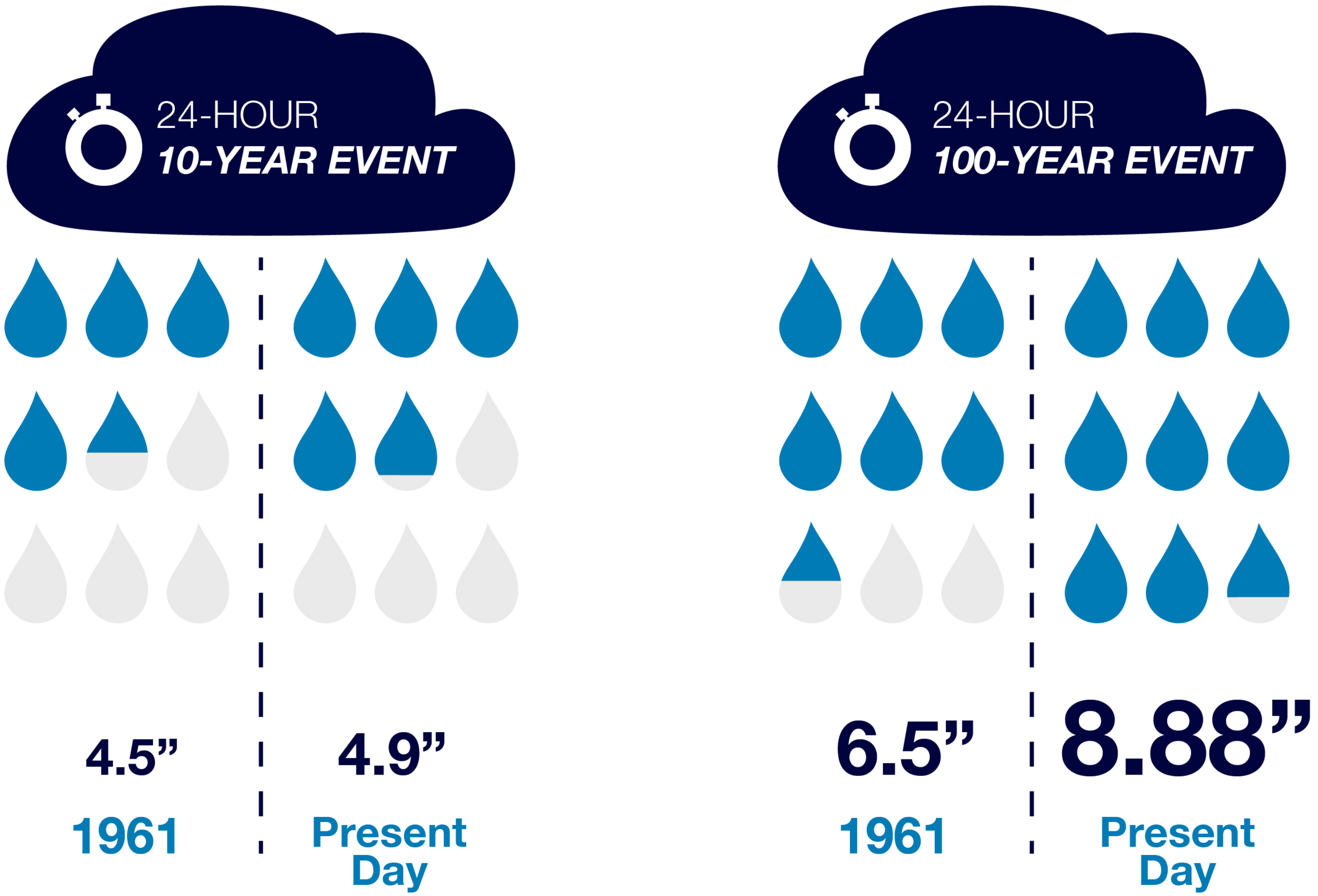
INCREASED BY MORE THAN

70%

BETWEEN 1958-2010

Massachusetts Executive Office of Energy & Environmental Affairs. 2019. “Changes in Precipitation.” Massachusetts Climate Change Clearinghouse. Resilientma.org/changes/changes-in-precipitation

CHANGES IN **PRECIPITATION**



1961 Data: NOAA TP-40
Present Day Data: Cornell University Northeast Regional Climate Center (NRCC) and Natural Resource Conservation Services (NRCS). Extreme Precipitation in New York and New England: Precipitation Frequency Duration Graphs. 1 hr- 24hr (100 yr and 500 yr reoccurrence). http://precip.eas.cornell.edu/

EXTREME PRECIPITATION

8%

Increase in extreme precipitation events by midcentury

13%

Increase in extreme precipitation events by 2100

Source: Executive Office of Energy and Environmental Affairs, Adaptation Advisory Committee. 2011. “Massachusetts Climate Change Adaptation Report,” 19.

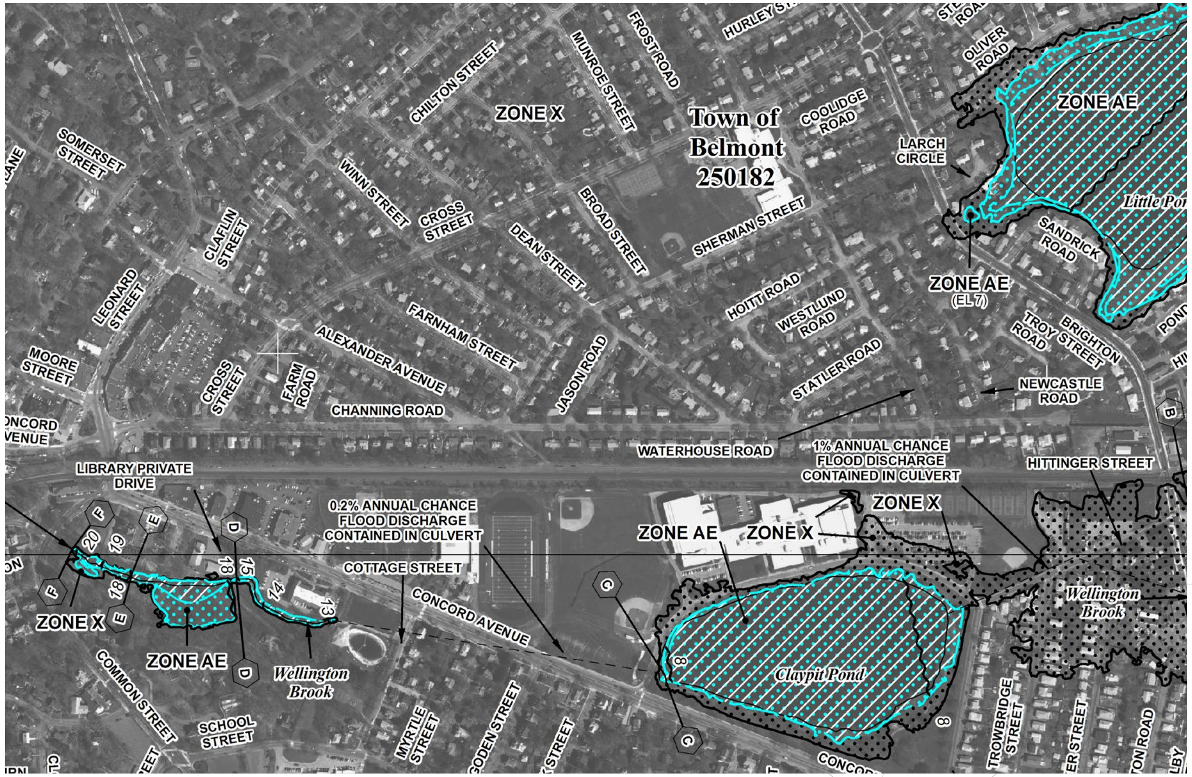
FLOODING

ZONE	ANNUAL CHANCE	FLOODPLAIN
A, AE, A1-A30	1% ANNUAL CHANCE	100-YEAR FLOODPLAIN
X	0.2% ANNUAL CHANCE	500-YEAR FLOODPLAIN

"By 2050, Boston could experience the current 100- year riverine flood every two to three years on average"

Source: Executive Office of Energy and Environmental Affairs, Adaptation Advisory Committee. 2011. "Massachusetts Climate Change Adaptation Report," 19.

RIVERINE FLOODING



Above: a portion of the FEMA Flood Insurance Rate Map (FIRM) for Belmont

LOCALLY IDENTIFIED AREAS OF FLOODING[2]

Trapelo Road @ Mill Rd.

Claypit Pond

Acorn Park Road—addressed!

REPETITIVE FLOOD LOSS STRUCTURES

1

repetitive loss structure

Defined as an NFIP-insured structure that has had at least 2 paid flood losses of more than $1,000 each in any 10-year period since 1978[1]

1. Federal Emergency Management Agency (FEMA). 2019. "Definitions." Accessed August 29, 2019. Fema.gov/national-flood-insurance-program/definitions#R
2. Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 14.

STORMWATER FLOODING

New walkway and drainage improvements near the Belmond Center Commuter Rail on Concord Ave. Photo credit: Town of Belmont, 2018, via Twitter.

Areas with:

- Poor drainage
- High amounts of impervious surface
- Undersized culverts

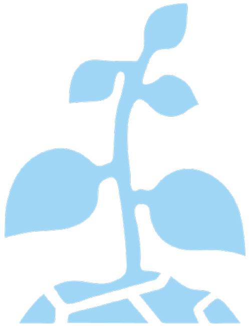
EROSION

- Caused by riverine flow & stormwater[1]
- Increased precipitation, including winter rains, could increase erosion[1]
- Drier soils will reduce resistance to erosion
- The 2018 Rock Meadow Conservation Master Plan identified three actions to reduce erosion:[2]
  - Redesign main parking lot
  - Support trails with a crushed gravel overlay
  - Allow “invasive” species to grow where appropriate

1. Executive Office of Energy and Environmental Affairs, Adaptation Advisory Committee. 2011. “Massachusetts Climate Change Adaptation Report,” 42.
2. Freedman, Sam and Taurean Gagnon. 2018. “Rock Meadow: A Conservation Master Plan for the Town of Belmont, Massachusetts.” The Conway School.

2016

The most notable recent drought event was in



The occurrence of droughts **lasting 1 to 3 months** could go up by as much as **75% over existing conditions** by the end of the century, under the high emissions scenario

Source: Executive Office of Energy and Environmental Affairs, Adaptation Advisory Committee. 2011. “Massachusetts Climate Change Adaptation Report,” 17.

BRUSH FIRE

Belmont Fire Fighters Local 1637 battle a vehicle fire started by mechanical issues. Photo by the Belmont Police, 2018, via Twitter.

- 12+ brush fires can occur in Belmont each year
- Brush fires are relatively frequent in the western part of Town.
- The areas with the highest incidences include:
  - Mclean Open Space
  - Beaver Brook Reservation
  - Belmont Hill
  - Rock Meadow

Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 15.

WINTER STORMS

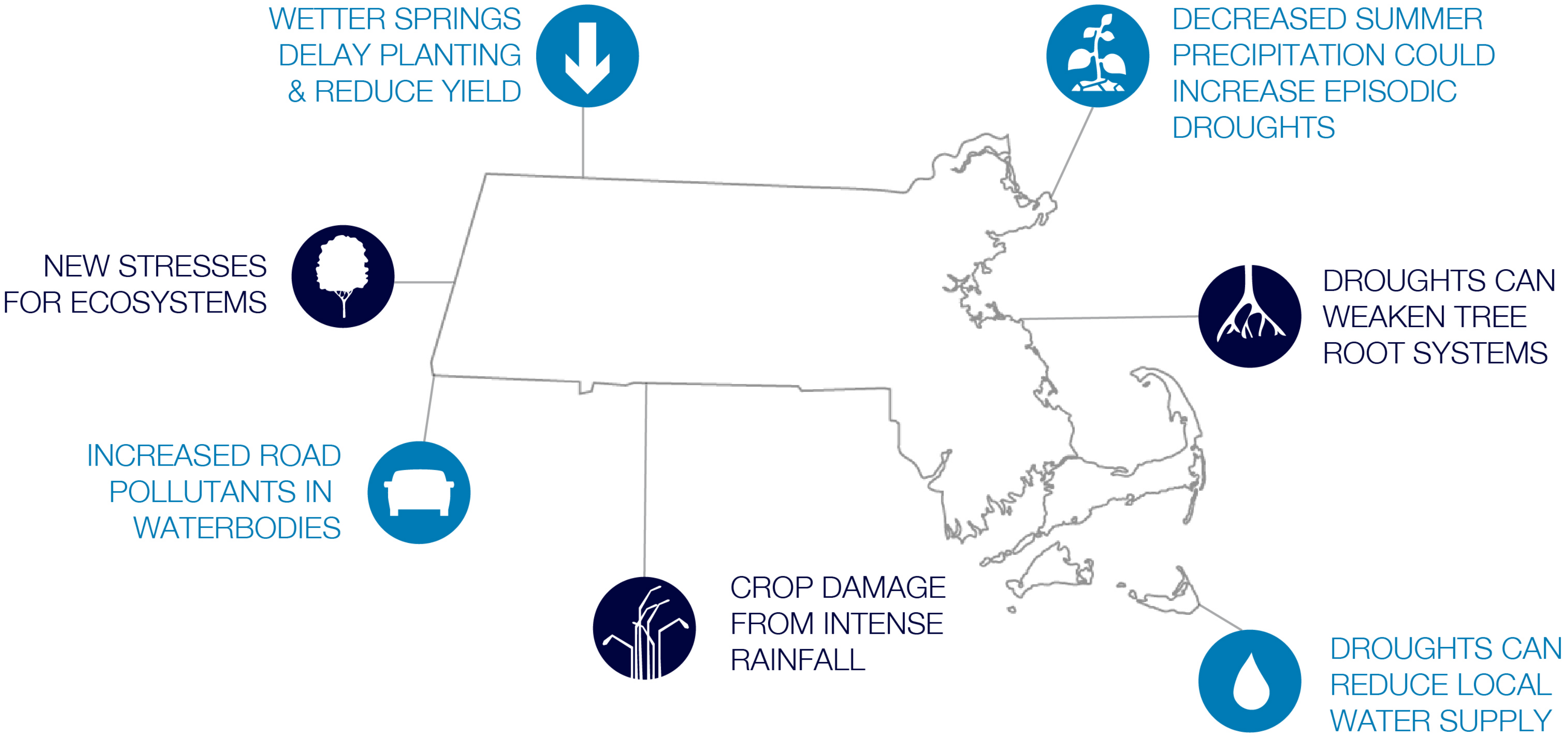
- The blizzard of 2013 left nearly **400,000 Massachusetts residents without power**[1]
- “Heavy blizzards are among the **most costly and disruptive** weather events for Massachusetts communities.”[1]
- 4 nor’easters in 2018 took out **85 trees**

1: Resilient MA Climate Change Clearinghouse for the Commonwealth. “Extreme Weather,” 2017.
2. Metropolitan Area Planning Council (MAPC). 2011. “Town of Belmont Hazard Mitigation Plan,” 15.

IMPACTS OF CHANGING **PRECIPITATION**

HIGHER AVERAGE ANNUAL PRECIPITATION

INCREASED BY ABOUT 10% IN THE NORTHEAST INTHE LAST 50 YEARS



Massachusetts Executive Office of Energy & Environmental Affairs. 2019. “Changes in Precipitation.” Massachusetts Climate Change Clearinghouse. http://www.resilientma.org/changes/changes-in-precipitation

HURRICANES AND EXTREME WIND

HURRICANE

Sandy

was the most recent hurricane

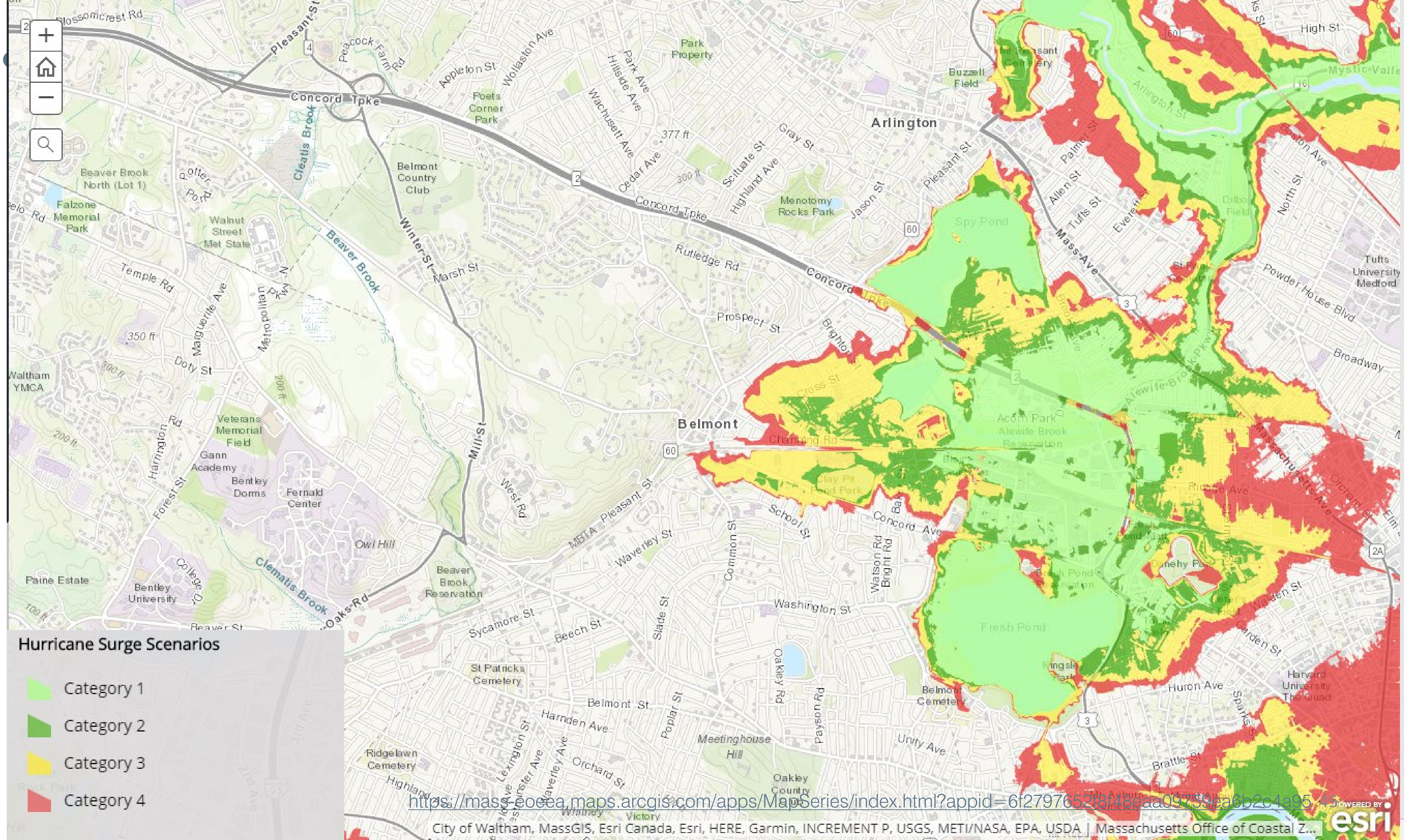
Upward trend in North Atlantic **hurricane** activity since 1970

Nor'easters along the Atlantic coast are increasing in frequency and intensity

MEMA WEATHER ADVSORY: Fourth March nor'easter expected to bring heavy snow, high winds and more coastal flooding

Posted Mar 20, 2018 at 12:34 PM
Updated Mar 20, 2018 at 12:56 PM

Source: Climate Science Special Report, Fourth National Climate Assessment (NCA4), Volume prepared by the U.S. Global Change Research Program (USGCRP)
Article: https://belmont.wickedlocal.com/news/20180320/mema-weather-advsory-fourth-march-noreaster-expected-to-bring-heavy-snow-high-winds-and-more-coastal-flooding



https://mass-eoeea.maps.arcgis.com/apps/MapSeries/index.html?appid=6f2797652f8f48eaa09759ea6b2c4a95

BOSTON SEA LEVEL RISE PROJECTIONS (ft)

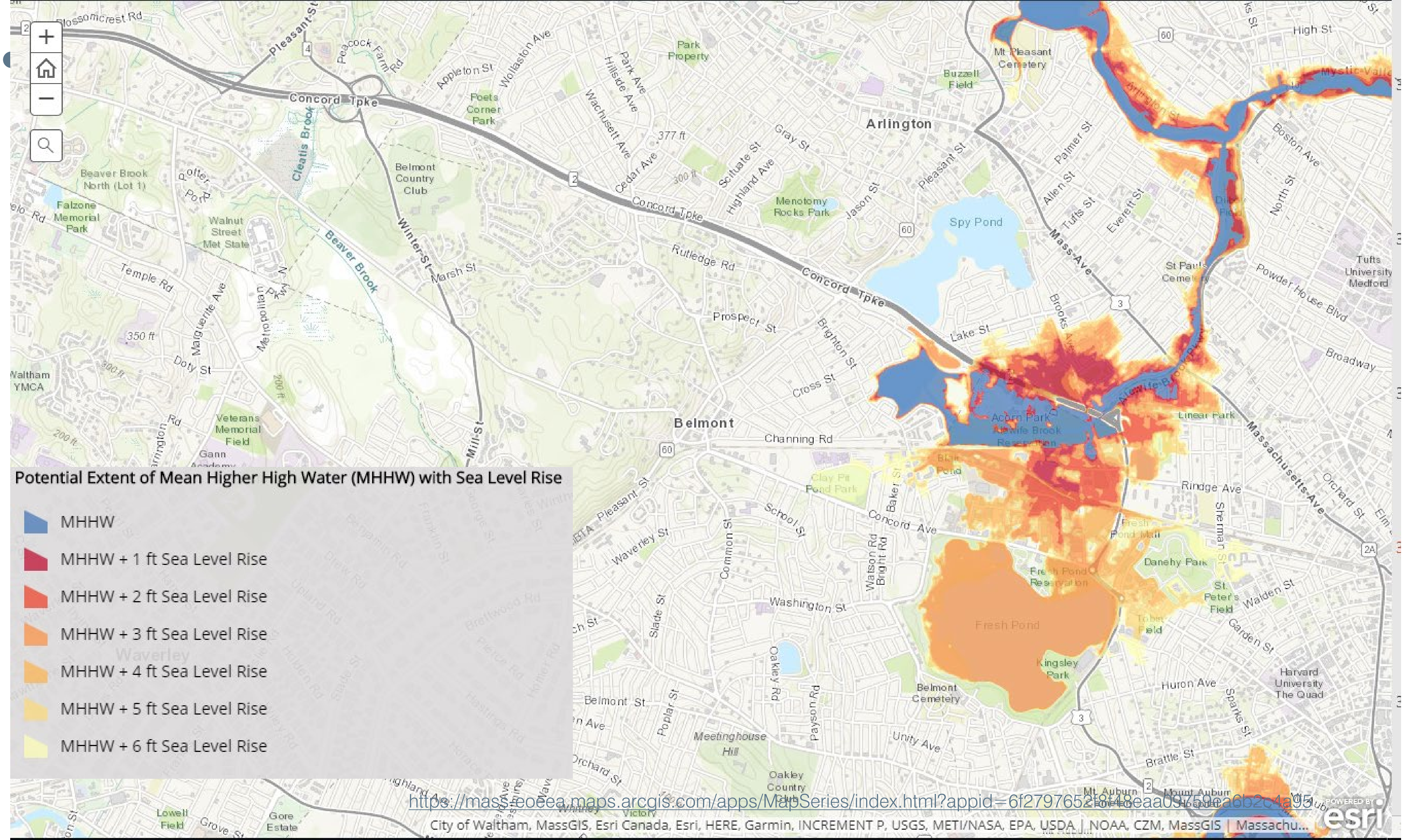
Increased coastal flooding

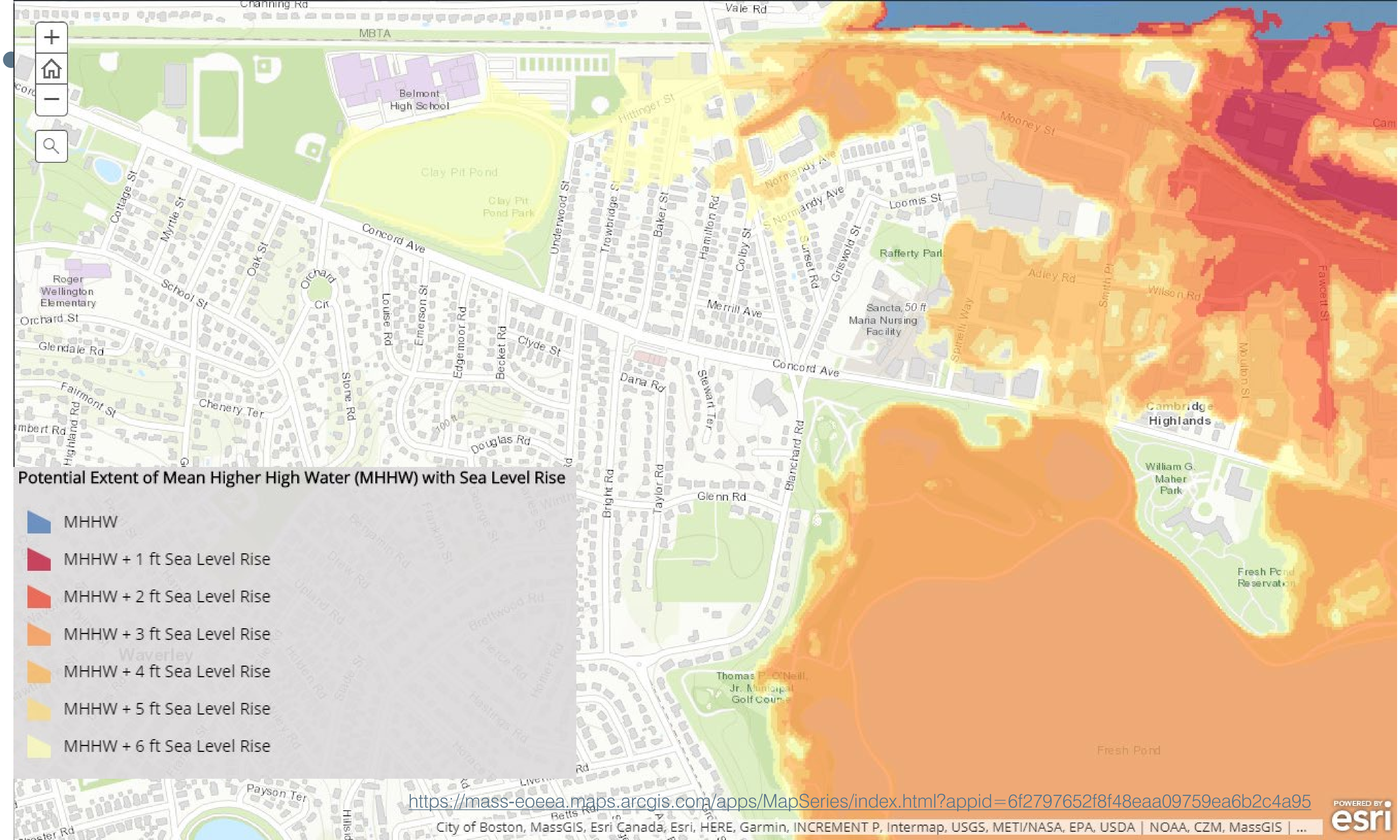
Permanently inundated low-lying coastal areas

Increased shoreline erosion

Emission Scenario	2030	2050	2070	2100
Intermediate	0.7	1.4	2.3	4.0
Intermediate-High	0.8	1.7	2.9	5.0
High	1.2	2.4	4.2	7.6
Extreme	1.4	3.1	5.4	10.2

(Source: Northeast Climate Adaption Science Center)

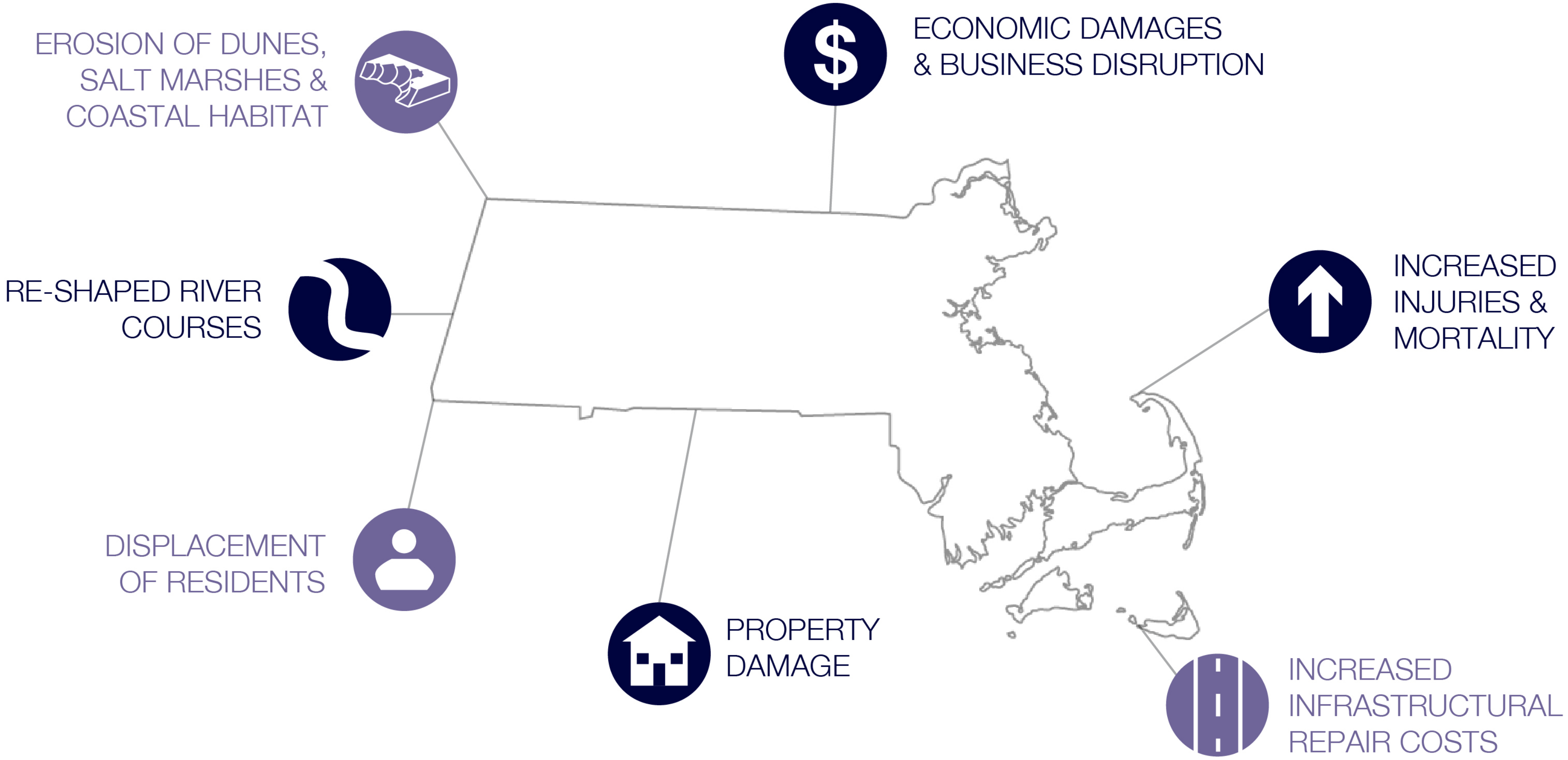

Potential Extent of Mean Higher High Water (MHHW) with Sea Level Rise
MHHW
MHHW + 1 ft Sea Level Rise
MHHW + 2 ft Sea Level Rise
MHHW + 3 ft Sea Level Rise
MHHW + 4 ft Sea Level Rise
MHHW + 5 ft Sea Level Rise
MHHW + 6 ft Sea Level Rise
Arlington
Belmont
Spy Pond
Fresh Pond
Concord Tpke
https://mass-eoeea.maps.arcgis.com/apps/MapSeries/index.html?appid=6f279765
City of Waltham, MassGIS, Esri Canada, Esri, HERE, Garmin, INCREMENT P, USGS, METI/NASA, EPA, USDA | NOAA, CZM, MassGIS | Massachu...


Potential Extent of Mean Higher High Water (MHHW) with Sea Level Rise
MHHW
MHHW + 1 ft Sea Level Rise
MHHW + 2 ft Sea Level Rise
MHHW + 3 ft Sea Level Rise
MHHW + 4 ft Sea Level Rise
MHHW + 5 ft Sea Level Rise
MHHW + 6 ft Sea Level Rise
MBTA
Belmont High School
Clay Pit Pond
Clay Pit Pond Park
Concord Ave
Roger Wellington Elementary
Orchard St
Glendale Rd
School St
Cottage St
Myrtle St
Oak St
Orchard Cir
Louise Rd
Emerson St
Edgemoor Rd
Becket Rd
Clyde St
Fairmont St
Chenery Ter
Stone Rd
Douglas Rd
Underwood St
Trowbridge St
Baker St
Hamilton Rd
Colby St
Sunset Rd
Griswold St
Normandy Ave
Hittinger St
Mooney St
Loomis St
Rafferty Park
Adley Rd
Wilson Rd
Fawcett St
Merrill Ave
Sancta Maria Nursing Facility
Dana Rd
Stewart Ter
Blanchard Rd
Glenn Rd
Bright Rd
Taylor Rd
Cambridge Highlands
William G. Maher Park
Fresh Pond Reservation
Fresh Pond
Thomas P. O'Neill, Jr. Municipal Golf Course
Payson Ter
Waverley
Vale Rd
Channing Rd
https://mass-eoeea.maps.arcgis.com/apps/MapSeries/index.html?appid=6f2797652f8f48eaa09759ea6b2c4a95
City of Boston, MassGIS, Esri Canada, Esri, HERE, Garmin, INCREMENT P, Intermap, USGS, METI/NASA, EPA, USDA | NOAA, CZM, MassGIS | ...
POWERED BY esri

Weston & Sampson

IMPACTS OF **EXTREME WEATHER**

STORMS ARE BECOMING MORE INTENSE AND DAMAGING



Massachusetts Executive Office of Energy & Environmental Affairs. 2019. “Extreme Weather.” Massachusetts Climate Change Clearinghouse. http://www.resilientma.org/changes/extreme-weather

RISK MATRIX

Photo: Downed tree and power line at School Street and Bow Road. Photo by Belmont Light, 2019, via Twitter.

RISK MATRIX

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.com

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S					Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Societal									
Environmental									

IDENTIFY HAZARDS

Photo: Downed tree and power line on Hurd Road. Photo by Belmont Light, 2018, via Twitter.

RISK MATRIX: HAZARDS

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.com

H-M-L priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or					Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Societal									
Environmental									

HAZARDS IN BELMONT

CHOOSE 4 FOR THE MVP ACTION PLAN

- Extreme Temperatures
- Extreme Precipitation and Flooding
- Winter Storms
- Hurricanes, Sea Level Rise
- Tornadoes
- Severe Storms, Wind
- Drought
- Brush Fires

Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 11.

RISK MATRIX: FEATURES

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.com

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

				Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)				**Priority**	**Time**
Features	**Location**	**Ownership**	**V or S**					**H** - **M** - **L**	**S**hort **L**ong **O**ngoing
Infrastructural									
Societal									
Environmental									

RISK MATRIX: FEATURES

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Features	Location	Ownership	V or S
Infrastructural			
Societal			
Environmental			

RISK MATRIX: FEATURES

FEATURES	LOCATION	OWNERSHIP	VULNERABILITY OR STRENGTH
Infrastructural	Town wide	State	Vulnerability
Societal	Multi- vs. Single-neighborhood	Town	Strength
Environmental	Specific location	Private	Both
		Shared	

FEATURES IN BELMONT

Photo: Police station at 40 Woodland Street. Photo by Belmont Police, 2019, via Twitter.

INFRASTRUCTURAL FEATURES

Police Department

Photo by the Belmont Police Department

Fire Department

Photo by the Belmont Police Department

Wastewater Treatment & Collection

Community Centers

Photo by the Belmont Police Department.

Roadways

Photo by the Belmont Police Department

Water Supply

INFRASTRUCTURAL FEATURES

Beech Street Center, used as a cooling center. Photo by the Belmont Police Department.

Critical Infrastructure includes:

- Facilities important for disaster response and evacuation.
  - Emergency operations centers
  - Fire stations
  - Water pump stations
- Facilities where additional assistance might be needed during an emergency.
  - Nursing homes
  - Elderly housing
  - Day care centers

Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 16.

SOCIETAL FEATURES

Population	Belmont	Massachusetts
2010	24,330	6,547,790
2018	26,330	6,902,149
Age		
Under 18 years:	25%	20%
65+ years:	17%	17%
Additional Information		
Median household income:	$118,370	$74,167
Persons in poverty:	6%	10%
With a disability:	4%	8%
Language other than English spoken at home:	29%	23%

Source: U.S. Census Bureau, 2019

ENVIRONMENTAL FEATURES

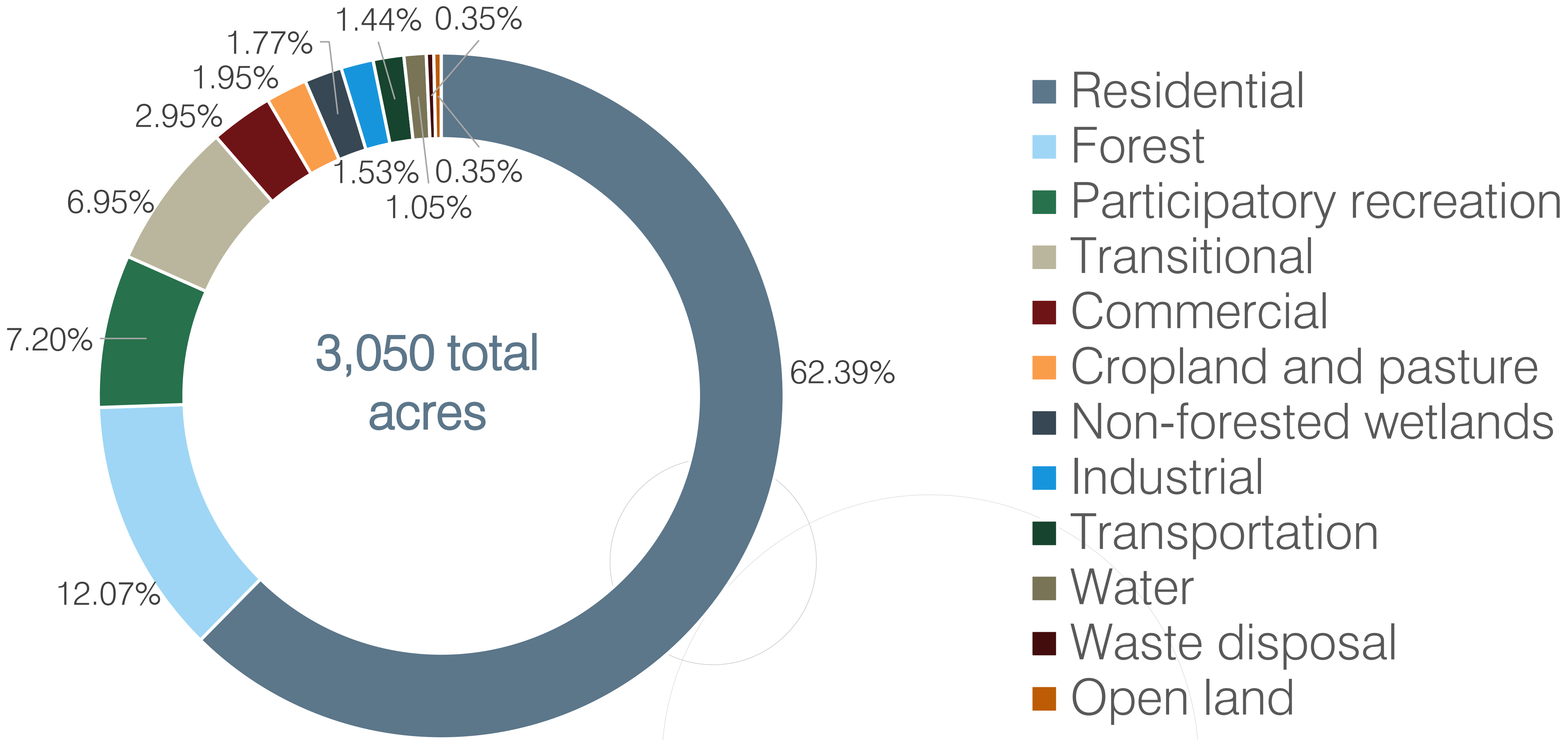
Photo credit: Franklin Tucker, Patch Staff

Belmont's Open Space[1]

- 2/3rd of open space is publicly-accessible
- The largest open space areas are:
  - Beaver Brook Reservation (313 acres)
  - Town Conservation land at McLean (140 acres)
  - Habitat Education Center and Wildlife Sanctuary (88 acres)
  - Rock Meadow Open Space (70 acres)

1. Belmont Planning Board, Belmont Office of Community Development. 2010. "A Vision for Belmont: Mapping a Sustainable Future." 35.

Belmont's Land Use



Weston & Sampson

Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 4.

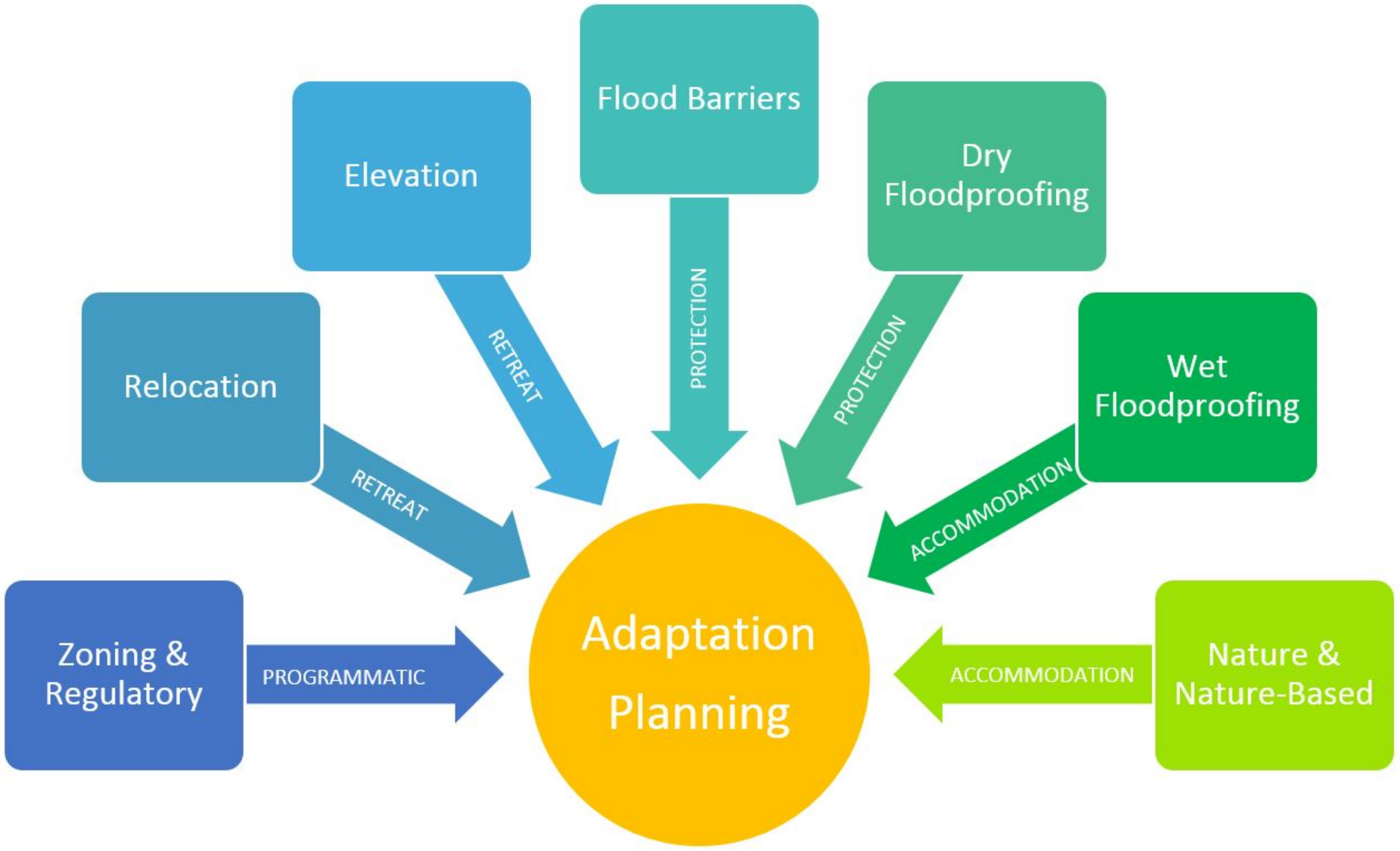
15 MINUTE BREAK!

Photo: "Touch a Truck" at Wellington School. Photo by Belmont EMA, 2019, via Twitter.

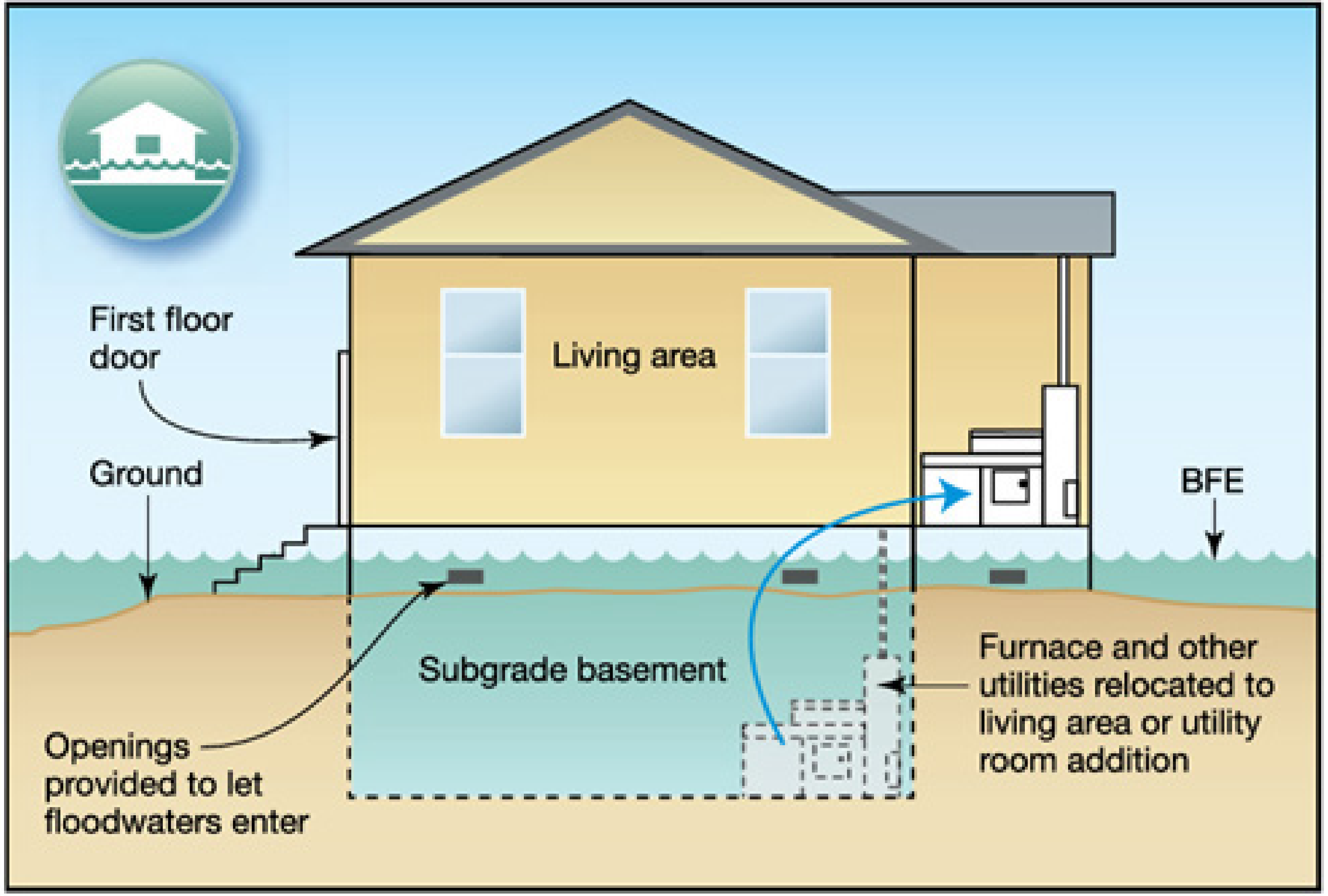
ADAPTATION STRATEGIES

Photo: the LimeBike Bike Share program in Belmont. Photo by the Town of Belmont, 2018, via Twitter.

COMMUNITY ACTIONS

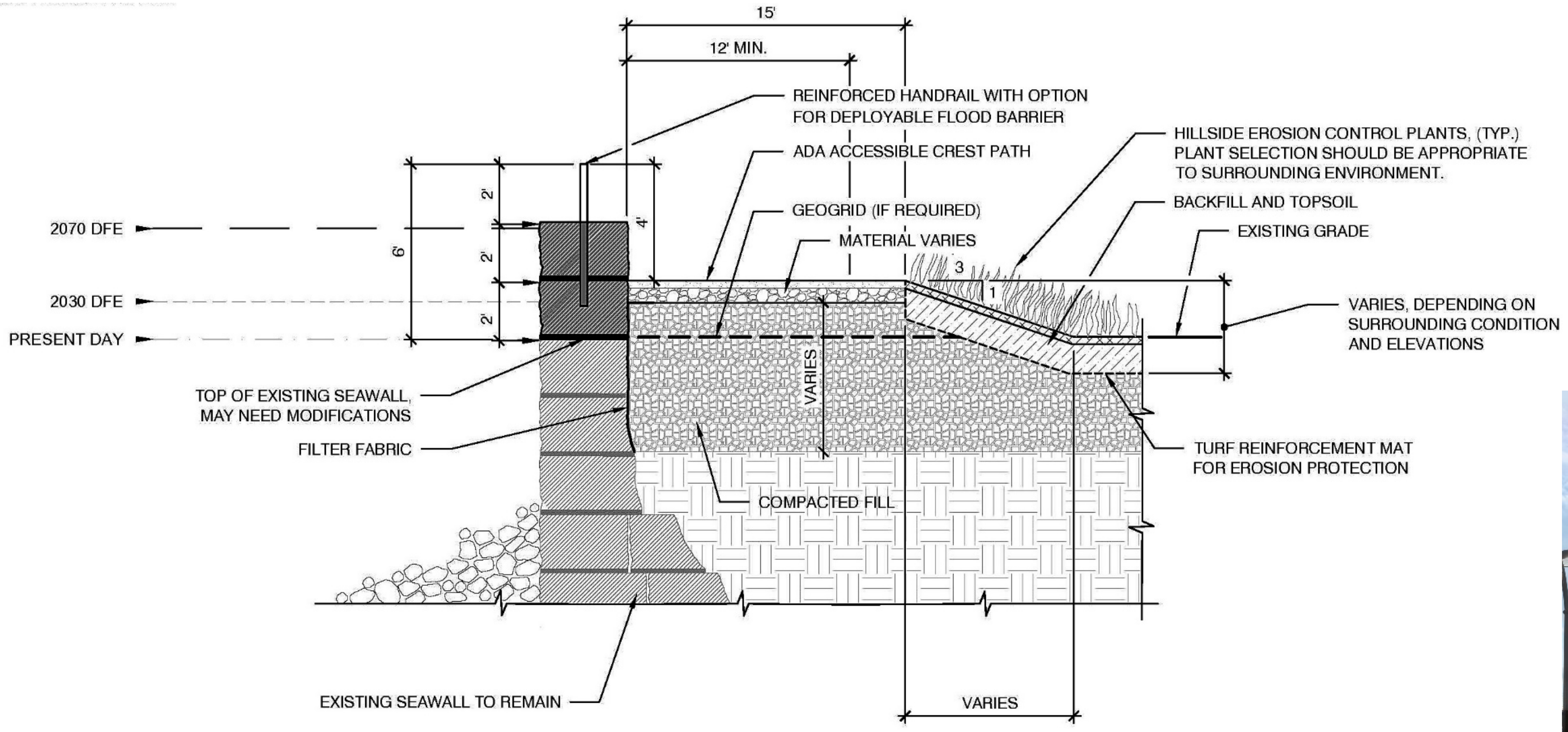


WET FLOODPROOFING

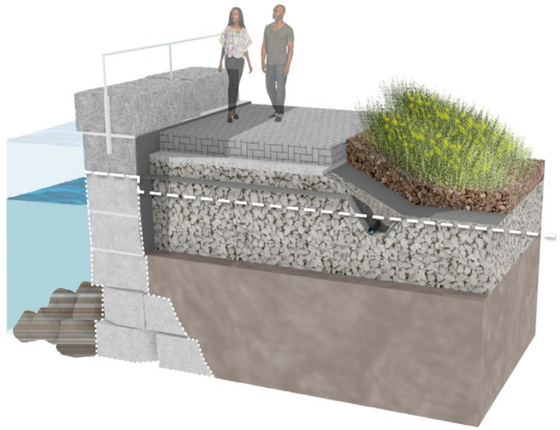


RAISED BUILDINGS

FLOOD WALLS



HARBORWALK BARRIER SEAWALL SAMPLE SECTION



DEPLOYABLE FLOOD BARRIER

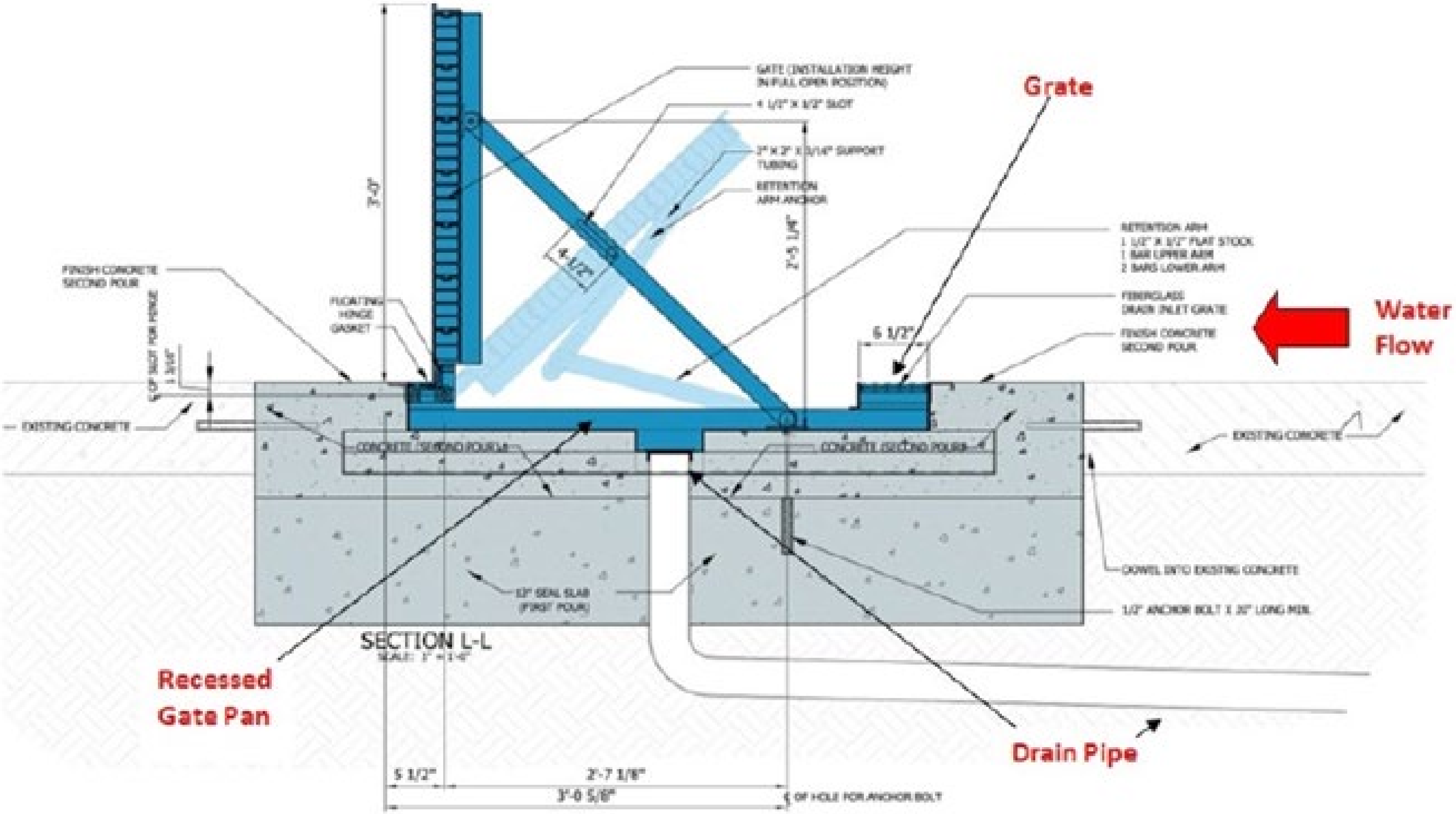
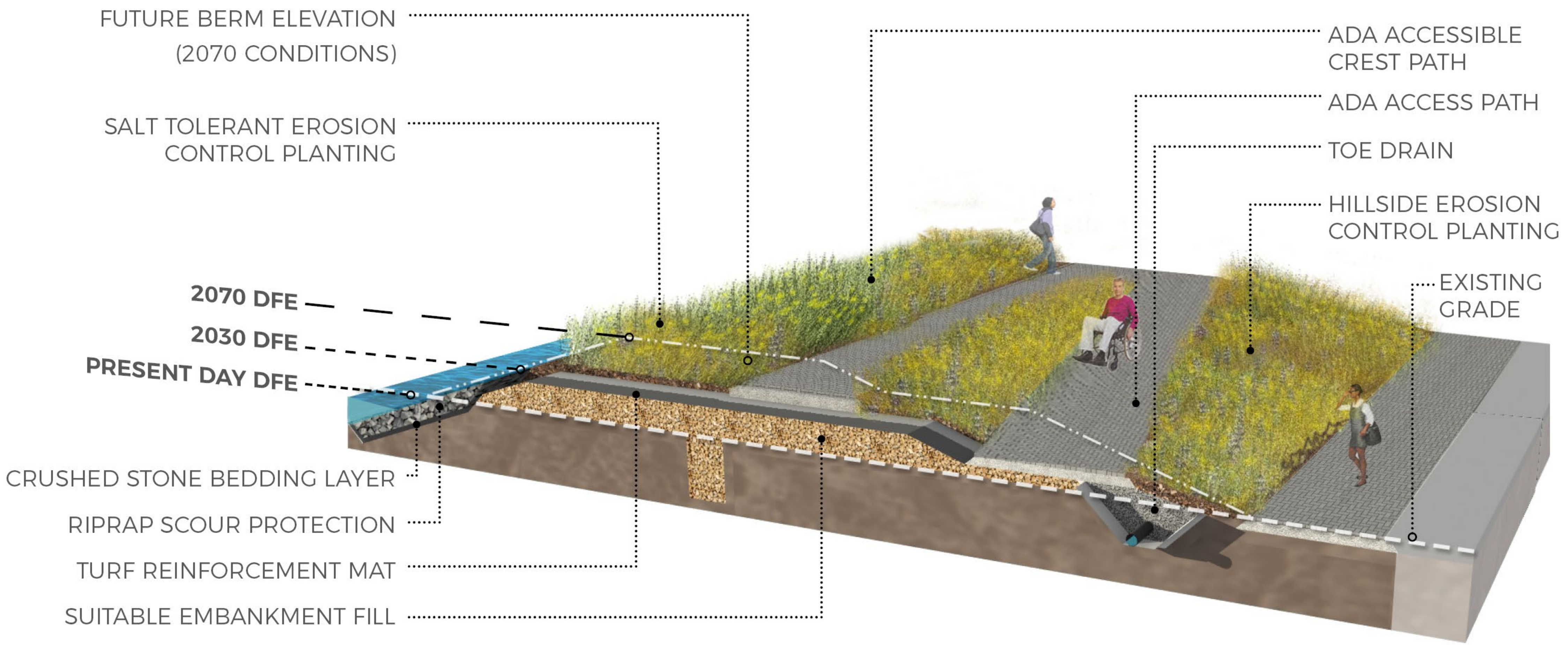


FIGURE 1 | A FloodBreak barrier gate diagram

PREVENTING SEWER BACKFLOW

VEGETATED BERM



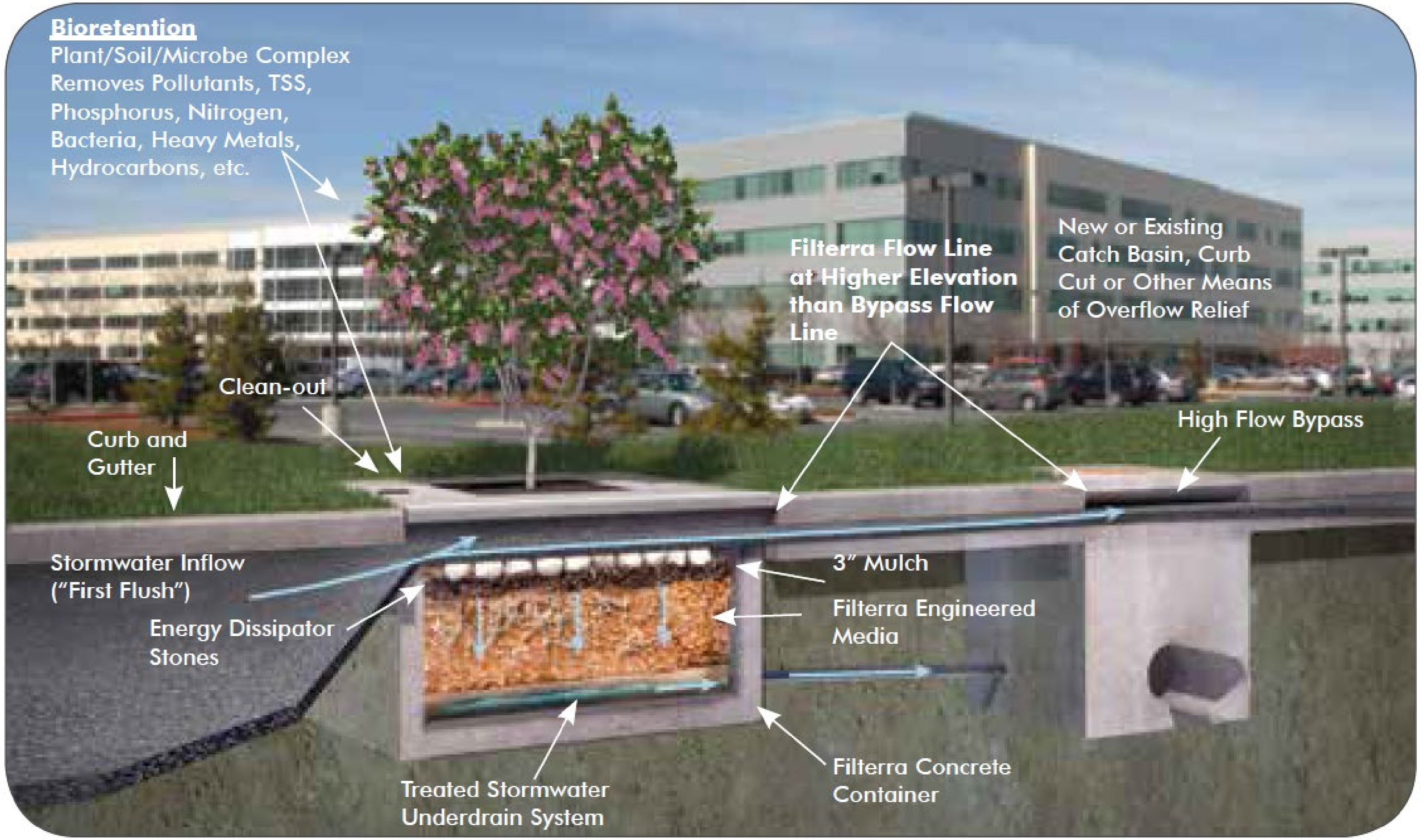
MULTI-PURPOSE FLOOD STORAGE

CLOUDBURST STREETS

LOW IMPACT DEVELOPMENT (LID)

POROUS ASPHALT & PERMEABLE PAVERS

STREET TREES & TREE BOX FILTERS



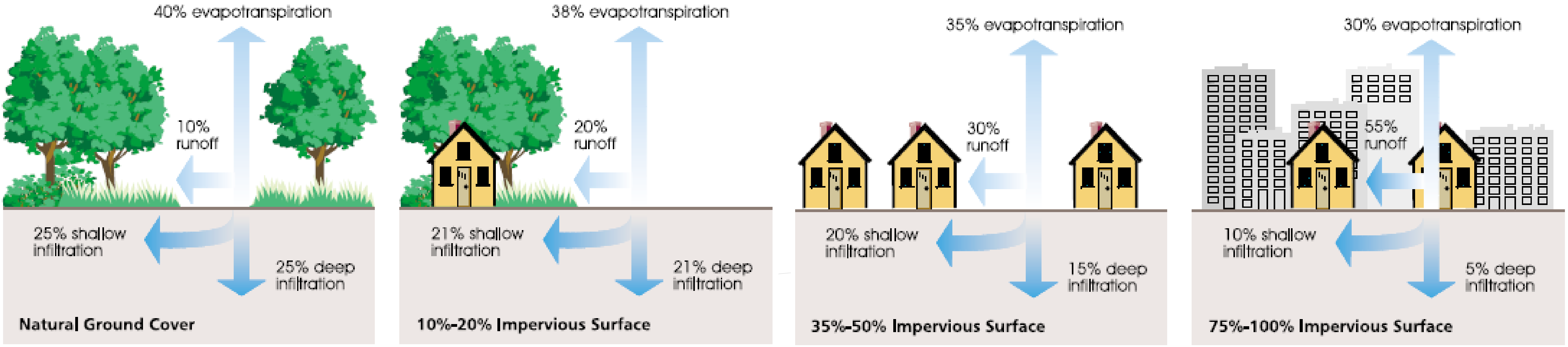
STREET TREES & TREE BOX FILTERS

Rain Garden in a median strip of a townhouse project. Please note the depressed curb and grate inlet structure

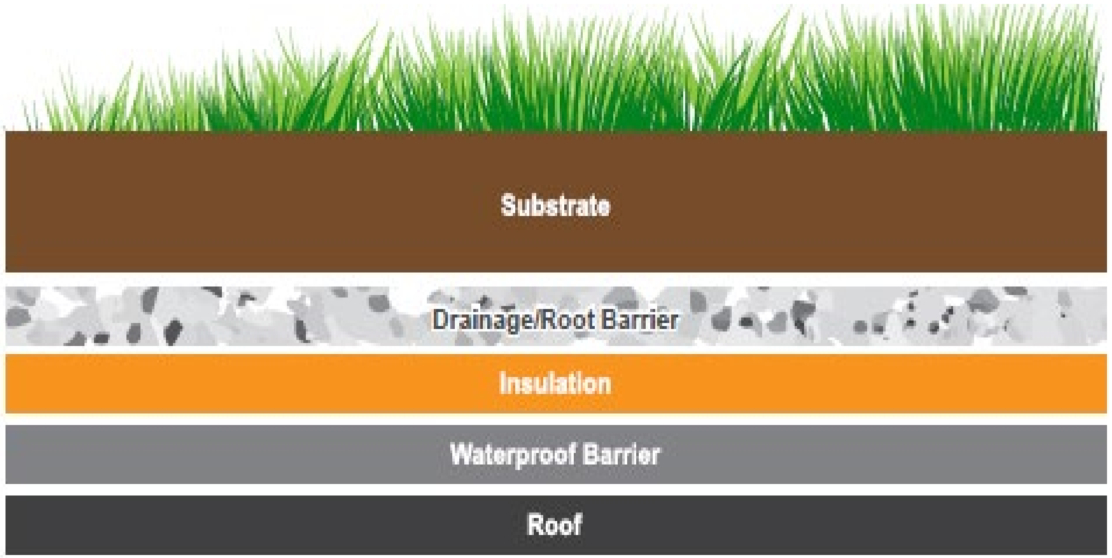
STORMWATER DETENTION & RETENTION

CULVERT WIDENING TO IMPROVE HABITAT & FLOW

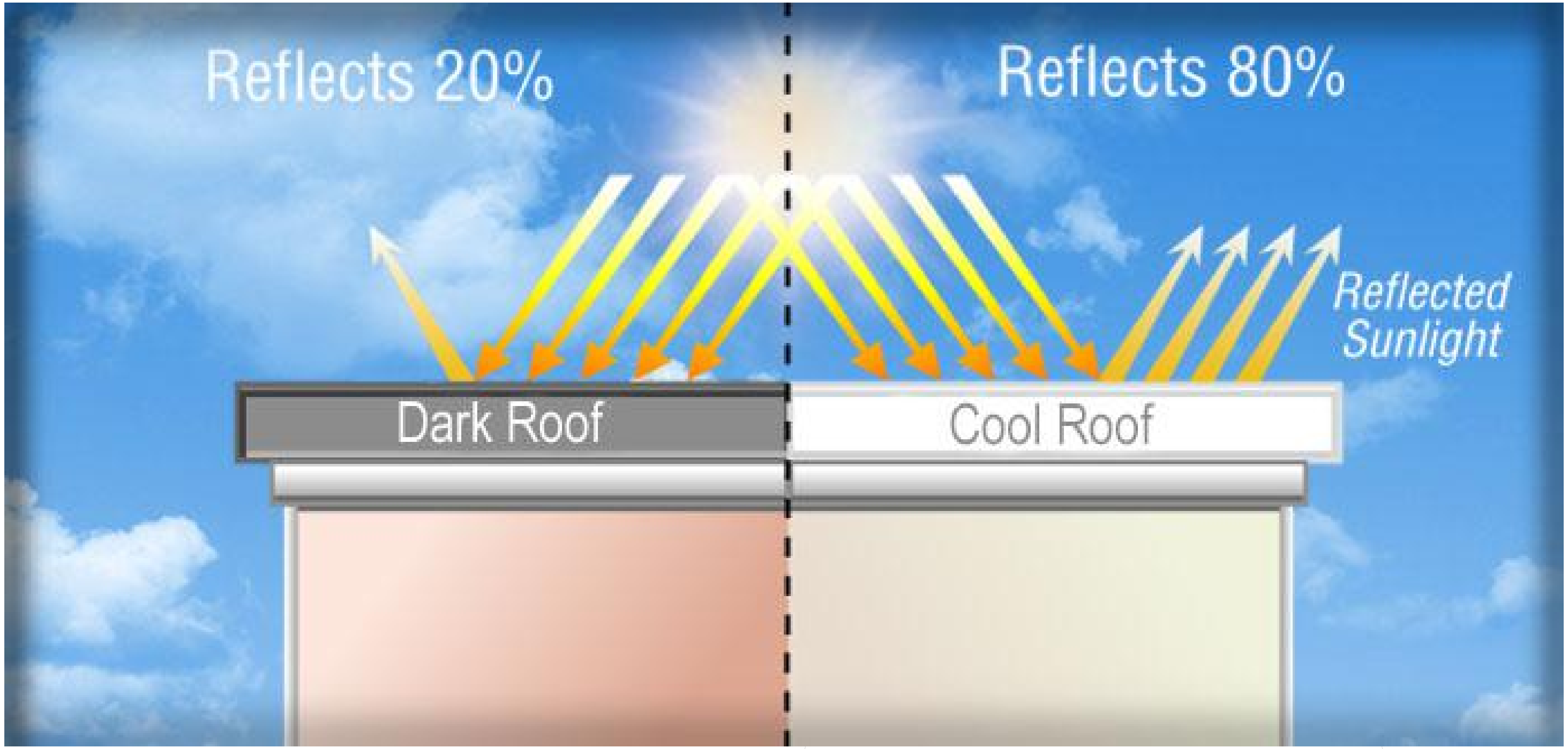
REDUCE IMPERVIOUS AREAS



GREEN ROOFS


Substrate
Drainage/Root Barrier
Insulation
Waterproof Barrier
Roof

COOL ROOFS



Source: Heat Island Group at Lawrence Berkeley National Laboratory

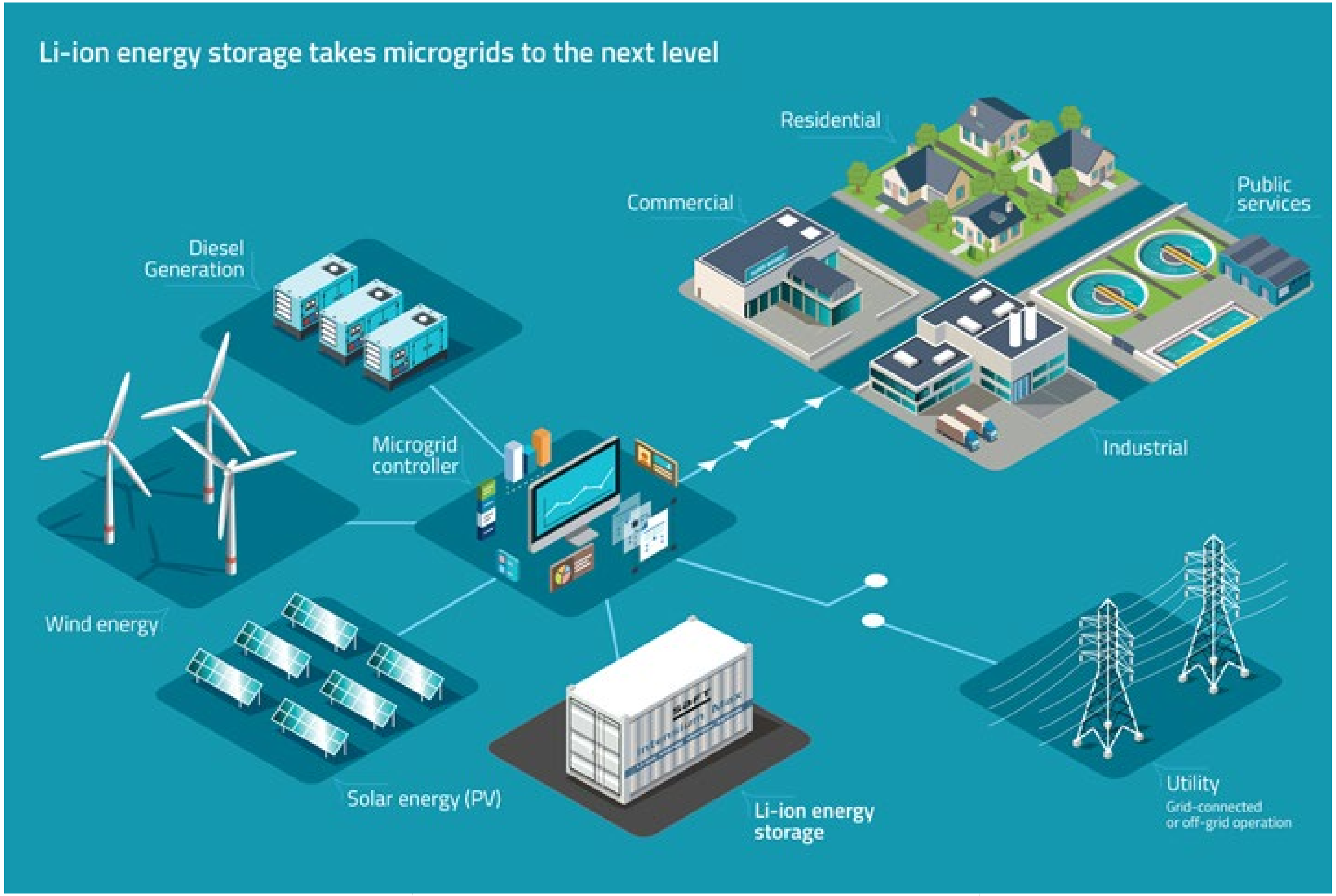
Figure 1: Dark vs. Cool Roof Surface Temperatures

A dark roof (left) becomes much hotter than a cool white roof (right) on a sunny afternoon.

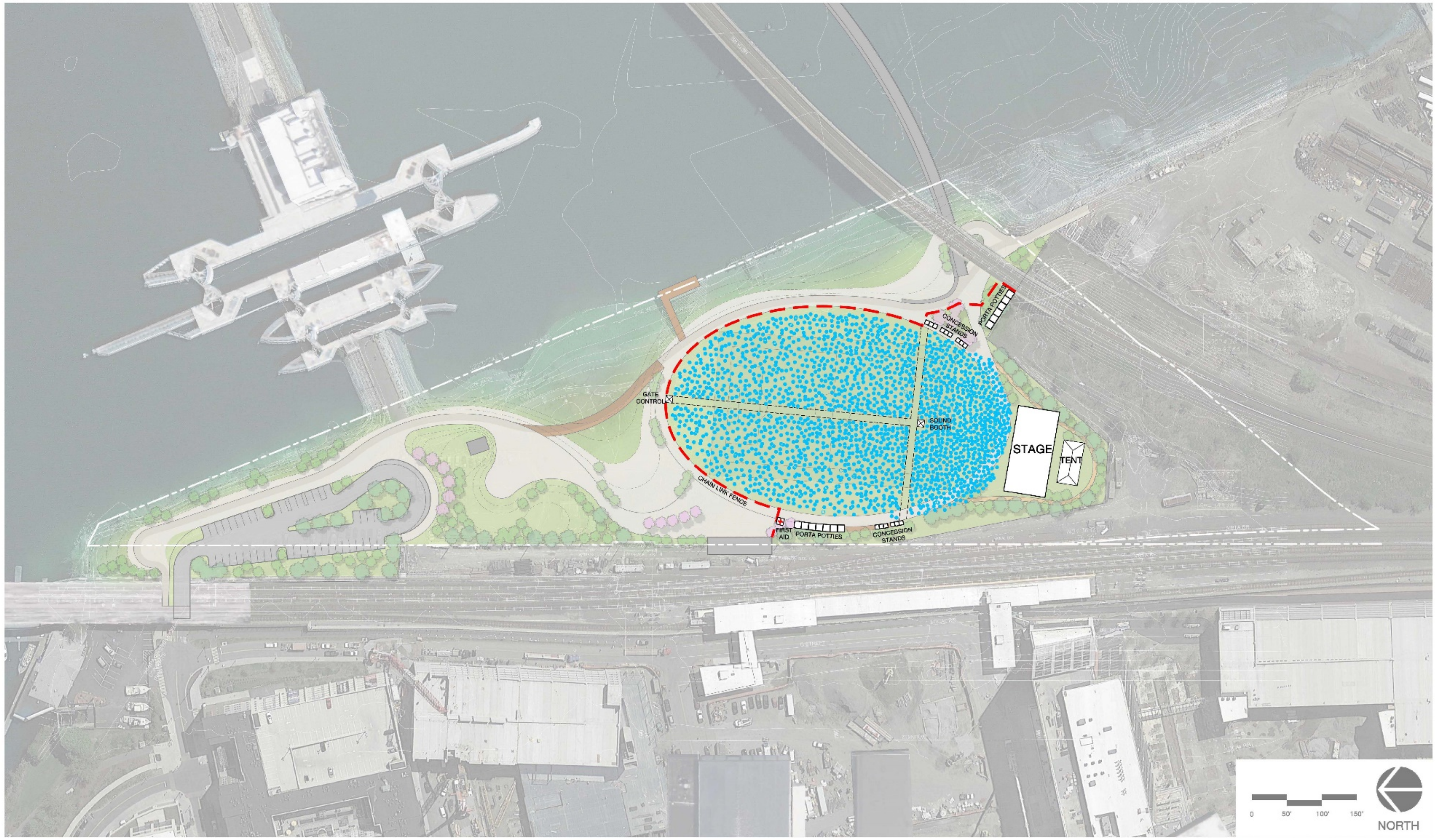
Source: U.S. Department of Energy Guidelines for Selecting Cool Roofs

COOLING CENTERS

RENEWABLE MICRO-GRIDS



LANDSCAPE DESIGN TO ACCOMMODATE WATER



CONCEPT #1 - CROWD DIAGRAM

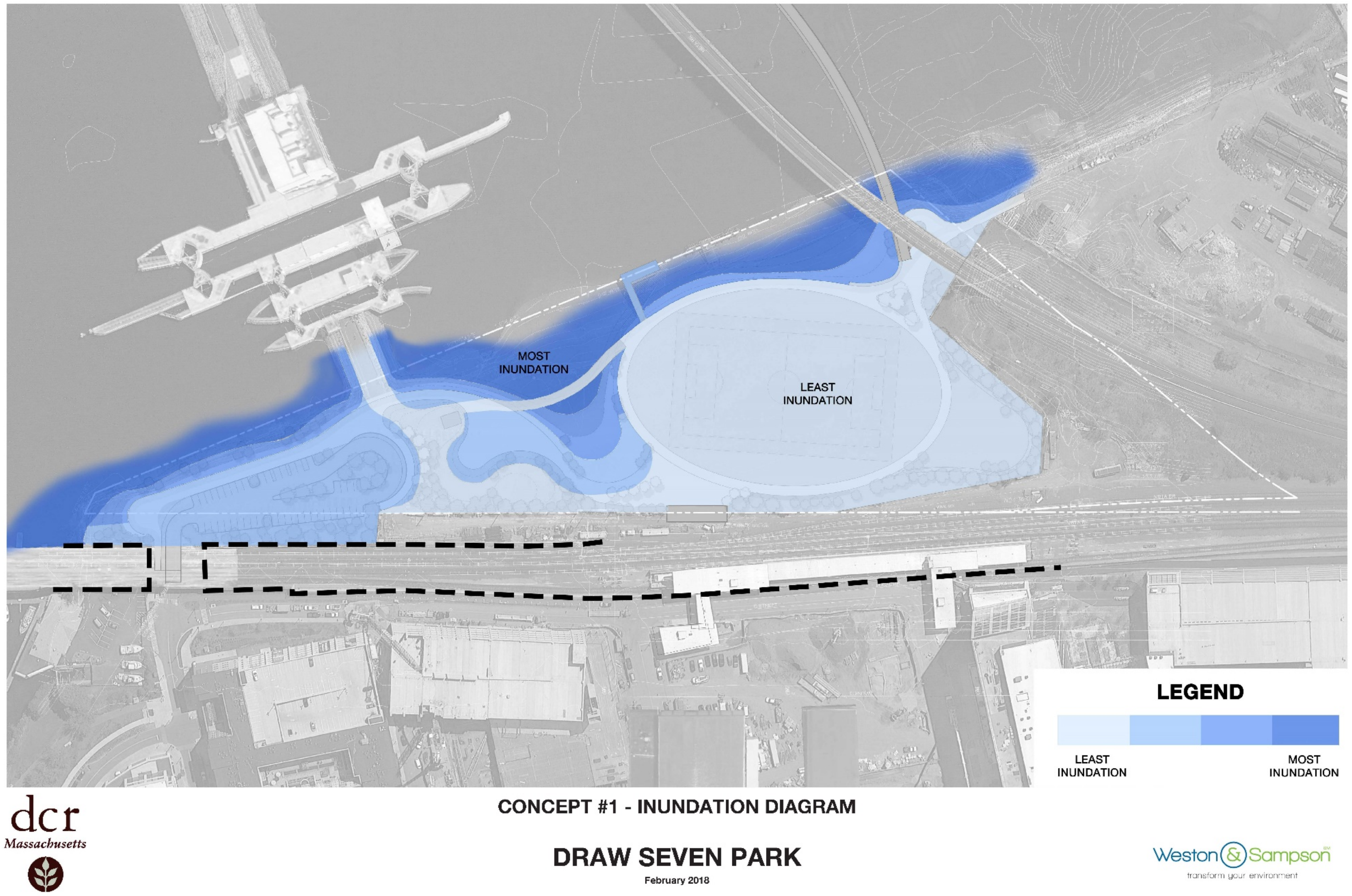
dcr Massachusetts

DRAW SEVEN PARK

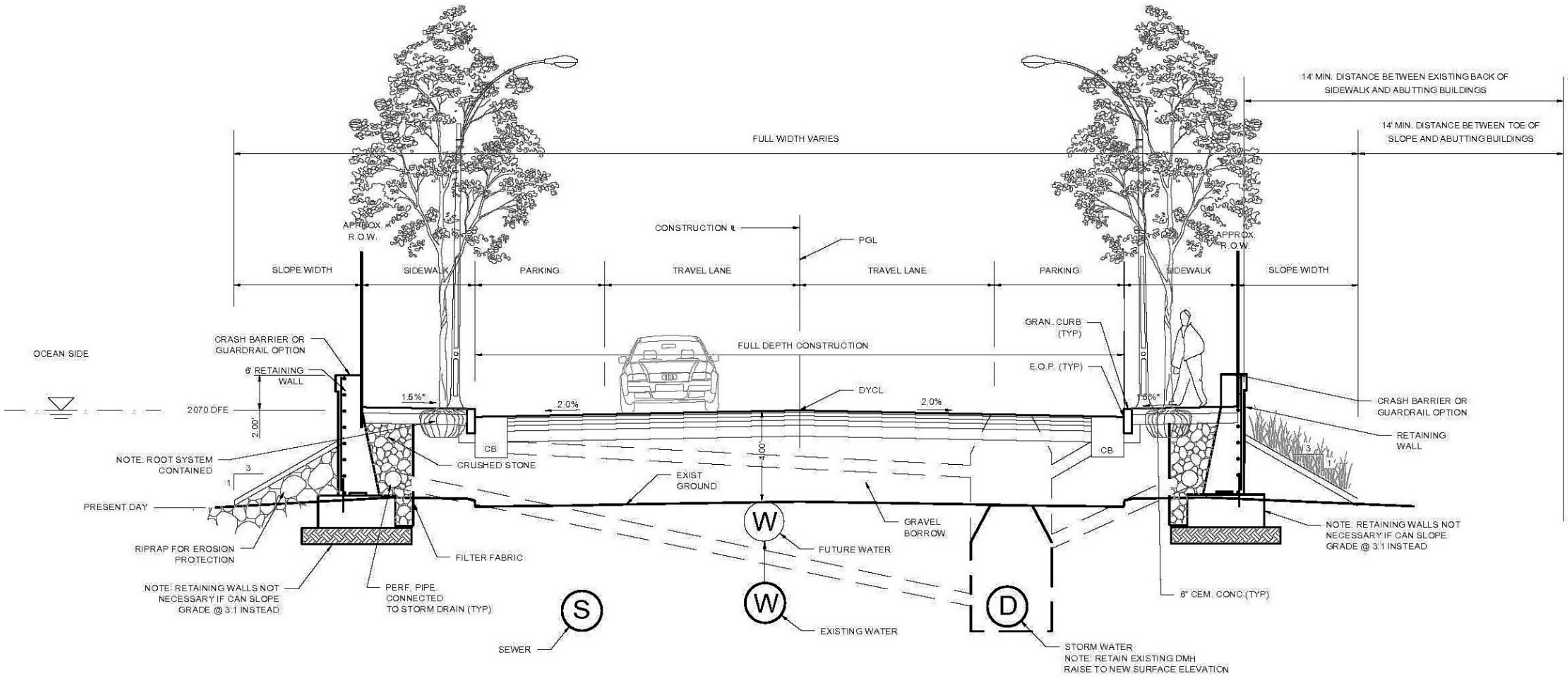
February 2018

Weston & Sampson
transform your environment

LANDSCAPE DESIGN TO ACCOMMODATE WATER



RAISED ROADWAYS



SAMPLE SECTION

RETROFITTED FLOODPROOF DOORWAYS

RE-EVALUATE LOCAL REGULATIONS & POLICIES

BROOKLINE MUNICIPAL VULNERABILITY PREPAREDNESS (MVP) ACTION PROJECT

town of brookline, massachusetts

Weston & Sampson will audit the Town of Brookline's stormwater, floodplains, zoning bylaws, public way design guidelines, wetlands bylaws, and Department of Public Works' Site Plan Review Checklist to identify opportunities to mandate higher standards for climate resiliency and to identify any conflicts these standards might have with State policy. Our approach is centered around the promotion of nature-based solutions and strategies such as green infrastructure, low impact development (LID), open space protection, and floodplain protection. The project is funded by a Municipal Vulnerability Preparedness Action Grant from the Massachusetts Executive Office of Energy & Environmental Affairs.

Weston & Sampson will identify opportunities for incorporating standards into the Town of Brookline's bylaws and other planning instruments to increase the town's resilience against the effects of climate change, including increased temperatures as well as increased precipitation frequency/intensity and associated flooding. Implementation of this project will help to reduce risk of climate change impacts to public infrastructure, private property, natural resources, and human safety and welfare. The project's specific recommendations for bylaw amendments as well as sustainability standards for site plan review will be targeted at new and renovated projects across all building sectors: residential, multifamily and affordable housing, commercial, and institutions.

Weston & Sampson's deliverables, identified as priority action items in the town's "Climate Vulnerability Assessment," will include: recommendations for new or amended town bylaws and regulations mandating LID measures, LID Best Management Practices - narrative and Site Plan Review checklist - that targets owners and developers of new and renovated residential, multifamily, and commercial properties, and assists in educating them of the overall benefits to the environment and the value in protecting their properties from climate change impacts. The standards and checklists will serve as imperative components of the "Site Plan Review" ordinance that the town will be adopting and are intended to limit storm and flood damage, mitigate stormwater runoff, reduce impervious surfaces, and improve ecosystem resiliency.

- convene a core team of leaders from departments, boards, and commissions
- review existing By-laws
- conduct literature review of examples from other municipalities
- develop and evaluate alternatives
- develop draft recommendations; workshop them with town's Boards, Commissions, and Departments.
- develop final recommendations and assist with preparation of package to town meeting
- conduct community outreach

client contact

Maria Morelli
Senior Planner,
Climate Action/Land Use
Town of Brookline
Department of Planning & Community Development
mmorelli@brooklinema.gov
617-730-2670

westonandsampson.com

Weston & Sampson

DEFINE COMMUNITY ACTIONS

Photo: Summer movie night. Photo by Belmont Recreation, 2018, via Twitter.

15 MINUTE BREAK!

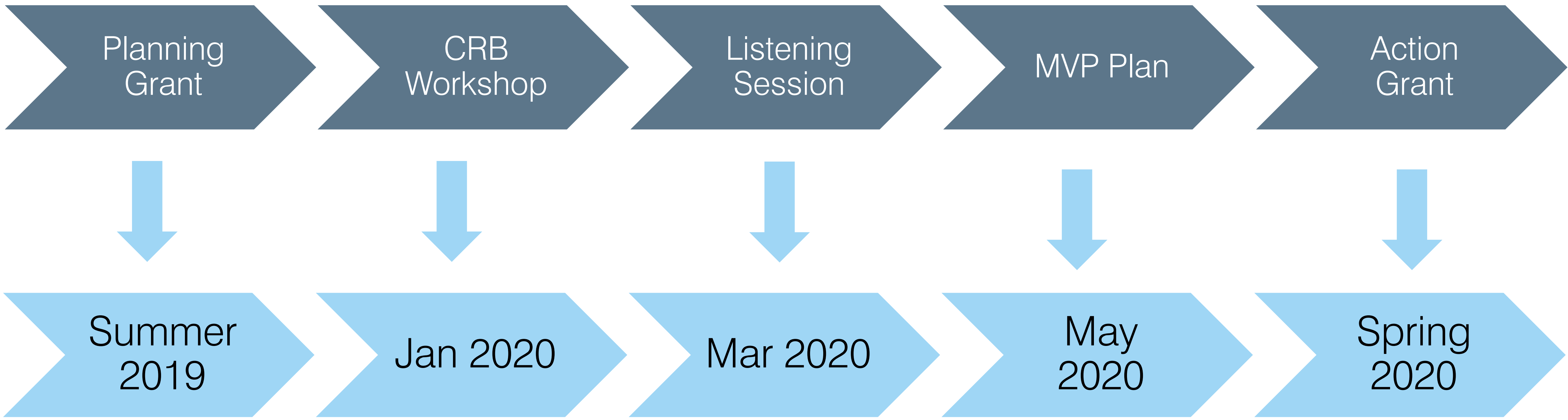
Photo: "Touch a Truck" at Wellington School. Photo by Belmont EMA, 2019, via Twitter.

IDENTIFY PRIORITY ACTIONS

Photo: Upgrading electric service in Belmont Center. Photo by Belmont Light, 2019, via Twitter.

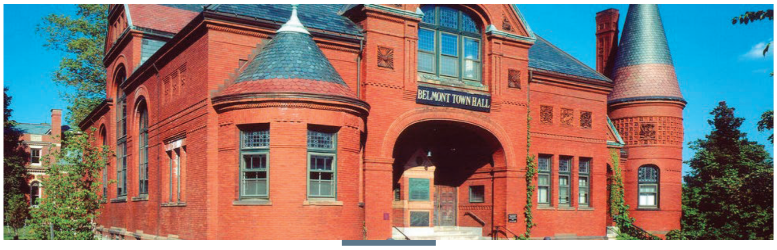
WRAP-UP & CLOSING REMARKS

Photo: Underwood Pool. Photo by Belmont Recreation, 2018, via Twitter.


Planning Grant
CRB Workshop
Listening Session
MVP Plan
Action Grant
Summer 2019
Jan 2020
Mar 2020
May 2020
Spring 2020

THANK YOU

Weston & Sampson℠



TOWN OF BELMONT

Community Resilience Building Workshop

Monday, January 27, 2019

Photo: Belmont Town Hall, Town of Belmont Facebook.

WELCOME W&S

Amanda Kohn

Lydia Kifner

Deanna Lambert

Alex Gaspar

Justin Gould

Mike Warner

Photo: Professional Development Day. Belmont Website, 2019.

WELCOME CORE TEAM

Jon Marshall

Jay Marcotte

Mary Trudeau

Steve Dorrance

Wesley Chin

Wayne Haley

James MacIsaac

Glenn Clancy

Diana Ekman

Photo: Professional Development Day. Belmont Website, 2019.

WELCOME PARTICIPANTS

Your name

Organization/Relationship to Belmont

Favorite thing about Belmont

Photo: Professional Development Day. Belmont Website, 2019.

WORKSHOP OUTLINE

- LUNCH -

PRESENTATION:

- Overview of Science & Data
- Characterization of Hazards

INDIVIDUAL TABLES:

- Identify Community Features

- BREAK-

INDIVIDUAL TABLES:

- Identify and Prioritize Actions

- BREAK -

LARGE GROUP DISCUSSION:

- Determine Overall Priority Actions

Photo: K9 Grim. Photo by Belmont Police, 2018, via Twitter.

Municipal Vulnerability Preparedness Program

Carolyn Meklenburg

MVP Regional Coordinator, Greater Boston

MA Executive Office of Energy and Environmental Affairs

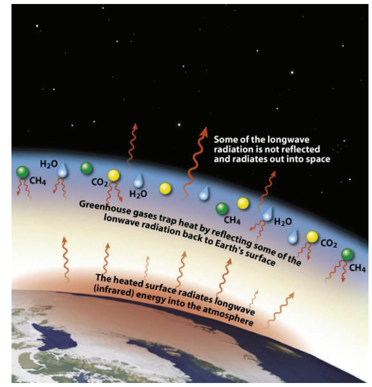
Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) – September 2018

- Acknowledges that climate change is already worsening natural hazards, integrating information and planning elements for 14 natural hazards that affect the Commonwealth
- Uses best scientific data and projections to assess risk and vulnerability
- Evaluates the Commonwealth's existing capabilities to implement agency-specific and statewide activities to reduce risk and increase resilience

GREENHOUSE GASES (GHG)

- Naturally occurring
- Act as a blanket
- Examples: carbon dioxide and methane

Climate mitigation ensures there is less to adapt to and is a key component of our community's resilience



Smithsonian Environmental Research Center. "Too Much of a Good Thing." http://forces.si.edu/atmosphere/02_04_07.html

MASSACHUSETTS GHG GOALS

- Established by the Global Warming Solutions Act (GWSA) of 2008
- 25% reduction in GHG emissions by 2020
- 80% reduction in GHG emissions by 2050
- 1990 is the baseline year

Source: Commonwealth of Massachusetts. 2019. "Global Warming Solutions Act 10-year Progress Report," 10.

FIGURE 3 | TRENDS OF GROWTH IN GSP, VMT, AND POPULATION WHILE GHG EMISSIONS ARE DECREASING AND ENERGY USE HAS BEEN STABLE

Source: Commonwealth of Massachusetts. 2019. "Global Warming Solutions Act 10-year Progress Report," 10.

MA 2050 Decarbonization Plan

EEA is conducting an **80x50 Study** to identify the strategies, policies, and implementation pathways for MA to achieve at least 80% Greenhouse Gas reductions by 2050.

The results of that research will be published in a **2050 Roadmap report** and will inform the setting of a **2030 GHG emissions limit** and the development of the **Clean Energy and Climate Plan for 2030**.

More information and opportunities to get involved:
www.mass.gov/2050Roadmap

Bill S.10:

An Act for Climate Change Adaptation Infrastructure Investments in the Commonwealth

- Proposed new source of revenue for loans, grants, and technical assistance to municipalities and regional partnerships for priority adaptation projects
  - Proposed deeds excise increase → est. $137M annually ($1B in ten years)
  - Recurring, long-term revenue stream for multi-year project feasibility

RESILIENCE = **MITIGATION** + **ADAPTATION**

RESILIENCE
The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner.

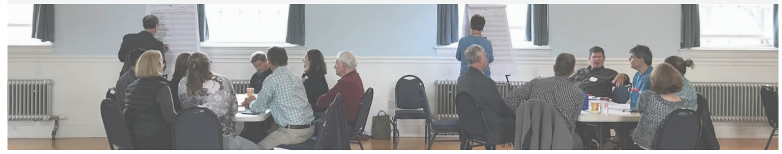
MITIGATION
aims to reduce the causes of climate change

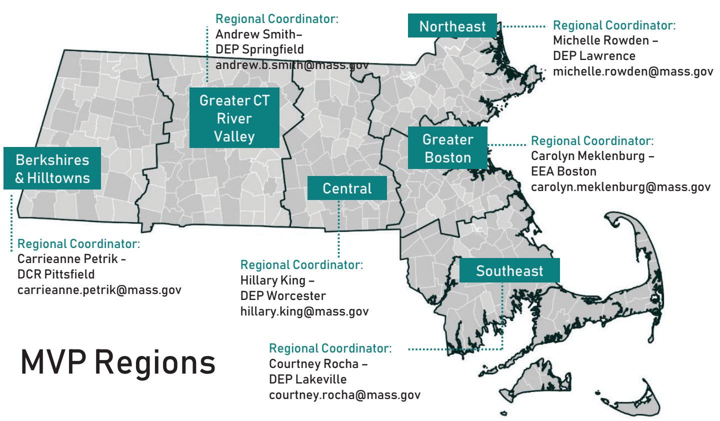
ADAPTATION
involves modifying our decisions, activities and ways of thinking to adjust to a changing climate

Definitions taken from the Massachusetts 2018 State Hazard Mitigation and Climate Adaptation Plan and Canada in a Changing Climate report (Adaptation.NRCan.gc.ca)

MVP is a *community-led, accessible* process that:

- Employs local knowledge and buy-in
- Utilizes partnerships and leverages existing efforts
- Reaches and responds to risks faced by EJ communities and vulnerable populations
- Is based in best available climate projections and data
- Incorporates principles of nature-based solutions
- Demonstrates pilot potential and is proactive





MVP Regions

MVP Planning Grant

COMMUNITY RESILIENCE BUILDING WORKSHOP(S)

- Define and characterize hazards using latest science and data
- Identify existing and future community vulnerabilities and strengths
- Develop and prioritize community adaptation actions
- Determine overall priority actions
- Receive MVP designation

MVP Action Grant

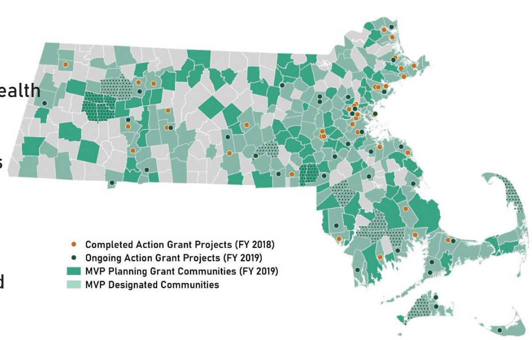
Implement priority adaptation actions identified through planning process

Three Years of MVP

MVP Designations
71% of the Commonwealth
249 communities

Action Grant Projects
FY18: 37
FY19: 36

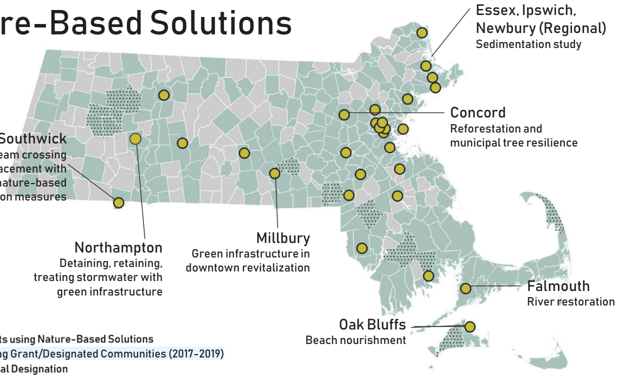
Total Awards
$17M+ in planning and action grants to date



MVP Action Grants: Project Types

- Vulnerability and Risk Assessment
- Community Outreach and Education
- Local Bylaws, Ordinances, Plans, and Other Management Measures
- Redesigns and Retrofits
- Nature-Based Flood Protection, Drought Mitigation, Water Quality, and Water Infiltration Techniques
- Nature-Based, Infrastructure and Technology Solutions to Reduce Vulnerability to Extreme Heat and Poor Air Quality
- Nature-Based Solutions to Reduce Vulnerability to other Climate Change Impacts
- Ecological Restoration and Habitat Management to Increase Resiliency
- Energy Resilience
- Chemical Safety
- Land Acquisition for Resilience
- Subsidized Low-Income Housing Resilience Strategies
- Mosquito Control Districts

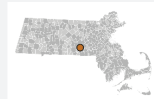
Nature-Based Solutions



Example Action Grant Projects

Nature-Based Flood Protection, Drought Prevention, Water Quality, and Water Infiltration Techniques

Millbury



Utilizing green infrastructure like stormwater planters, bioretention bump outs, rain gardens, and other measures like porous pavers and pervious pavement to reduce heat island effects and stormwater runoff into the Blackstone River.

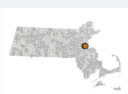
Nature-based solutions

Example Action Grant Projects

Local Bylaws, Ordinances, Plans, and Other Management Measures

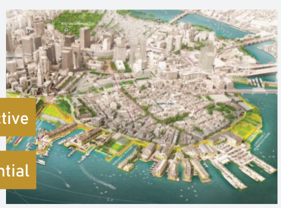
Redesigns and Retrofits

Boston



Developing its first ever resilient building code so that development in the future floodplain is prepared for at least three feet of sea level rise, the likely scenario by late century.

Retrofitting a major waterfront park into a legacy park that uses nature-based solutions to address climate vulnerabilities while providing important access to recreation for residents.



Proactive

Pilot potential

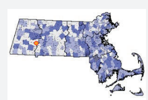
Community co-benefits

Nature-based solutions

Example Action Grant Projects

Detailed Vulnerability and Risk Assessment, Further Planning

Holyoke



Conducted a detailed demographic analysis of individuals who arrived in Holyoke from Puerto Rico as a result of Hurricane Maria and develop recommendations for planning for future climate change migrants in Holyoke

Table 12

How did the Holyoke municipal government respond to your needs? Was the response...	Freq.	Percent
Helpful	26	63.4
I don't know	7	17.1
Neither helpful nor unhelpful	2	4.9
There was no response from this resource	6	14.6
Total	**41**	**100**

Informational graphics from Holyoke's final report

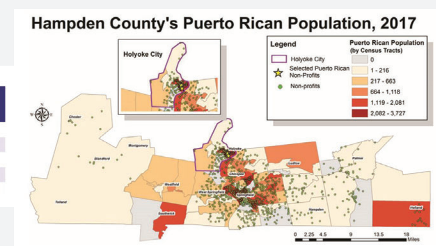
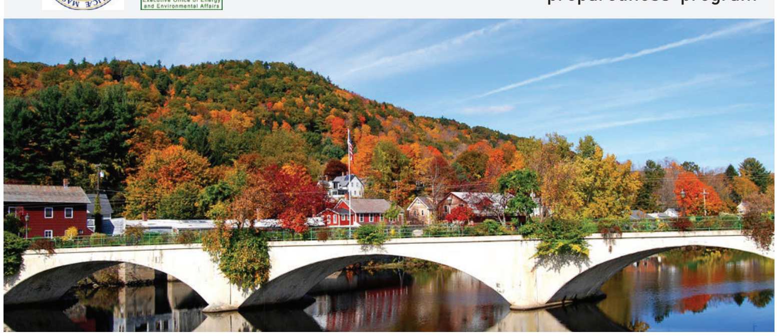
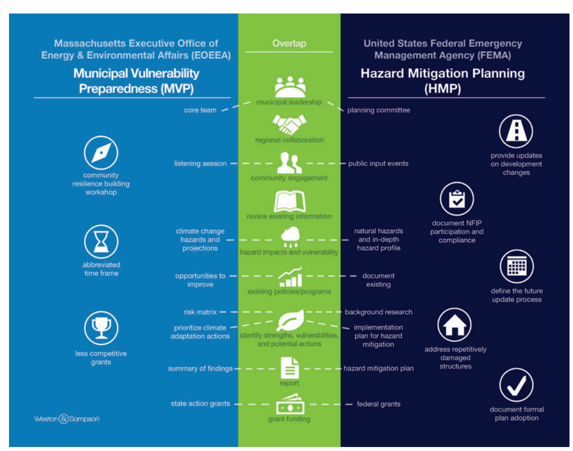


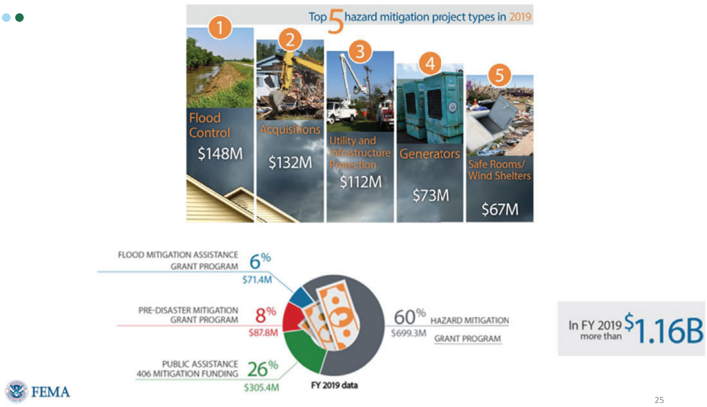
Image credits: Town of Holyoke, Hunter College CUNY, El Instituto UCONN

carolyn.meklenburg@mass.gov

https://www.mass.gov/municipal-vulnerability-preparedness-program







DATA RESOURCES

In Belmont and Massachusetts

- Massachusetts Climate Change Projections (NECSC, 2018)
- Town of Belmont Hazard Mitigation Plan, 2011
- A Working Vision for Belmont's Future: Priorities and Progress, 2015
- Massachusetts Climate Change Adaptation Report (MA EEA, 2011)
- A Vision for Belmont: Mapping a Sustainable Future, 2010
- Rock Meadow: A Conservation Master Plan, 2018
- Input from Municipal Officials
- Town of Belmont Climate Action Plan, 2009

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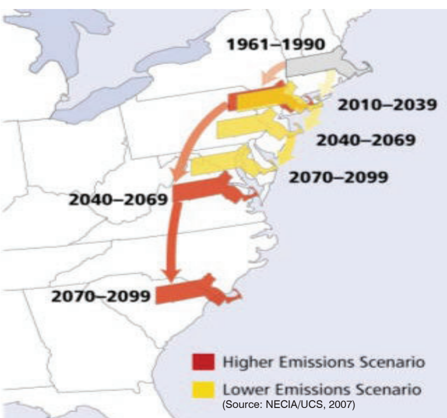


EXTREME TEMPERATURES

WARMER ANNUAL AIR TEMPERATURES
UP 0.5°F PER DECADE SINCE 1970, ON AVERAGE

WARMER WINTERS
UP 1.3°F PER DECADE SINCE 1970, ON AVERAGE

Source: ResilientMA.org, "Rising Temperatures," 2017

Weston & Sampson

EXTREME TEMPERATURES IN MASSACHUSETTS

6	24	35
2005 OBSERVED ANNUAL AVERAGE	MID-CENTURY PROJECTED ANNUAL AVERAGE	END-OF-CENTURY PROJECTED ANNUAL AVERAGE

DAYS WITH TEMPERATURES ABOVE 90°F

145	114	101
2005 OBSERVED ANNUAL AVERAGE	MID-CENTURY PROJECTED ANNUAL AVERAGE	END-OF-CENTURY PROJECTED ANNUAL AVERAGE

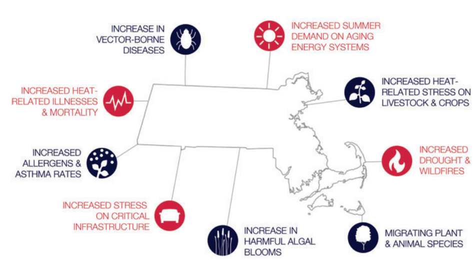
DAYS WITH TEMPERATURES BELOW 32°F

Massachusetts Executive Office of Energy & Environmental Affairs. 2019. "ResilientMA Datagrapher." Massachusetts Climate Change Clearinghouse. Resilientma.org/datagrapher/?c=Temp/state/tx90/ANN/MA/
Notes: Mid-century projected annual averages use a 2040-2069 time range. End-of-century project annual averages use a 2080-2097 time range.

Weston & Sampson

IMPACTS OF RISING TEMPERATURES

WARMER ANNUAL AIR TEMPERATURES UP 0.5°F PER DECADE SINCE 1970, ON AVERAGE
WARMER WINTERS UP 1.3°F PER DECADE SINCE 1970, ON AVERAGE



Massachusetts Executive Office of Energy & Environmental Affairs. 2019. "Rising Temperatures." Massachusetts Climate Change Clearinghouse. http://www.resilientma.org/changes/rising-temperatures

http://belmontonian.com/news/with-heat-wave-coming-belmont-light-asks-customers-to-cut-energy-use/
https://patch.com/massachusetts/belmont/how-to-beat-this-heat-wave

With Heat Wave Coming, Belmont Light Asks Customers To Cut Energy Use

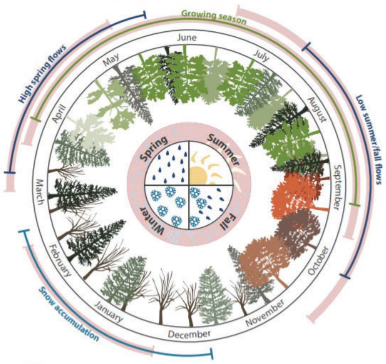
JULY 17, 2019 BY FRANKLIN B. TUCKER — LEAVE A COMMENT

How To Beat This Heat Wave

Belmont Studio Cinema and the public library are opened and air-conditioned.

By Franklin Tucker, Patch Staff
Jul 5, 2013 5:41 am ET

Northeast and Midwest seasonal patterns



Shifted season projected from increasing temperatures and precipitation changes
Image credit: Northeast Climate Science Center, University of Maryland Center for Environmental Science

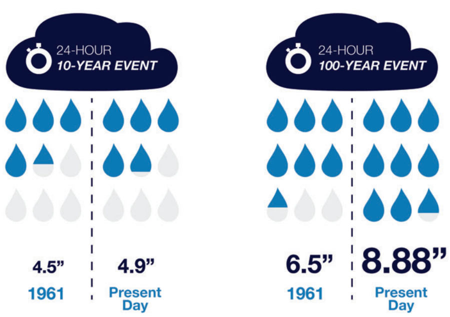
CHANGES IN PRECIPITATION

MORE **INTENSE & FREQUENT** EXTREME RAIN EVENTS

PRECIPITATION DURING **HEAVY EVENTS** IN THE NORTHEAST **INCREASED BY MORE THAN 70%** BETWEEN 1958-2010

Massachusetts Executive Office of Energy & Environmental Affairs. 2019. "Changes in Precipitation." Massachusetts Climate Change Clearinghouse. Resilientma.org/changes/changes-in-precipitation

CHANGES IN **PRECIPITATION**



1961 Data: NOAA TP-40
Present Day Data: Cornell University Northeast Regional Climate Center (NRCC) and Natural Resource Conservation Services (NRCS). Extreme Precipitation in New York and New England: Precipitation Frequency Duration Graphs. 1 hr- 24hr (100 yr and 500 yr reoccurrence). http://precip.eas.cornell.edu/

EXTREME PRECIPITATION

8%
Increase in extreme precipitation events by midcentury

13%
Increase in extreme precipitation events by 2100

Source: Executive Office of Energy and Environmental Affairs, Adaptation Advisory Committee. 2011. "Massachusetts Climate Change Adaptation Report," 19.

FLOODING

ZONE	ANNUAL CHANCE	FLOODPLAIN
A, AE, A1-A30	1% ANNUAL CHANCE	100-YEAR FLOODPLAIN
X	0.2% ANNUAL CHANCE	500-YEAR FLOODPLAIN

"By 2050, Boston could experience the current 100- year riverine flood every two to three years on average"

Source: Executive Office of Energy and Environmental Affairs, Adaptation Advisory Committee. 2011. "Massachusetts Climate Change Adaptation Report," 19.

RIVERINE FLOODING

Above: a portion of the FEMA Flood Insurance Rate Map (FIRM) for Belmont

LOCALLY IDENTIFIED AREAS OF FLOODING[2]

Trapelo Road @ Mill Rd.
Claypit Pond
Acorn Park Road—addressed!

REPETITIVE FLOOD LOSS STRUCTURES

1
repetitive loss structure

Defined as an NFIP-insured structure that has had at least 2 paid flood losses of more than $1,000 each in any 10-year period since 1978[1]

1. Federal Emergency Management Agency (FEMA). 2019. "Definitions." Accessed August 29, 2019. Fema.gov/national-flood-insurance-program/definitions#R
2. Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 14.

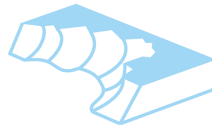
STORMWATER FLOODING

New walkway and drainage improvements near the Belmond Center Commuter Rail on Concord Ave. Photo credit: Town of Belmont, 2018, via Twitter.

Areas with:

- Poor drainage
- High amounts of impervious surface
- Undersized culverts

EROSION



- Caused by riverine flow & stormwater[1]
- Increased precipitation, including winter rains, could increase erosion[1]
- Drier soils will reduce resistance to erosion
- The 2018 Rock Meadow Conservation Master Plan identified three actions to reduce erosion:[2]
  - Redesign main parking lot
  - Support trails with a crushed gravel overlay
  - Allow "invasive" species to grow where appropriate

1. Executive Office of Energy and Environmental Affairs, Adaptation Advisory Committee. 2011. "Massachusetts Climate Change Adaptation Report," 42.
2. Freedman, Sam and Taurean Gagnon. 2018. "Rock Meadow: A Conservation Master Plan for the Town of Belmont, Massachusetts." The Conway School.

2016

The most notable recent drought event was in

The occurrence of droughts **lasting 1 to 3 months** could go up by as much as **75% over existing conditions** by the end of the century, under the high emissions scenario

Source: Executive Office of Energy and Environmental Affairs, Adaptation Advisory Committee. 2011. "Massachusetts Climate Change Adaptation Report," 17.

BRUSH FIRE

Belmont Fire Fighters Local 1637 battle a vehicle fire started by mechanical issues. Photo by the Belmont Police, 2018, via Twitter.

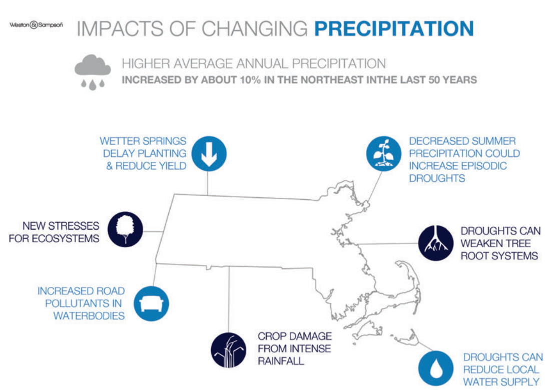
- 12+ brush fires can occur in Belmont each year
- Brush fires are relatively frequent in the western part of Town.
- The areas with the highest incidences include:
  - Mclean Open Space
  - Beaver Brook Reservation
  - Belmont Hill
  - Rock Meadow

Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 15.

WINTER STORMS

- The blizzard of 2013 left nearly **400,000 Massachusetts residents without power**[1]
- "Heavy blizzards are among the **most costly and disruptive** weather events for Massachusetts communities."[1]
- 4 nor'easters in 2018 took out **85 trees**

1: Resilient MA Climate Change Clearinghouse for the Commonwealth. "Extreme Weather," 2017.
2. Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 15.



Massachusetts Executive Office of Energy & Environmental Affairs. 2019. "Changes in Precipitation." Massachusetts Climate Change Clearinghouse. http://www.resilientma.org/changes/changes-in-precipitation

HURRICANES AND EXTREME WIND

HURRICANE Sandy was the most recent hurricane

Upward trend in North Atlantic **hurricane** activity since 1970

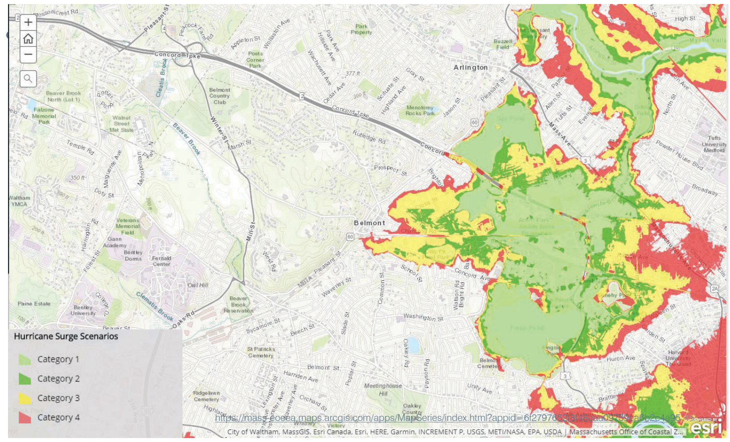
Nor'easters along the Atlantic coast are increasing in frequency and intensity

MEMA WEATHER ADVSORY: Fourth March nor'easter expected to bring heavy snow, high winds and more coastal flooding

Posted Mar 20, 2018 at 12:34 PM
Updated Mar 20, 2018 at 12:56 PM

Weston & Sampson

Source: Climate Science Special Report, Fourth National Climate Assessment (NCA4), Volume prepared by the U.S. Global Change Research Program (USGCRP)
Article: https://belmont.wickedlocal.com/news/20180320/mema-weather-advsory-fourth-march-noreaster-expected-to-bring-heavy-snow-high-winds-and-more-coastal-flooding



BOSTON SEA LEVEL RISE PROJECTIONS (ft)

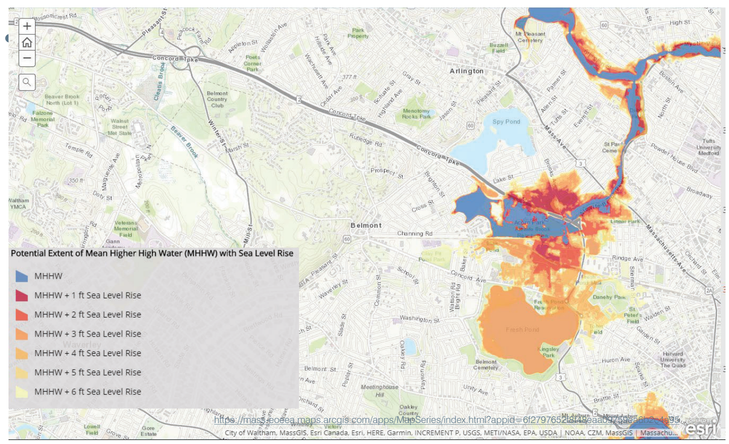
Increased coastal flooding

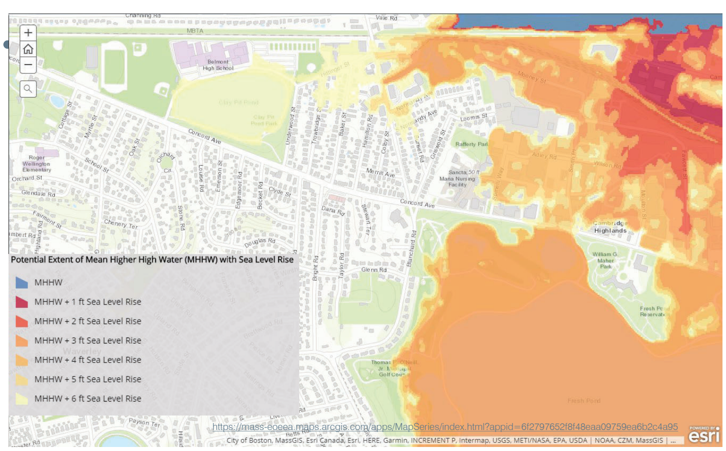
Permanently inundated low-lying coastal areas

Increased shoreline erosion

Emission Scenario	2030	2050	2070	2100
Intermediate	0.7	1.4	2.3	4.0
Intermediate-High	0.8	1.7	2.9	5.0
High	1.2	2.4	4.2	7.6
Extreme	1.4	3.1	5.4	10.2

(Source: Northeast Climate Adaption Science Center)

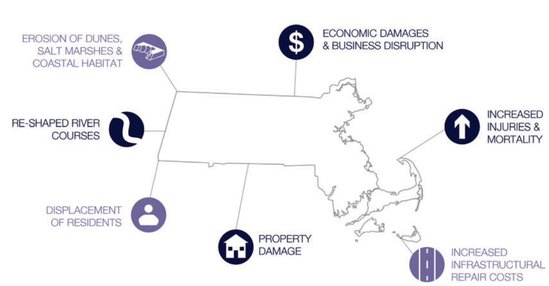




Weston & Sampson

IMPACTS OF EXTREME WEATHER

STORMS ARE BECOMING MORE INTENSE AND DAMAGING

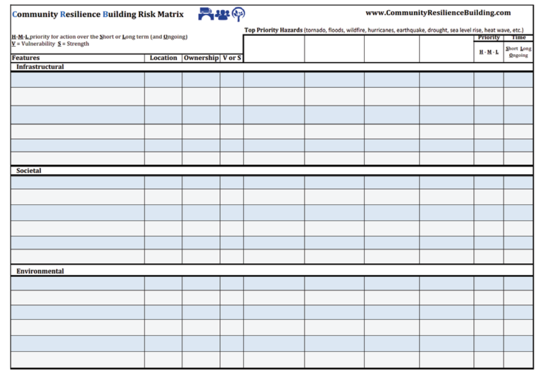


Massachusetts Executive Office of Energy & Environmental Affairs. 2019. "Extreme Weather." Massachusetts Climate Change Clearinghouse. http://www.resilientma.org/changes/extreme-weather

RISK MATRIX

Photo: Downed tree and power line at School Street and Bow Road. Photo by Belmont Light, 2019, via Twitter.

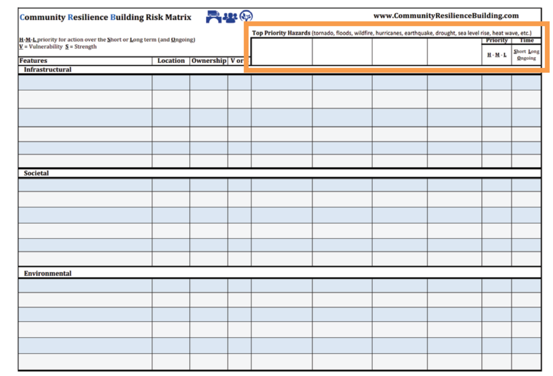
RISK MATRIX



IDENTIFY HAZARDS

Photo: Downed tree and power line on Hurd Road. Photo by Belmont Light, 2018, via Twitter.

RISK MATRIX: HAZARDS



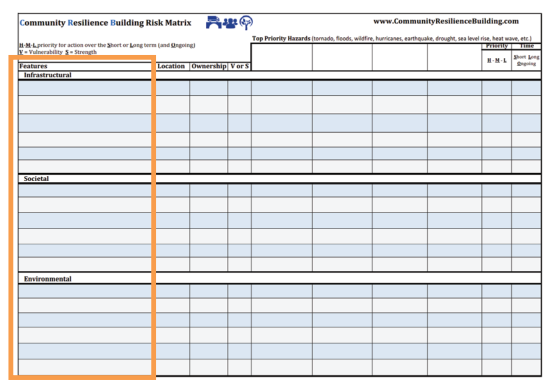
HAZARDS IN BELMONT

CHOOSE 4 FOR THE MVP ACTION PLAN

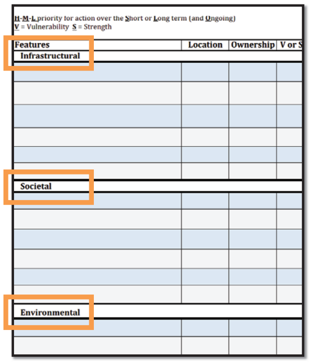
Weston & Sampson

Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 11.

RISK MATRIX: FEATURES



RISK MATRIX: FEATURES


H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Features	Location	Ownership	V or S
Infrastructural			
Societal			
Environmental			

RISK MATRIX: FEATURES

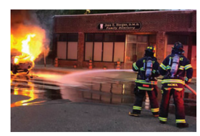
FEATURES	LOCATION	OWNERSHIP	VULNERABILITY OR STRENGTH
Infrastructural	Town wide	State	Vulnerability
Societal	Multi- vs. Single-neighborhood	Town	Strength
Environmental	Specific location	Private	Both
		Shared	

FEATURES IN BELMONT


Photo: Police station at 40 Woodland Street. Photo by Belmont Police, 2019, via Twitter.

INFRASTRUCTURAL FEATURES

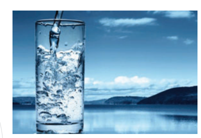

Police Department
Photo by the Belmont Police Department


Fire Department
Photo by the Belmont Police Department

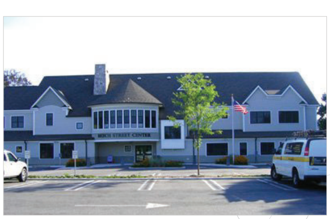

Wastewater Treatment & Collection


Community Centers
Photo by the Belmont Police Department.


Roadways
Photo by the Belmont Police Department


Water Supply

INFRASTRUCTURAL FEATURES


Beech Street Center, used as a cooling center. Photo by the Belmont Police Department.

Critical Infrastructure includes:

- Facilities important for disaster response and evacuation.
  - Emergency operations centers
  - Fire stations
  - Water pump stations
- Facilities where additional assistance might be needed during an emergency.
  - Nursing homes
  - Elderly housing
  - Day care centers

Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 16.

SOCIETAL FEATURES

Population	Belmont	Massachusetts
2010	24,330	6,547,790
2018	26,330	6,902,149
Age		
Under 18 years:	25%	20%
65+ years:	17%	17%
Additional Information		
Median household income:	$118,370	$74,167
Persons in poverty:	6%	10%
With a disability:	4%	8%
Language other than English spoken at home:	29%	23%

Source: U.S. Census Bureau, 2019

ENVIRONMENTAL FEATURES

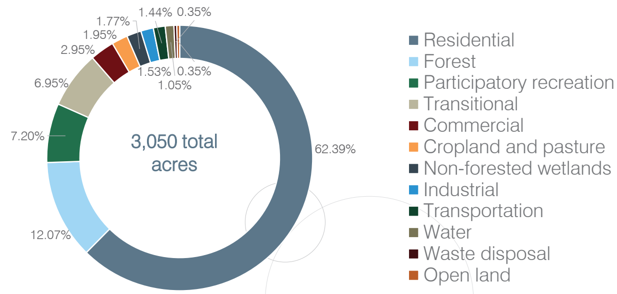
Photo credit: Franklin Tucker, Patch Staff

Belmont's Open Space[1]

- 2/3rd of open space is publicly-accessible
- The largest open space areas are:
  - Beaver Brook Reservation (313 acres)
  - Town Conservation land at McLean (140 acres)
  - Habitat Education Center and Wildlife Sanctuary (88 acres)
  - Rock Meadow Open Space (70 acres)

1. Belmont Planning Board, Belmont Office of Community Development. 2010. "A Vision for Belmont: Mapping a Sustainable Future." 35.

Belmont's Land Use



Weston & Sampson

Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 4.

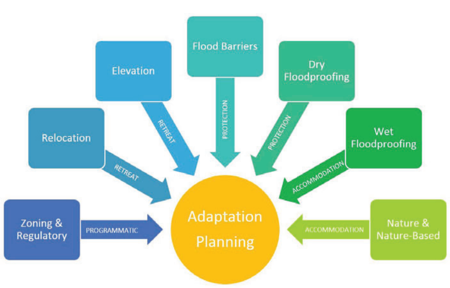
15 MINUTE BREAK!

Photo: "Touch a Truck" at Wellington School. Photo by Belmont EMA, 2019, via Twitter.

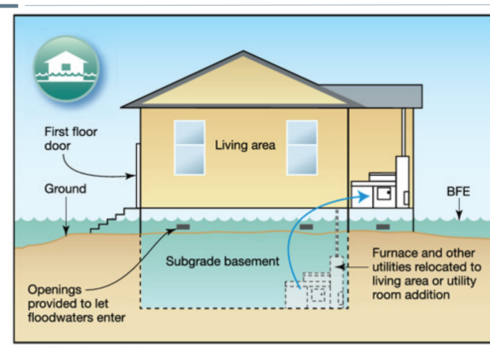
ADAPTATION STRATEGIES

Photo: the LimeBike Bike Share program in Belmont. Photo by the Town of Belmont, 2018, via Twitter.

COMMUNITY ACTIONS

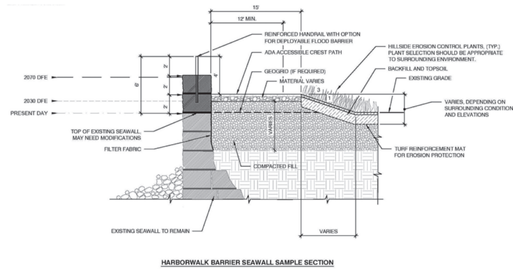


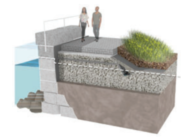
WET FLOODPROOFING



RAISED BUILDINGS

FLOOD WALLS





DEPLOYABLE FLOOD BARRIER

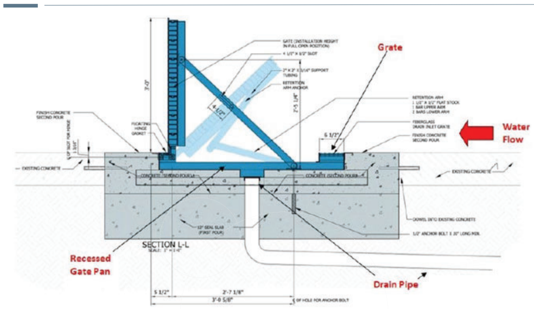
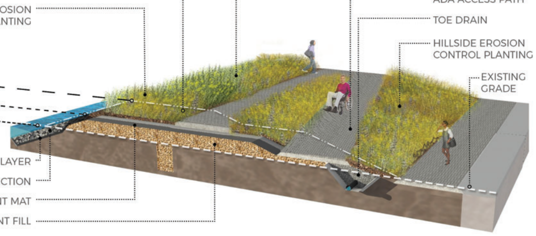


FIGURE 1 | A FloodBreak barrier gate diagram

PREVENTING SEWER BACKFLOW

VEGETATED BERM



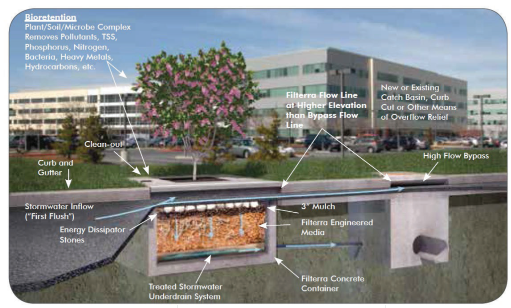
MULTI-PURPOSE FLOOD STORAGE

CLOUDBURST STREETS

LOW IMPACT DEVELOPMENT (LID)

POROUS ASPHALT & PERMEABLE PAVERS

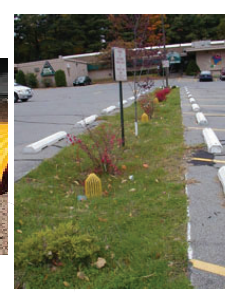
STREET TREES & TREE BOX FILTERS



STREET TREES & TREE BOX FILTERS

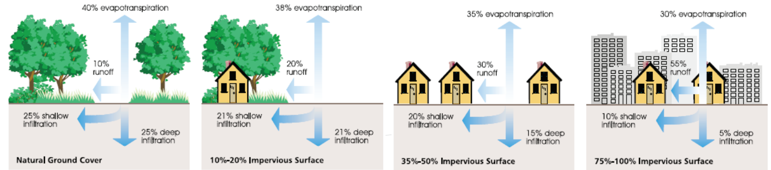
Rain Garden in a median strip of a townhouse project. Please note the depressed curb and grate inlet structure

STORMWATER DETENTION & RETENTION

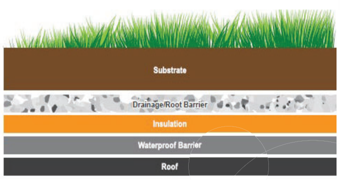


CULVERT WIDENING TO IMPROVE HABITAT & FLOW

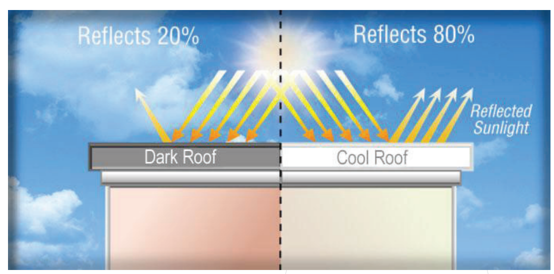
REDUCE IMPERVIOUS AREAS



GREEN ROOFS

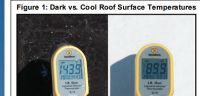


COOL ROOFS



Source: Heat Island Group at Lawrence Berkeley National Laboratory

Figure 1: Dark vs. Cool Roof Surface Temperatures

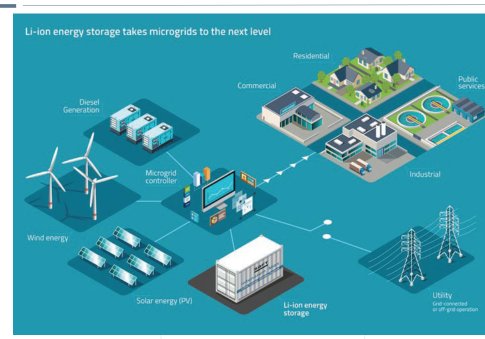


A dark roof (left) becomes much hotter than a cool white roof (right) on a sunny afternoon.

Source: U.S. Department of Energy Guidelines for Selecting Cool Roofs

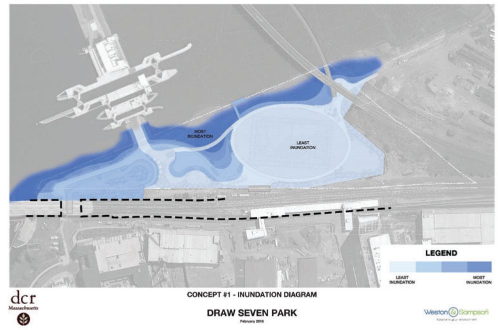
COOLING CENTERS

RENEWABLE MICRO-GRIDS

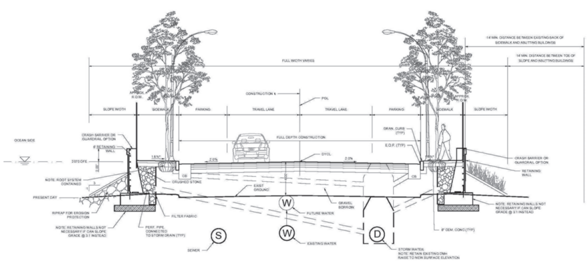


LANDSCAPE DESIGN TO ACCOMMODATE WATER

LANDSCAPE DESIGN TO ACCOMMODATE WATER



RAISED ROADWAYS



RETROFITTED FLOODPROOF DOORWAYS

RE-EVALUATE LOCAL REGULATIONS & POLICIES


BROOKLINE MUNICIPAL VULNERABILITY PREPAREDNESS (MVP) ACTION PROJECT
town of brookline, massachusetts

DEFINE COMMUNITY ACTIONS

Photo: Summer movie night. Photo by Belmont Recreation, 2018, via Twitter.

15 MINUTE BREAK!

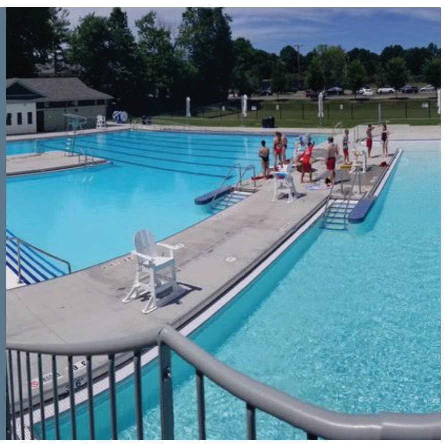
Photo: "Touch a Truck" at Wellington School. Photo by Belmont EMA, 2019, via Twitter.

IDENTIFY PRIORITY ACTIONS

Photo: Upgrading electric service in Belmont Center. Photo by Belmont Light, 2019, via Twitter.

WRAP-UP & CLOSING REMARKS

Photo: Underwood Pool. Photo by Belmont Recreation, 2018, via Twitter.



Planning Grant	CRB Workshop	Listening Session	MVP Plan	Action Grant
Summer 2019	Jan 2020	Mar 2020	May 2020	Spring 2020

Weston & Sampson

THANK YOU

Weston & Sampson

Moderate Priorities from the Community Resilience Building Workshop

The following actions were identified during the CRB workshop but were not included in the 2020 implementation road map (Chapter 7) that identifies the department with the primary responsibility for implementing the action, projected cost, and potential funding sources. However, they are still important actions that the Town may want to pursue and are captured here for future reference. Some actions may have been considered moderate because they are under the jurisdiction of a state agency, cost, feasibility, overall benefit to the broad community, or a variety of other factors.

- Strengthen the stormwater bylaw
- Develop regulations on pesticide and insecticide control, and educate the public on their impacts to the stormwater system
- Evaluate the effect extreme precipitation events have on the sewer system and disconnect sump pumps and other illicit connections that pollute during these events
- Improve the resiliency of the Town's water bodies by investigating pollution reduction
- Implementing a public survey to prioritize the critical facilities that should receive backup power resources.
- Install a battery storage system for the public library's power system to increase energy redundancy
- Evaluate communication strategies for usage reductions
- Investigate automated timers to prevent brown outs
- Study the impacts of long-term power outages on Belmont
- Continue with the de-commissioning of Station 1, which is subject to flooding
- Educate vulnerable populations on extreme heat related illness and available cooling centers
- Secure additional funding to provide translation to non-English speakers during emergencies
- Develop partnerships with private organizations to ensure essential services such as grocery stores and hospitals are prepared for hazards
- Distribute information about air quality and health to the general public
- Upgrade the MBTA stations to be ADA accessible
- Evaluate alternative transportation's resiliency to natural hazards and climate change
- Partner with MBTA to create commuting tourism base in Town
- Install electric vehicle charging stations in Belmont
- Evaluate upgrades needed to large private buildings so they can be used as cooling and heating centers, including age specific cooling areas like sprinkler parks
- Study the Housing Authority's preparedness for hazard events and identify resources needed
- Become Natural Wildlife Certified and Audubon Certified community. Increase wildlife friendly vegetation plantings and partner with regional veterinarians to rehabilitate sick wildlife. Encourage habitat protection and public education on beneficial wildlife for green spaces, such as birds, insects, and bees.
- The Town's multiple business centers should become public information centers and walkable resources in the event of a natural hazard

- Utilize the high education level in Town by encouraging volunteering and recruiting new Citizens Emergency Response Team members. Create a database of different fields of expertise so the knowledge can be used.
- Engage youth and teenagers in training for emergency preparedness and involve them in volunteer organizations
- Keep industrial activity out of flood zones
- Maintain well irrigation system for recreation fields
- Perform a study on which locations in Town are best suited to house solar energy
- Study the feasibility of reducing gas demand and gas infrastructure in Town
- Encouraging private parties to adopt green solutions for power and stormwater
- Develop an open space and transportation plan that examines access to open space in Belmont
- Increase data storage of data centers
- Implement using police patrols to alert certain areas of incoming extreme weather
- Create a database of pet-friendly emergency spaces
- Implement compost regulations and a curbside compost pick up program. Increase public awareness of trash pick up guidelines to reduce pests
- Investigate a regional partnership with Cambridge for water storage
- Consider implementing Town-mandated outdoor water use restrictions during times of drought

Town of Belmont
Monday, January 27th, 2020
Community Resilience Building Workshop

Name	Table	Signature
Adam Dash	3	
Andy Healy	1	
Anne Marie Mahoney	2	
Anne-Marie Lambert	1	Anne-Marie M. Lambert
Ara Yogurtian	2	[illegible]
Ben Thivierge	1	[illegible]
Catherine Cagle	3	
Charlie Smart	4	[illegible]
Dave Rogers	4	[illegible]
David Pinsonneault	1	
Diana Ekman	1	[illegible]
Elizabeth Lipson	1	

Town of Belmont
Monday, January 27th, 2020
Community Resilience Building Workshop

Name	Table	Signature
Emily Sullivan	3	[signature]
Fred Paulsen	4	
Glenn Clancy	3	[signature]
James MacIsaac	3	
Jason Marcotte	2	
Jon Marshall	1	
Julie Wormser	4	
Juliet Jenkins	2	[signature]
Kate Bowen	3	[signature]
Mark Mancuso	3	
Mary Trudeau	4	
Maryann Scali	2	
Michael Bourgeois	2	
Michael Macrae	2	
Michael Santoro	1	

Town of Belmont
Monday, January 27th, 2020
Community Resilience Building Workshop

Name	Table	Signature
Nava Niv-Vogel	4	
Nicholas Iannuzzi	3	
Phil Thayer	4	
Roger Fussa	3	
Roger Wrubel	2	
Sam Osmancevic	3	
Sarah White	4	
Steve Dorrance	4	S Dorrance
Wayne Haley	2	
Wesley Chin	3	
Carolyn Meklenburg		Carolyn Meklenburg
Hillary Monahan	3	Hillary Monahan
Patrice Garvin		
Steve Pinkerton		
Justin Gould		
Mike Warner		

Town of Belmont
Monday, January 27th, 2020
Community Resilience Building Workshop

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Name	Table	Signature
Adam Dash	3	[illegible]
Andy Healy	1	
Anne Marie Mahoney	2	Anne Marie B. Mahoney
Anne-Marie Lambert	1	
Ara Yogurtian	2	
Ben Thivierge	1	
Catherine Cagle	3	
Charlie Smart	4	
Dave Rogers	4	
David Pinsonneault	1	[illegible]
Diana Ekman	1	
Elizabeth Lipson	1	

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Juliet Jenkins	2	
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Mark Mancuso	3	
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Michael Macrae	2	
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Phil Thayer	4	
Roger Fussa	3	
Roger Wrubel	~~2~~ 1	
Sam Osmancevic	3	
Jeff Sarah White	4	
Steve Dorrance	4	
Wayne Haley	2	
Wesley Chin	3	
Patrice Garvin	3	
Justin Gould	3	
Stephen Pinkerton	4	

Municipal Vulnerability Preparedness Planning Grant Project

Weston & Sampson

Town of Belmont
Monday, January 27th, 2020
Community Resilience Building Workshop

Stakeholders Invited to Attend Belmont ‘s Community Resilience Building Workshop

√ indicates invitee also attended the Workshop

Attend ?	Name	Title	Affiliation
√	Diana Ekman	Assistant Director of Health Department	Health Board
√	Glenn Clancy	Community and Economic Development Director	Community and Economic Development
√	Jason Marcotte	DPW Director	DPW
√	Jon Marshall	Assistant Town Administrator, Parks and Recreation Department	Parks and Recreation
√	Mary Trudeau	Conservation Commission	Conservation Commission
√	Patrice Garvin	Town Administrator	Town of Belmont
√	Steve Dorrance	Facilities Director	Facilities
√	Wesley Chin	Health Department Director	Health Board
√	Wayne Haley	Director of Emergency Management Agency, Assistant Fire Chief	Fire Department, Local Emergency Management Committee Chair
	James MacIsaac	Assistant Police Chief	Police Department
√	Adam Dash	Vice Chair/Chair	Select Board/Municipal Light Board
√	Anne-Marie Lambert	Co-Chair	Belmont Stormwater Working Group
√	Ara Yogurtian	Building Division, Assistant Director	Building Division
√	Ben Thivierge		Belmont Light
√	Charlie Smart		Information Technology Advisory
√	Fred Paulsen	Co-Chair	Belmont Stormwater Working Group
√	Maryann Scali	Chair	Council on Aging
√	Juliet Jenkins	Chair	Cultural Council
√	Nicholas Iannuzzi	Chair	Zoning Board of Appeals
√	Nava Niv-Vogel	Director	Council on Aging
√	Rogelio Fussa	Vice Chair	Vision 21 Implementation Committee
√	Anne Marie Mahoney	Chair	Capital Budget Committee
√	Michael Bourgeois		Belmont Light Department
√	Micahel Macrae		Light Board Advisory Committee
√	Kate Bowen		School Committee
√	Phil Thayer		Resident
√	Sam Osmancevic		Belmont Light Department
√	Hillary Monahan		Massachusetts Water Resource Authority
	Anthony Ferrante	Vice Chair	Recreation Commission
	Andy Healy	Director of Facilities	McClean Hospital

Stakeholders Invited to Attend Belmont 's Community Resilience Building Workshop

√ indicates invitee also attended the Workshop

Attend ?	Name	Title	Affiliation
	John Phelan	Superintendent of Schools	Belmont Schools
	Belmont Food Pantry		Belmont Food Pantry
	Elizabeth Lipson	Co-Chair	Housing Trust
	Carl Brauer	Chair	Human Rights Commission
	Charles Laverty, III	Vice Chair	Housing Authority
	Christopher Roy	Manager	Belmont Light
	Dana Miller	Chair	Transportation Advisory Committee
	David Kane	Chair	Recreation Commission
	Donna David	Vice Chair	Board of Health
	David Frizzell	Fire Chief	Fire Department
	Kevin Dorn	Chair	Vision 21 Implementation Committee
	Frank French	Chair	Water Advisory Board
	Charles Hamann	Chair	Bylaw Review Committee
	Rachel Heller	Co-Chair	Housing Trust
	Janet Amdur	Coordinator	Youth and Family Services
	Janet MacDonald	Chair	Disability Access Commission
	James Berets	Vice Chair	Information Technology Advisory
	Demetrios Zarkadas	Vice Chair	Zoning Board of Appeals
	Julie Lemay	Chair	Board of Health
	Jaclyn Martin	Executive Director	Housing Authority
	James Roth	Chair	Conservation Commission
	Jeffrey Wheeler	Senior Planner	Housing Trust
	Steve Klionsky	Chair	Light Board Advisory Committee
	Laurence Macdonald	Vice Chair	Transportation Advisory Committee
	Lauren Meier	Co-Chair	Historic District Commission
	Lisa Harrington	Co-Chair	Historic District Commission
	Lucia Gates	Chair	Shade Tree Committee
	Marty Bitner	Co-Chair	Energy Committee
	Michael Cahalane	Vice Chair	Council on Aging
	Matt Ellenberger	Worship Leader	St. Lukes/St. Joes New Roads Catholic Community
	Mark Mancuso	Manager	Water Division
	Mark Mancuso	Manager	Water Division
	Michael Santoro	Highway Division Manager	Highway Division
	Michael Santoro	Manager	Highway Division
	Paul Roberts	Chair	Information Technology Advisory
	Steve Pinkerton	Chair	Planning Board
	Peter Struzziero	Library Director	Belmont Public Library

Stakeholders Invited to Attend Belmont ‘s Community Resilience Building Workshop

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Attend ?	Name	Title	Affiliation
	Richard Nohl	Assistant Director	Emergency Management Agency
	Roger Colton	Co-Chair	Energy Committee
	Robert Upton	Veteran's Services Officer	Veteran's Services
	Susan Burgess-Cox	School Committee, Chair	School Committee
	Margaret Velie	Chair	Community Preservation Committee
	Thomas Caputo	Chair	Select Board
	David Alper	Chair	Youth Commission
	Tom Walsh	Town Staff	Shade Tree Committee
	William Lovallo	Chair	Belmont High School Building Committee
	Donna Brescia	Chair	Housing Authority
	Fran Yuan	Vice Chair	Human Rights Commission
√	Carolyn Meklenburg	MVP Regional Coordinator	MVP Program
√	Dave Rogers	State Representative, 24th Middlesex District	Massachusetts House of Representatives
√	Julie Wormser	Climate Director	Mystic River Watershed
√	Roger Wrubel	Director	Mass Audubon Habitat Education Center
	Eric Worrall	Northeast Regional Director	MA Department of Environmental Protection
	Jim Gammill	Chairperson	Minuteman District School Committee
	Marilyn Petitto Devaney	Governor's Councilor, 3rd Councilor District, Middlesex County	MA Governor's Council
		Martin Pillsbury	Environmental Planning Director
	Patrick Herron	Director	Mystic River Watershed
	Priscilla Geigis or Dan Driscoll	Deputy Commissioner for Conservation and Resource Stewardship	DCR
	Sarah White	Hazard Mitigation Unit Supervisor	MEMA
	Stephen Estes-Smargiassi	Director of Planning and Sustainability	MWRA
	William Brownsberger	State Senator, 2nd Suffolk & Middlesex District	Massachusetts Senate
	Katherine Clark	Congresswoman, 5th Congressional District	US House of Representatives
	Watertown-Belmont Chamber of Commerce		Watertown - Belmont Chamber of Commerce
	National Grid		Utilities - National Grid
√	David J Pinsonneault	Town of Lexington	Director of Public Works
√	Emily Sullivan	Town of Arlington	Conservation Agent

Stakeholders Invited to Attend Belmont 's Community Resilience Building Workshop

√ indicates invitee also attended the Workshop

Attend ?	Name	Title	Affiliation
	Adam Chapdelaine	Town of Arlington	Town Manager
	Catherine Cagle	City of Waltham	Director of Planning
	Louis A DePasquale	City of Cambridge	City Manager
	James J. Malloy	Town of Lexington	Town Manager
	City of Cambridge	other	City of Cambridge
	City of Waltham	other	City of Waltham
	Town of Lexington	other	Town of Lexington

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Extreme Temperatures	Wind	Extreme Precipitation and Snow	Drought	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Electric infrastructure	Town	Eversource/ Town	V	Evaluate communication strategies for usage reductions.	Selective removal of street trees. Put lines underground with road projects.	Study impacts of long-term outages. Explore alternative supplies/redundancies with Eversource. Microgrid solutions. Coordinate with Ems for medically sensitive		M	O/S
Stormwater infrastructure and drainage	Town	Town	V	Encourage private parties to adopt green solutions for power and stormwater.		Study and model stormwater in Clay Pit area. Upgrade sizes. Feasibility study of Little River restoration. Strengthen stormwater bylaw. Create swales/storage areas.		H	S/L
Roads (All)	Trapelo, Concord, Rte 2, Pleasant, Leanard, Prospect	Town/State	V/S		Trimming trees.	Capacity analysis for culverts at Spy Pond, Clay Pit to Blair, and Tripelo Rd. More storage areas in clay-lined areas like Wellington by Pequosette Park and Winns by Clafton.		L	L
Crit. Facilities	Beech St, Elem school, Chenery school	Town	V/S	Partner with Star Market during emergencies.		More generators and microgrids. Public survey for what resources would be wanted and when. Public engagement/outreach for emergency services. Backup		H	O/L
Multiple large private buildings	Mclane, royal belmont, belmont hill, churches	Private	S	Evaluate upgrades/efficient systems for new development. Coordinate for cooling/heating centers. Partner and educate for age-specific cooling areas like sprinkler parks.				M	O/S
Commuter rail/buses/bike path	Town	MBTA/private	S	Upgrade T stations to be ADA accessible. Make more accessible to bikers. Partner with MBTA to create commuting tourism base in town. Evaluate bus shelters/stops for emergency		Partner with MBTA to create commuting tourism base in town. Alexander Ave pedestrian path - make sure properly designed for climate change.		M/H	O/L
Societal									
Neighborhood/worship communities	Town	Private	S	Educate groups and town on resources and needs of both groups and town.		Partnerships with town and groups for engagment and outlreach for emergencies, supplemental shelters (Ex. Saint Joseph's)		L	O
Well-connected residents	Town	Private	S					L	O
Housing authority	Town	Town	V/S	Study equipment needs and communication needs.		Recognize clean-up after events and identify solutions.		M	O/S
Elderly population	Town		V	System for checking-in, home health care. Reverse 911, educate population on opt-in. for cell phones.				H	O
Socially isolated populations (disabled, language barriers, isolated, homeless, climate refugees)	Town		V	Fund shelters with showers/clothing swap for homeless/low income. Cooperate with churches/private centers/Underwood Pool, Hockey Rink. Database for		Regional partnership with Cambridge for water storage.		H/M	S
Regional partnerships (surrounding towns, Mystic River Watershed Assoc.)			S/V			Feasibility study for pumping clay pit pond, partner with Cambridge.		H	L
Environmental									
Inflow and infiltration pollution	Town	Town	V			Depave large parking lots (Ex. Saint Joseph's), increase number of swales, LID. Repair seage pipes. Inventory septic systems. Incentives for private partnerships.		M/H	O/S
Green space (including Belmont acres)/street trees/dense areas with no parks		Town/private	S/V	Plant trees along travel lanes, dense areas, and streams.	Replant with more resilient plantings.		Purchase off-road equipment for FD for fire fighting,	H	L
Streams (flashy, erosion)	Beaver Brook, Wellington, Winns Brook		V	Plant trees along streams.		Daylight streams to expand capacity.	Pass wetlands bylaw.	M	L
Wildlife			V/S	Wildlife-favored tree plantings, river side. Become Natural Wildllife Habitat Certified and Audobon Certified as a town.			Partnerships with town and regional vets for sick wildlife. Identify wildlife rehabilitators. Plantings which provide food for	M	S/L
Little industrial activity	Purecoat North	Private	V/S			Keep out of flood zones, make easily accessible.		M	O
Pests (invasives, rats, mosquitos, ticks)			V	Public engagement/education for reducing standing water.				H	O

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V = Vulnerability **S** = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Extreme Temps	Wind (all-encompassing)	Extreme Precipitation and Snow Storms	Drought	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Public Transportation and Roads	Town-wide	State, Town, MBTA	V	Build sidewalks in Town and maintain them. Require residents to clean them. Use permeable pavement in sidewalks to increase infiltration and decrease ice on road.	Increase hazard tree maintenance and funding for tree maintenance contractor	Educate public on staying home, not driving, not salting sidewalks in snowstorms	Build sidewalks in Town and maintain them. Require residents to clean them. Use permeable pavement in sidewalks to increase infiltration	H	O
Electric Infrastructure	Town-wide	Town	B	Educate public on time of electric use during heat waved. Investigate automated timers to prevent brown-outs	Create new regulations requiring new developments to have underground utlities	Continue Heatsmart Program and rebates for heat pumps and efficient appliances		H	O
Stormwater/Sewer Infrastucture	Town-wide	Town	V			Funding for sewer lining program, increase catch basin cleaning and street sweeping to twice a year	Money for maintence and upkeep of system	H	O
Drinking Water System Infrastructure	Town-wide	Town	B				Consider implementing Town mandated water ban	L	O
Emergency Shelters/Senior Center	Middle School, Senior Center	Town	S	Install battery storage system for library power. Energy redundancy	Analysis of feasibility of solar backup on senior center. Energy redundancy	Solar panels on back of new police station for redundancy		H	S/O
Town-wide Emergency Communication	Town-wide	Town, various	B	More education on reverse 911 system, have people sign up at any public office.				H	S/O
Incinerator Site	Specific	Town	V			Put cap on incinerator site to prevent water from getting into the contaminated soil		H	O
Seniors	Town-wide	N/A	V	Information on hazards distributed to seniors. Wellness checks implemented during hazards. Emergency transportation provided. Outreach on illness				H	O
Youth 0-5yrs old	Town-wide	N/A	V	Outreach on illness	Information sessions on emergency preparedness put on by the Fire Department, and Police at the library, recreation department, pool. Make brochures to hand out. Target places in Town that this community frequents			H	O
Non-English Speakers	Town-wide	N/A	V	Outreach on illness	Information sessions on emergency preparedness put on by the Fire Department, and Police at the library, recreation department, pool, Chinese-American organization. Make brochures to hand out. Target places in Town that this community frequents			H	O
High Education Level in Town	Town-wide	N/A	B	Create a database of people in Town and their expertise so the Town can use their knowledge	Education about volunteering	Citizens Emergency Response Team- recruit new people from various backgrounds		M	O
Disabled Population	Town-wide	N/A	V	Outreach on illness	Information sessions on emergency preparedness put on by the Fire Department, and Police at the library, recreation department, pool. Make brochures to hand out. Target places in Town that this community frequents			H	O
Multiple Business Centers	Town-wide (3+)	N/A	S	Become public information centers. Become walkable resources during a hazard				M	O
Streams, Ponds, Wetlands	Town-wide	Town	B	Implement a Belmont Wetlands Bylaw. Conduct study to see how these features can become more resilient. Install rain gardens in Town to increase infiltration and recharge				M	O
Open Space	Town-wide	Town/Private	B				Purchase Side-by-Side UTV with water tank to fight brush fires	M	S/O
Trees	Town-wide	Town/Private	B		Increased funding for hazard tree removal and tree trimming			H	O
Air Quality	Town-wide	N/A	V	Information dissipation to the public about air quality and earth. Increase public transportation to decrease the amount of cars on the roads. Complete the bike path through Belmont				H	O
Pests (rodents, coyotes, ticks, geese, mosquitos)	Town-wide	N/A	V	Town use BT to treat mosquitos in ponds. Install signage in recreation areas about ticks and mosquitos				H	O
Recreation Space	Town-wide	Town	S				Maintain well irrigation system for fields	M	O

Community Resilience Building Risk Matrix

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V = Vulnerability **S** = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	WIND	EXTREME TEMPS	EXTREME PRECIPITATION (EP)	DROUGHT	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
municipal buildings	Townwide	Town	B	fortify roofing tiles and HVAC systems	Window weatherization	Elevate mechanical systems and evaluate Butler for issues	ALL-implement building plan with climate resilience measures-- Library and	M	O
electric utilities	Belmont Center is underground, otherwise	Belmont Light	B	Decommission Station 1 as planned, which experiences flooding (in year 3 of 4); 2/3 of wire is underground and could finish the undergrounding where possible; tree trimming and maintenance				H	O
water utilities	Townwide/Quabbin	Town/MWRA	infrastructure is fairly						
transportation (roadways, MBTA, walking, biking)	Townwide	Town, MassDOT, MBTA	Redundancy and capacity -	EP: identify areas where LID opportunities exist on municipal property for stormwater to be managed onsite and on roadways; upgrade culverts (Beaver Brook, Clifton and Hickory (private), Belmont Street and Lexington St)				H	O
stormwater (beaver brook culvert)	Townwide	Town	V	^^				H	S/O
sewer (I/I impacts and 3 pump stations)	Townwide	Town	V	Disconnect sump pumps and other illicit connections that pollute during EP. Evaluation system of the impact of EP.				H	O
Societal									
Senior, including Belmont Manor	Townwide	-	V	Develop a comprehensive outreach strategy to vulnerable populations for climate change adaptation and preparedness	Create more transit options (vans) for getting people to shelters/form more partnerships; Develop an Emergency Response Plan that considers vulnerable populations and builds a database of people			M	O/L
Housing Authority and Housing Trust Properties	Multiple locations	Quasi-governmental	B		Upgrade and address public health threats like extreme temps and mold			M	O/L
Limited English Speakers	Townwide/residential neighborhoods	-	Network- S; Commun		Need additional funds for translation			M	O/L
Youth (schools, pre-k, focus on the population)	Townwide	Town/private	New school- S; Old and		More cooling in schools	Reexamine shelter capacity as part of the update to the Emergency Response Plan		M	O/L
People who are disabled	Townwide	-	V		Develop partnerships to ensure essential services are prepared for hazards			M	O/L
Low-income households	Townwide	-	V					M	O/L
Environmental									
tree (facing an aging tree population)	Townwide	public and private	B	Need a comprehensive tree planting and management plan that considers air quality, extreme temps, potential drought, location constraints and conflict with overhead utilities, wind breaks, urban heat. Develop recommended species list and watering plans.				H	O
stormwater quality	Townwide	Town	V	Develop regulations on pesticide/insecticide control, education on impact on stormwater; incentivize/require best practices/LID stormwater management				H	O
air quality	Townwide	-	V	Continue heat pump program, install EV charging stations,				M	O
access to open space	Some areas of town have better access than others	public and private	S- mainly, some	Develop a transportation/open space plan that looks at access; Look at developing a complete street with bike lanes to Grove Park				L	O
vector born diseases (mosquitos and rats)	Townwide	-	V		Increase work of Mosquito Control Collaborative (education, treatment, bat/bird houses)			H	O
gas lines	Townwide	National Grid	V			Study on feasibility of reducing gas lines and the demand		L	L

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

H-**M**-**L** priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Extreme Temperatures	Wind (all encompassing)	Extreme Precipitation (including snow)	Drought	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Roadways	Town-Wide	Town/State	V	Study to identify vulnerable roadways and stormwater flooding solutions				H	O
Data Centers	Library, Homer	Town	V/S	Install HVAC and redundant power -Increase data storage				H	S
Little Pond/Clay Pond/Mill Pond		DCR	V	pollution reduction program accelerating the I&I program in town		Overflow Protection		H	O
Impervious Areas	Town-Wide	Private/Public	V	stormwater utility fee or building permit fee				L	S
Stormwater Management System	Town-Wide	Town/State	V/S	**See roadways and impervious areas solutions**				H	O
Emergency Shelters	Chenery	Town	V/S	improvement of mechanical systems at Chenery-including emergency generator assessment of town wide need for emergency shelter look into emergency preparation of Belmont Manor Nursing Home				M	L
Societal									
Disabled/Elderly	Town-Wide		V/S	increase cooling centers-outreach to homebound disabled/elderly transportation to cooling centers update elderly emergency preparedness plan				M	S
Non-English Speaking	Town-Wide		V	translator in public safety emergency notifications in other languages				L	S
Low Income/Homeless	Waverly, Town Meadow		V	police patrols to alert of incoming extreme weather need for social worker				L	O
Pets	Town-Wide		V	database of locations for pets to go allocation of pet friendly space				L/M	S
Youth/Teens	Town-Wide		V/S	making them aware of volunteer opportunities/creating new opportunities training for emergency preparedness				M	O
Environmental									
Town/Private Trees	Town-Wide	Town, Private	V/S	identify/evaluate town tree planting needs for climate readiness general maintenance identify pruning needs educate private property owners				H	S/O
Rats/Ticks	Town-Wide	Town, Private	V	trash pick-up compost regulations/collection program increase public awareness/signage				L	O
Wetlands	Town-Wide	Town	V/S	increase/preserve wetlands stream daylighting				M	L
Birds/Insects	Town-Wide	Town	V/S	encourage beekeeping increase habitat public education				H	O
Solar Energy	Town-Wide	Residential	V/S	study to determine what areas of town are best suited				M	L
Vector-Borne Diseases	Town-Wide		V	mosquito control projects maintain relationships with state agencies				M	O

TABLE 1

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Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Extreme Temps	Wind	Extreme Precip. + Snow	Drought	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Electric Infr.	Town	EverSource/ Town	V	• Eval. Communication strategies for usage reductions	• Selective removal of Street trees • Put lines underground w/ road projects	• Study impacts of long-term outage • Explore alternative Supplies/redundancies, communicate w/ Eversource • Microgrid Solutions • Coordinate w/ EMs for medically sensitive people ★		M	O/S
SW Infr. + Drainage (study clay pit)	Town	Town	V	• Encourage private parties to adopt green solutions - power, SW		• Study Clay Pit SW model • Upgrade sizes • Create Swales/Storage areas • Regional partnership w/ Cambridge for Storage ★★ Short-term • Feasibility of Little River	• Strengthen SW bylaw	H	S/L
Roads (All)	• Tripelo • Rt2 • Concord • Pleasant • Leonard → Prospect		V/S		• Trimming trees	• Capacity analysis for culverts at Spy Pond, Clay Pit to Blair, and Tripelo Rd • More Storage areas in clay-lined areas • Wellington by Pequosette Park • Winns by Clafton		L	L
Crit. Facilities • Beech St. • Elem. School • Cheney School	Town	Town				• Generators/microgrids • Public Survey for what resources would be located when • Public engagement/outreach for emergency services	• Partner w/ Star Market during emergencies • Backup power for McLean health facility	H	O/L
Multiple Large Private Buildings	• Belmont Day • McLane • Royal Belmont • Belmont Hill School • Churches (17) - Latter Day Saints	Private	S	add education • Eval. upgrades/efficient systems for new development • Coordinate for cooling centers/heating centers • Partner for age-specific cooling areas (ie Sprinkler park)				M	O/S
Commuter Rail/Buses/Bike Path	Town	MBTA/Private	S	• Upgrade T Stations to be ADA accessible, make more accessible to bikers, partner w/ MBTA, create commuting tourism base • Eval. bus shelters/stops for emergencies • Street trees		• Alexander Ave Ped. path - make sure properly designed for climate change		M/H	O/L
Societal									
Neighborhood/worship Communities	Town	— Private	S	• Educate groups and town on resources + needs of both groups + town		• Partnerships w/ town and groups for engagement + outreach for emergencies, Supplemental Shelters (Saint Joseph)		L	O
Well-connected Residents ~~Worship~~ ~~Communities~~	Town	~~Private~~ —	S					L	O
Housing Authority			V/S	• Study equipment needs + Communication needs, outreach		• Recognize clean-up after events, identify solutions		M	O/S
Elderly Population			V	• System for checking-in, home health care, reverse-911, educate population on opt-in for reverse 911				H	O
Socially Isolated Pop. disabled, language barriers, isolated, homeless, climate refugees	Town		V	• Fund shelters w/ showers/cloth swaps for homeless/low income folks/coop. w/ churches/private centers/Underwood pool, hockey rink • Database of vulnerable populations		★		H/M	S
Regional Partnerships - surrounding towns/cities, Mystic River			S/V			★★ • Feasibility study for pumping Clay Pit Pond, partner w/ Cambridge		H	L
Environmental									
I/I pollution		Town				• Depave large parking lots, Increase number of SW swales, LID, partner with private (ie. Saint Joseph's) • Incentives for private partnerships • Repair Sewage pipes • Inventory Septic Systems		M/H	O/S
Green Space (including Belmont Acres)/Street Trees/dense areas - no parks		Town/Private	S/V	• Along travel lanes, dense areas - Street trees, Underwood Park	• Replant w/ more resilient plantings		• Purchase off-road equipment for FD for fire prevention/fighting	H	L
Streams - flashy, erosion	• Beaver Brook • Wellington • Winn's Brook	—		• Plant tree at Stream banks		daylight streams to expand capacity	• Pass wetlands bylaw	M	L
Wildlife		—	V/S	• Wildlife-favored tree plantings/enhancements - river side • Become Natural Wildlife Habitat Certified as a community + Audubon Certified • Educational outreach			• Partnerships w/ town + regional vets for sick wildlife • Identify wildlife rehabilitators • plantings which provide food for wildlife	M	S/L
Little Industrial Activity	• Purecoat North	Private	V/S			• Keep out of flood zone, make easily accessible		M	O
Pests - invasives, rats, mosquitos, ticks		—		• Public engagement/education for reducing standing water				H	O

* Table 4 *

Table #2

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

H-M-L priority for action over the **S**hort or **L**ong term (and **O**ngoing)
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Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Extreme Temps	Wind (all-encompasing)	Extreme Precipitation + Snow storms	Drought	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Public Transportation + Roads	townwide	State/Town/MBTA	V	build sidewalks, maintain them, and require residents to clean them	↑ hazard tree maintenance ↑ funding for tree maintenance contract	educate public to stay home/dont drive/not use salt on sidewalk	permeable pavement sidewalks, ↑ infiltration ↓ ice on rd	H	O
Electric Infrastructure	townwide	Town	B	education for public on time of use during heat waves + on automated timers to prevent brownouts	have new regulations requiring new developments have underground utilities	continue heatsmart program - rebates for heat pumps + efficient appliances		H	O
Stormwater/sewer infrastructure	townwide	Town	V			sewer lining program clean CBs 2x yr street sweeping 2x yr	↑ money for maintenence + upkeep	H	O
Drinking water infrastructure system	townwide	Town	B				consider implementing Town regulated water ban	L	O
Emergency Shelters/Senior Center	Middle School/Senior center	Town	S	battery storage system for library power	analysis of feasibility of solar backup on senior center backup power redundancy	solar panels on back of new police station for redundancy		H	S/O
Townwide/Emergency Communication	townwide	town + Various	B			more education on [illegible] all system, have people sign up at any public office		H	S/O
Societal incinerator site		town	V			put cap on to prevent water into contaminated soil		H	O
Seniors	townwide	N/A	V		information distributed wellness checks during hazards		emergency transportation	H	O
Youth 0-5 yrs	townwide	N/A	V	outreach on illness	information sessions on emergency preparedness @ library, rec dept, pool	fire, health dept, police, town clerk brochures made	target places these communities frequent	H	O
non-english speakers	townwide	N/A	V			chinese american organization		H	O
high education level in Town	townwide	N/A	B	create a database of people in town + their expertise so the town can use their knowledge	education about volunteering	citizens emergency response team - recruit new people from various backgrounds		M	O
disabled population	townwide	N/A	V					H	O
multiple business centers	3+ (multiple)	N/A	S		become public information centers	walkable resources during a hazard		M	O
Environmental									
Streams + ponds + wetlands	townwide	town	B		belmont wetlands bylaw implementation	↑ conduct study to see how they can become more resilient ↑ rain gardens to increase infiltration for recharge		M	O
open space	townwide	town/private	B				side by side UTV w/water tank to fight brush fires	M	S/O
trees	townwide	town/private	B		hazard tree removal tree trimming			H	O
air quality	townwide	N/A	V	information dissapation to public about health ↑ public transportation, ↓ cars on rd complete the bike path				H	O
pests (rodents, coyotes, ticks, mosquitos, geese)	townwide	N/A	V	BTI to treat mosquitos in ponds - Towndues signage in recreation areas about ticks + mosquitos				H	O
recreation space	townwide	town	S				maintain well irrigation system for fields	M	O

Community Resilience Building Risk Matrix

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Features	Location	Ownership	V or S	Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)				Priority	Time
				WIND	Extreme TEMPS	Extreme PRECIP.	Drought	H-M-L	Short Long Ongoing
Infrastructural									
3 Municipal buildings	Townwide	Town	B	fortify HVACs on roofs + roofing tiles; Building Plan – Library Plan for St. W. Station 1 – flooding – decommission (10 year plans) 3-4 in	window weatherization	Elevate mechanical systems in Buffer + others to reduce flooding		M	O
2 electric ~~Belmont~~ ~~Electric~~ ~~Water~~ utilities overhead	Belmont L underground	Belmont Light	B	3/4 underground; Tree-trimming/maintenance		Solar on old incinerator site (need cap)	→ need assistance permits during storm	H	O
water (potable) utilities underground	Townwide Quabbin	Town MWRA	Infra-S MWRA-V/S						
Transportation Town + MBTA	Townwide	Town managed MBTA	Redundancy-S Size-S Closure-V	ID LID stormwater opps (bump outs) / Assessment for opps LID; Clifton + Hickory Lane (private) – Update culverts (Beaver, Brook); Belmont St + Lexington St. flooding] – manage more stormwater onsite				H	O
Stormwater	Townwide	Town (mainly)	V					I	S/O
Sewer (I/I impacts) 3-pump stations	Townwide	Town	V	Disconnect sump pumps + other illicit connections; eval system for impact of Extreme Precip + Leaks (MS4)				H	O
Societal									
Seniors – Belmont Manor	Townwide	—	V	↑ OK	More transit opps (vans) for getting ppl to shelters; form partnerships	BEMA – ERP (H-S)			T
Housing Authority (state) + Housing Trust (town)	multiple	Quasi-State	B	Communications		Upgrades + address mold/public health threats			O/L
Non-English/English second language	Townwide (residences)	—	Network-S Comms-V	Strategy & implementation Translation				M	
Schools & Youth pre-K, daycare (w/ out ppl)	Townwide	Town private	new-S ~~old~~-V B		More cooling @ Schools	Re-examine shelter capacity			
People who are Disabled	townwide	—	V		Translated material – work w/ other groups more coordination				
Low-income	Town-wide	—	V-top	↓				—	L
Environmental									
Trees (aging)	Townwide	Public Private	B	Tree planting plan + consider the species + windbreak + infra conflicts	→ + consider climate extreme temp ~~heat~~ tree-trimming	+ consider air quality	watering plans	H	O
Stormwater quality	townwide	Town	V			Regs on pesticides, etc + edu / incentive + regs for LID/GI	→ especially on redevelopment	H	O
~~Climate~~ ~~Air~~ quality – areas w/ less open space	townwide	—	V		Heat pump program; EV charging stations	Transportation Plan / OSRP Plan		L/M	O
Access to open space – Hudson, Hill school, McLean	need to map parks walkability	Public Private	V-depending on owner S-public space		Complete Streets to Grove Park			L	O
Beaver Brook – vector borne	mos-townwide Rats-Access	—	V		$ for treatment to Mosquito control collaborative; Edu for Cats + Bats	Bird/Bat houses		H	O
Gas line	Townwide	Nat Grid	V		Reducing gas connections	~~[illegible]~~ study		L	L
Incinerator site \ transfer station	Concord Ave	Town	V		OR demand	Needs capped + Solar; contaminates Charles wetland vegetation G.W. quality		Super H	S

* Table 4 *

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V = Vulnerability **S** = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Extreme Temps	Wind	Extreme (incl. snow) Precipitation	Draught	Priority H-M-L	Time Short Long Ongoing
Belmont Light (etc.)									
Infrastructural ~~Overdevelopment~~	~~Belmont Hill~~	~~Private~~ Town	V/S	- assessment to determine readiness					
Roadways	Town-wide	Town/State	V			study to identify vulnerable roadways and SW flooding solutions		H	O
~~High School~~ Data Centers	library Homer	Town	V/S	- install HVAC + redundant power - increase data storage				H	S
Little Pond/Clay Pond/Mill Pond		DCR	V	- pollution reduction program		overflow protection		H	O
Impervious areas	Town-wide	private/public	V	+ accelerating the I+I program in town - Stormwater utility fee ↳ or building permit fee (based on sf)				L	S
Stormwater Mgmt System	Town-wide	Town/State	V/S	* see roadways + impervious area*				H	O
Emergency Shelters	Chenery ~~High School~~	Town	V/S	improvement of mechanical systems @ Chenery - including emergency generator - assessment of townwide need for emergency shelter look into emergency preparation of Belmont Manor Nursing Home				M	L
Societal									
disabled/elderly	Town-wide		V/S	Increase cooling centers - outreach to homebound disabled/elderly - transportation to cooling centers - update Elderly Emergency Preparedness Plan				M	S
non-english speaking	Town-wide		V	- translator in public safety - emergency notifications in other languages				L	S
low income/homeless	Waverly Rock Meadow		V	- police patrols to alert - need for social worker		- police patrols to alert		L	O
pets	Town-wide		V	- database of locations for pets to go - allocation of pet friendly space				L/M	S
~~Small business owners~~	Commercial district		V/S						
youth/teens	Town-wide		V/S	- making them aware of volunteer opportunities/creating new opportunities - training for emergency preparedness				M	O
Environmental									
Town trees (private)	Town-wide	Town private	V/S	- identify/evaluate town tree planting needs for climate readiness - general maintenance - identify pruning needs - educate private property owners				H	S/O
rats/ticks	Town-wide	Town/private	V	- trash pick up - compost regulations/collection program - increase public awareness/signage				L	O
wetlands	Town wide	Town	V/S	- increase/preserve wetlands - stream daylighting				M	L
birds/insects	Town wide	Town	V/S	- encourage beekeeping/chicken keeping - increase habitat - public education				H	O
solar energy	Town-wide	residential	V/S	- study to determine what areas of town are best suited				M	L
vector borne diseases	Town wide		V	- Mosquito control projects Maintain relationships w/ state agencies				M	O

ARLINGTON
LEXINGTON
CAMBRIDGE
WALTHAM
WATERTOWN
Belmont Hill
Mill Pond Dam
Duck Pond Dam
Clay Pit Pond
Little Pond
Legend
Back-up EOC
Belmont Light
Belmont Municipal Light Terminal Station
Belmont Public Library
Belmont School Department
Belmont Town Hall
Belmont Water
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Fire Department
Food/Grocery/Supply Store
Gas Station
Hazardous Material Site
Homer Municipal Building
Hospital/Clinic
Housing Authority Unit
Library
Nursing Home/Assisted Living
Places of Worship
Police Department
Power Substation
School
Temporary Police Department
Underground Storage Tank
Landfill
Conservation/Protected Land
Open Space
Bridge
FEMA National Flood Hazard Layer
1% Annual Chance of Flooding (Zones A, AE, AH, AO)
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Waterways
Rivers, Streams, and Brooks
Marsh/Bog/Wooded Marsh
Lakes, Ponds, Reservoirs
Environmental Justice 2010 Populations
>25% of residents are people of color (EJ 2010 Populations)
>25% of residents are 65+ (Census 2010)
>25% of residents are <18 (Census 2010)
Transportation
Railroad
MBTA Station
MBTA Commuter Rail (Active)
MBTA Bus Stop
MBTA Bus Route
FIGURE 1
TOWN OF BELMONT, MASSACHUSETTS
MUNICIPAL VULNERABILITY PREPARDNESS HAZARD AND FEATURE MAP
JANUARY 2020
SCALE: NOTED
Weston & Sampson
limited open space
Uplands - Van Swita partnership
UTV for Fire/Emergency access
fees for impervious surfaces
incentives for pervious paving in residential
bylaws/by-laws to residential run-off
commercial
flooding
need better tree canopy
Trapelo corridor predominant public transit users far from civic centers

FIGURE 1
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Weston & Sampson
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WATERTOWN
Miles
Belmont Hill
Concord Avenue
Trapelo Road
Belmont Street
Mill Pond Dam
Duck Pond Dam
Clay Pit Pond
Payson Park Reservoir Dam
Alewive station
exists
potential Bike Path
not in Key
Students
water shed for whole hill
Single storm drain street floods w/ heavy rain
easement that connects storm drain to Thomas st underground
Not under 18
cemetary
not a lot of Under 18

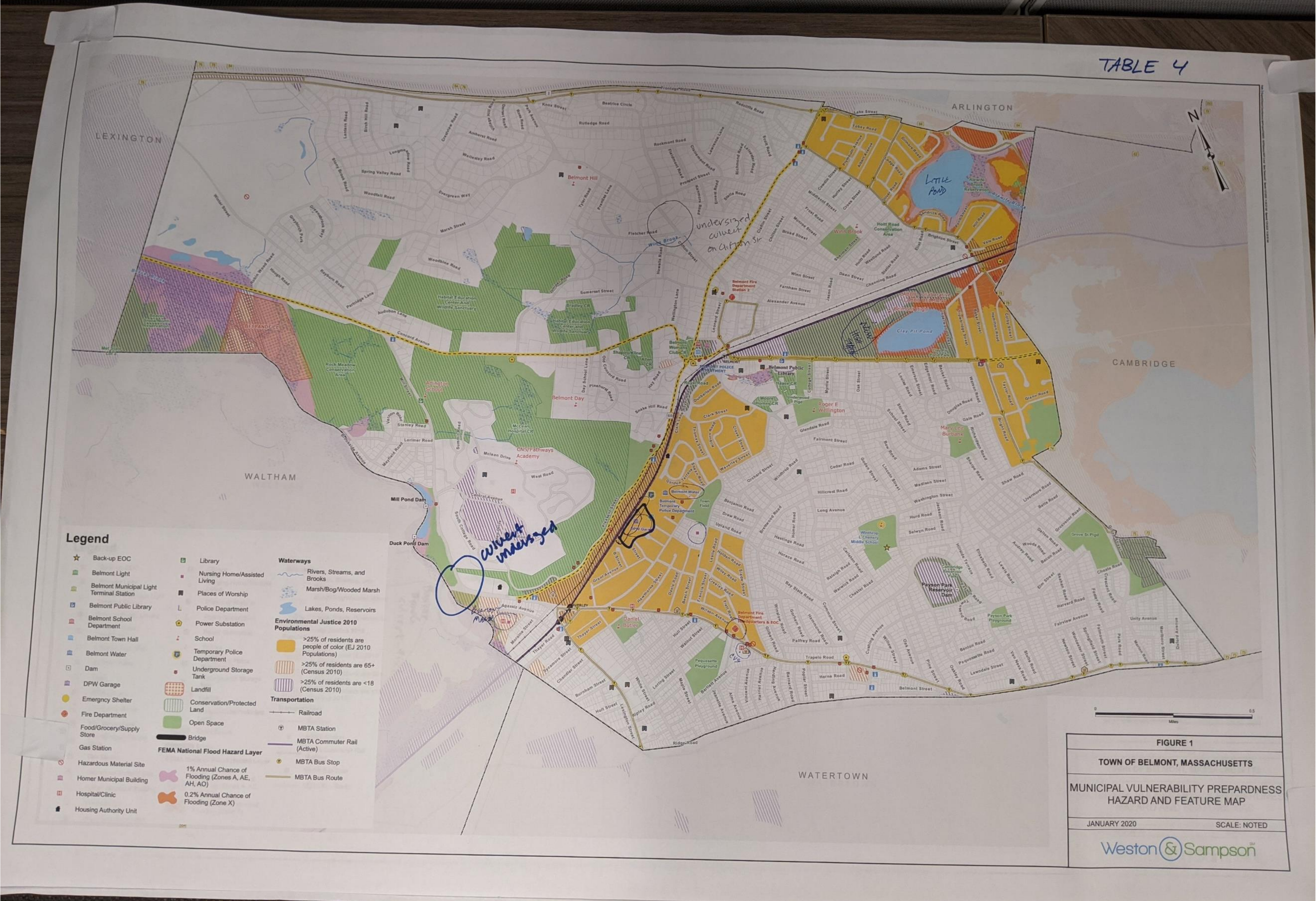

TABLE 4
LEXINGTON
ARLINGTON
CAMBRIDGE
WALTHAM
WATERTOWN
N
LITTLE POND
undersized culvert on Clifton St.
culvert undersized
Clay Pit Pond
Belmont Hill
Belmont Day
Rock Meadow Conservation Area
Habitat Education Center And Wildlife Sanctuary
CNS/Pathways Academy
Mill Pond Dam
Duck Pond Dam
Belmont Public Library
Belmont Police Department
Belmont Fire Department Station 2
Belmont Fire Department Headquarters & EOC
Roger E. Wellington
Winthrop L. Chenery Middle School
Payson Park Reservoir Dam
Pequossette Playground
Daniel Butler
Concord Avenue
Trapelo Road
Belmont Street
Pleasant Street
Common Street
Legend
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MBTA Bus Route
0
0.5
Miles
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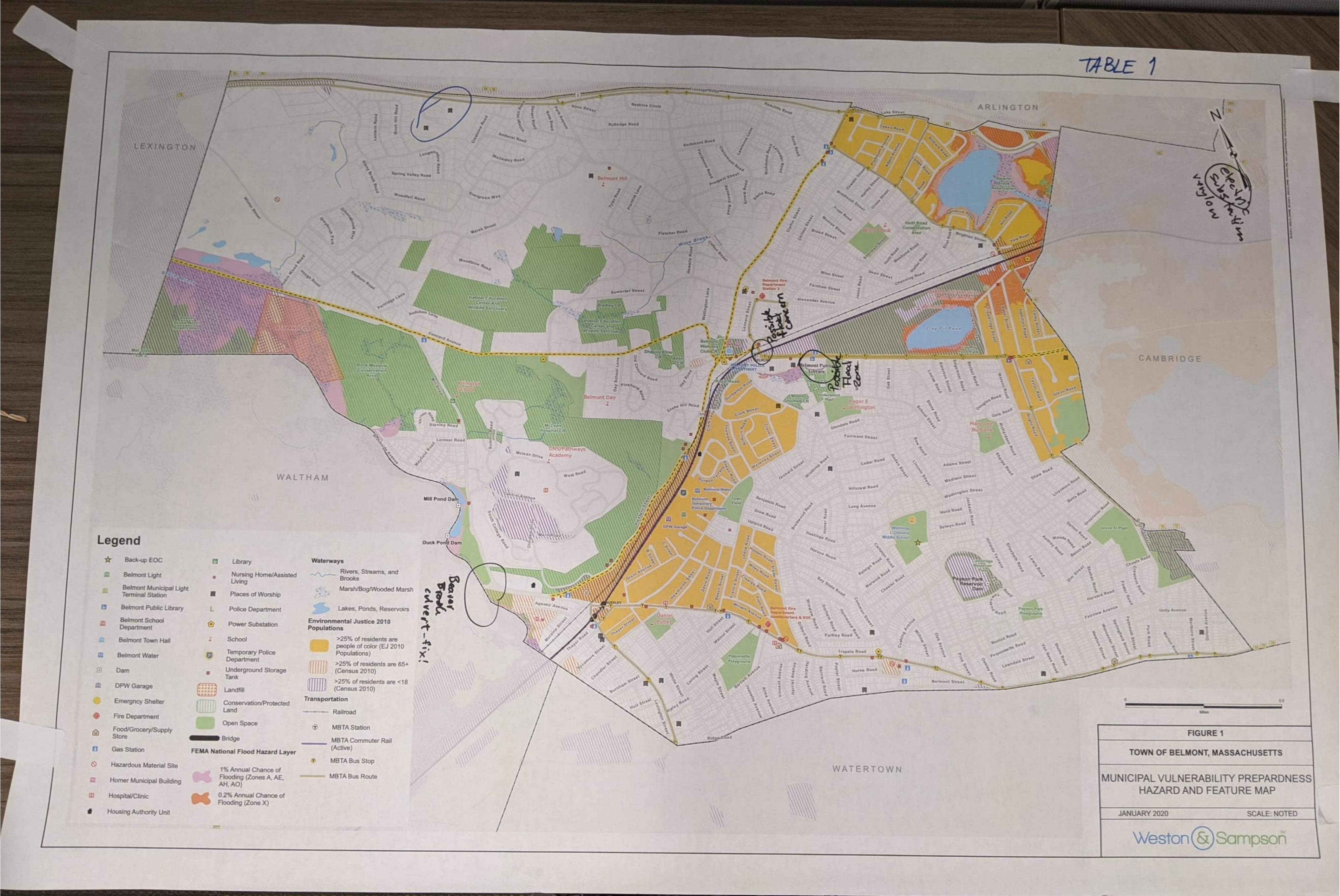
MUNICIPAL VULNERABILITY PREPAREDNESS HAZARD AND FEATURE MAP
JANUARY 2020
SCALE: NOTED
Weston & Sampson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Belmont Fire Department Headquarters & EOC
Daniel Butler
Belmont Temporary Police Department
DPW Garage
Possible flood concern
Possible Flood Zone
Beaver Brook culvert-fix!
electric substation very low

APPENDIX D

Public Engagement

TOWN OF BELMONT

Hazard Mitigation and Climate Adaptation Planning

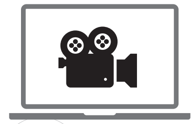
April 2020

Weston & Sampson

Photo: Lidar Speed Enforcement on Concord Ave. Photo by Belmont Police, 2019, via Twitter.

WEBINAR LOGISTICS

ONLINE EVENT



RECORDING

SURVEY

AGENDA

PRESENTATION AND DISCUSSION:

- Overview of Climate Change
- Strengths and Vulnerabilities
- Priority Action Items
- Next Steps

Photo: Downed tree and power line at School Street and Bow Road. Photo by Belmont Light, 2019, via Twitter.

MVP PROVIDES OPPORTUNITIES

- Improved **resilience and preparedness** of natural and climate-driven hazards
- **Collaboration with stakeholders** about climate change, natural hazards and impacts
- **Increased education**
- **Planning, and implementation** of priority actions
- **Funding** for resilience actions as well as efforts that are not exclusively resilience-based (i.e. improved parks, infrastructure)

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MVP COMPONENTS

PHASE 1 - PLANNING

- Receive Planning Grant
- Prioritize Action Items
- Complete MVP Program
- Submit Final Report for Approval
- Become Certified

PHASE 2 - ACTION

- Select an Action Item from Planning Phase
- Apply for Action Grant Funding
- Up to $2 million for planning, design, permitting, construction
- 25% grant match in cash or in-kind
- $10-15 million available

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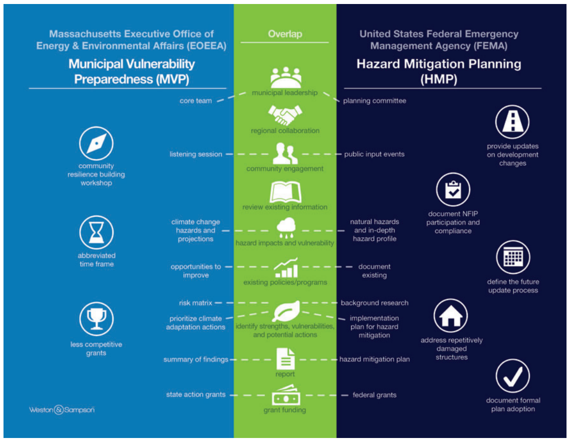
MVP ACTION GRANTS PROJECT TYPES

- **Vulnerability and Risk Assessment**
  - Community Outreach and Education
  - Local Bylaws, Ordinances, Plans, and Other Management Measures
  - Mosquito Control Districts
- **Redesigns and Retrofits**
  - Stormwater and Infrastructure Upgrades
  - Subsidized Low-Income Housing Resilience Strategies
  - Chemical Safety
  - Energy Resilience
- **Nature-Based Solutions**
  - Land Acquisition for Resilience
  - Ecological Restoration and Habitat Management to Increase Resiliency
  - Flood Protection, Drought Mitigation, Water Quality, and Water Infiltration Techniques
  - Infrastructure and Technology to Extreme Head and Poor Air Quality
  - Reduce Vulnerability to other Climate



SCOPE OF WORK

Core Team Meeting: Oct 15, 2019 → Hazard Analysis: Nov - Jan 2019 → CRB Workshop: January 27, 2020

Hazard Analysis: Nov - Jan 2019
- Updated Critical Facilities List
- Reviewed Hazard Mitigation and Climate Adaption Capacity
- Interviewed Key Staff

Drafted Priorities: Feb-Mar 2020 → Public Webinar: April 2020 → Public Comment: Coming May 2020

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TODAY'S SUMMARY

Focus on 4 Hazards

Identify:
- Vulnerabilities
- Strengths
- Priority Action Items

Across 3 Categories
- Infrastructure
- Societal
- Environmental

TOP HAZARDS IN BELMONT

Extreme Temperatures

Wind

Extreme Precipitation and Snow

Drought

EXTREME TEMPERATURES

WARMER ANNUAL AIR TEMPERATURES
UP 0.5°F PER DECADE SINCE 1970, ON AVERAGE

WARMER WINTERS
UP 1.3°F PER DECADE SINCE 1970, ON AVERAGE

Source: ResilientMA.org, "Rising Temperatures," 2017

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EXTREME TEMPERATURES
IN MASSACHUSETTS

6	24	35
2005 OBSERVED ANNUAL AVERAGE	MID-CENTURY PROJECTED ANNUAL AVERAGE	END-OF-CENTURY PROJECTED ANNUAL AVERAGE

DAYS WITH TEMPERATURES ABOVE 90°F

145	114	101
2005 OBSERVED ANNUAL AVERAGE	MID-CENTURY PROJECTED ANNUAL AVERAGE	END-OF-CENTURY PROJECTED ANNUAL AVERAGE

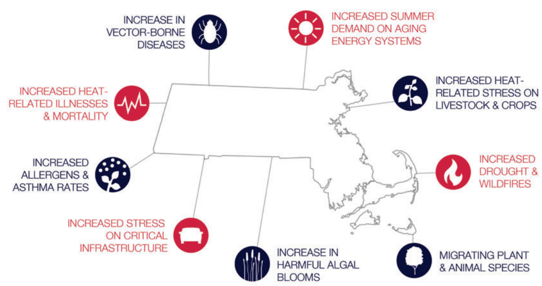
DAYS WITH TEMPERATURES BELOW 32°F

Massachusetts Executive Office of Energy & Environmental Affairs. 2019. "ResilientMA Datagrapher." Massachusetts Climate Change Clearinghouse. Resilientma.org/datagrapher/?c=Temp/state/tx90/ANN/MA/
Notes: Mid-century projected annual averages use a 2040-2069 time range. End-of-century project annual averages use a 2080-2097 time range.

IMPACTS OF **RISING TEMPERATURES**

WARMER ANNUAL AIR TEMPERATURES
UP 0.5°F PER DECADE SINCE 1970, ON AVERAGE

WARMER WINTERS
UP 1.3°F PER DECADE SINCE 1970, ON AVERAGE



Massachusetts Executive Office of Energy & Environmental Affairs. 2019. "Rising Temperatures." Massachusetts Climate Change Clearinghouse. http://www.resilientma.org/changes/rising-temperatures

CHANGES IN PRECIPITATION

MORE **INTENSE & FREQUENT** EXTREME RAIN EVENTS

PRECIPITATION DURING **HEAVY EVENTS** IN THE NORTHEAST **INCREASED BY MORE THAN 70%** BETWEEN 1958-2010

Massachusetts Executive Office of Energy & Environmental Affairs. 2019. "Changes in Precipitation." Massachusetts Climate Change Clearinghouse. Resilientma.org/changes/changes-in-precipitation

EXTREME PRECIPITATION

8%

Increase in extreme precipitation events by midcentury

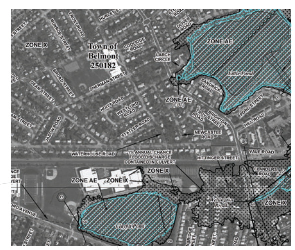
13%

Increase in extreme precipitation events by 2100

Source: Executive Office of Energy and Environmental Affairs, Adaptation Advisory Committee. 2011. "Massachusetts Climate Change Adaptation Report," 19.

FLOODING

New walkway and drainage improvements near the Belmond Center Commuter Rail on Concord Ave. Photo credit: Town of Belmont, 2018, via Twitter.



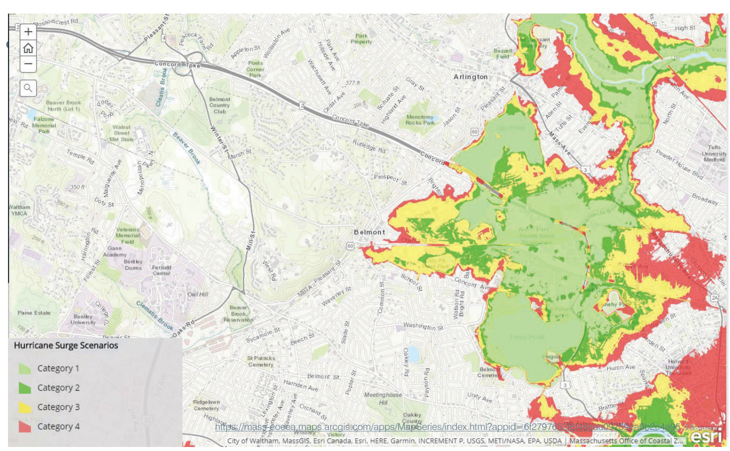
A portion of the FEMA Flood Insurance Rate Map (FIRM) for Belmont

WIND-RELATED HAZARDS

Downed tree and power lines. Photo by Belmont Light, 2019, via Twitter.

- These hazards include hurricanes, tornadoes, and high winds during severe storms
- Falling trees and downed power lines causing power outages are a top concern
- Upward trend in North Atlantic hurricane activity since 1970
- The Town's 100-year wind speed is 110 mph

Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 14.



Boston Sea Level Rise Projections (ft)

Increased coastal flooding

Permanently inundated low-lying coastal areas

Increased shoreline erosion

Emission Scenario	2030	2050	2070	2100
Intermediate	0.7	1.4	2.3	4.0
Intermediate-High	0.8	1.7	2.9	5.0
High	1.2	2.4	4.2	7.6
Extreme	1.4	3.1	5.4	10.2

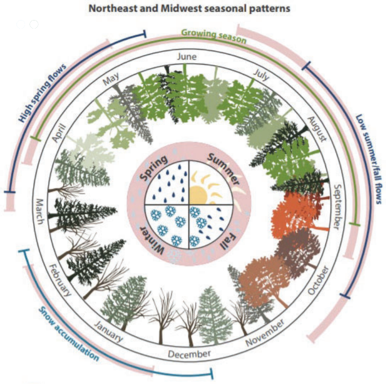
(Source: Northeast Climate Adaption Science Center)

WINTER STORMS

- The blizzard of 2013 left nearly 400,000 Massachusetts residents without power[1]
- "Heavy blizzards are among the most costly and disruptive weather events for Massachusetts communities."[1]
- The average annual snowfall for most of Belmont is 48-72 inches.[2]

1: Resilient MA Climate Change Clearinghouse for the Commonwealth. "Extreme Weather," 2017.
2. Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 15.

Northeast and Midwest seasonal patterns



Shifted season projected from increasing temperatures and precipitation changes
Image credit: Northeast Climate Science Center, University of Maryland Center for Environmental Science

2016

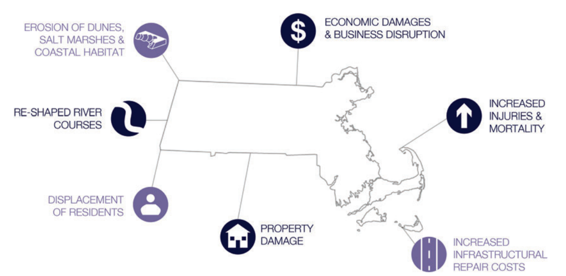
The most notable recent drought event was in

The occurrence of droughts **lasting 1 to 3 months** could go up by as much as **75% over existing conditions** by the end of the century, under the high emissions scenario

Source: Executive Office of Energy and Environmental Affairs, Adaptation Advisory Committee. 2011. "Massachusetts Climate Change Adaptation Report," 17.

IMPACTS OF **EXTREME WEATHER**

STORMS ARE BECOMING MORE INTENSE AND DAMAGING



Massachusetts Executive Office of Energy & Environmental Affairs. 2019. "Extreme Weather." Massachusetts Climate Change Clearinghouse. http://www.resilientma.org/changes/extreme-weather

Take the online survey to tell us **what hazard most concerns you**

STRENGTHS AND VULNERABILITIES

Photo: Downed tree and power line on Hurd Road. Photo by Belmont Light 2018, via Twitter.

INFRASTRUCTURE STRENGTHS

- Mobility options - commuter rail, buses, and bike path
- Critical facilities
- Data centers
- Emergency communication
- Drinking water infrastructure is all new
- MWRA has adequate water supply
- Locally managed electric infrastructure
- Municipal buildings
- Roadway access
- Opportunities for nature-based stormwater solutions
- Multiple large, private buildings and entities that could be great resources

INFRASTRUCTURE VULNERABILITIES

- Sanitary sewer system and pollutant loading
- Reliance on critical services and facilities and need for redundancies
- Occasional brownouts during high temperature events
- Aging and undersized stormwater infrastructure (Beaver Brook Culvert, Clifton and Hickory, Belmont St and Lexington St, Trapelo Rd)
- High maintenance demand to upkeep roadways and sidewalks
- Aging municipal building stock
- Flooding of substation 1 (decommissioning)
- Need additional data storage

Photo: Routine pole and transformer replacement on Beech Street. Photo by Belmont Light, 2018, via Twitter.

SOCIETAL STRENGTHS

- Multiple business centers
- Well connected and informed residents
- Neighborhood and worship communities
- Diverse perspectives and experiences across ages, abilities, and cultures
- Regional partnerships – Mystic River Watershed Association
- Current Housing Authority and Housing Trust properties
- Emergency shelters
- Senior Center

Community Centers

Photo by the Belmont Police Department.

SOCIETAL VULNERABILITIES

- Households with limited English-speaking abilities if communication is not translated
- At-risk of isolation or need of additional support (possibly youth, seniors, people with disabilities)
- Barriers to building personal resilience (income or homelessness)
- Need for more affordable and safe housing and to upgrade current facilities
- Need for shelter capacity checks
- Heat-related illnesses

ENVIRONMENTAL STRENGTHS

- Overall access to open space and recreation
- Little industrial activity compared to other communities
- Solar energy installments and opportunities
- Tree canopy and street trees
- Wetlands provide flood storage

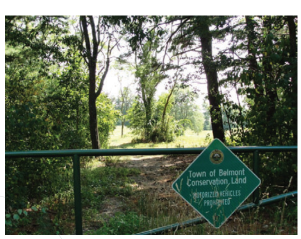


Photo credit: Franklin Tucker, Patch Staff

ENVIRONMENTAL VULNERABILITIES

- Few dense areas with less open space
- Air quality on hot days
- Aging gas lines
- Water quality (inflow and infiltration pollution, illicit connections, stormwater runoff)
- Vector borne diseases (from mosquitos and ticks)
- Invasive species and pests (rats, coyotes, geese)
- Native species in hotter temperatures and drought
- Flooding of waterbodies and flash flooding of streams
- Erosion near Beaver Brook, Wellington, and Winn Brook
- Loss or deterioration of wetlands
- Hazardous waste sites (historic incinerator and transfer site)
- Lots of impervious surface
- Trees are aging and need to plant more

EXISTING HAZARD PROTECTION

HIGHLIGHTS
- Emergency power generators
- Comprehensive Emergency Management Plan (CEMP)
- Drainage infrastructure maintenance
- Tree-trimming, removal, and planting program
- No outdoor burning
- Middlesex Mosquito Control District participation
- Site plan review
- Floodplain district in zoning
- Public education on stormwater management

Source: Metropolitan Area Planning Council (MAPC). 2011. "Town of Belmont Hazard Mitigation Plan," 30-35.

HIGH PRIORITY

- ***Replace the Trapelo Road Culvert**
- **Perform a culvert right-sizing study** to upgrade other culverts
- **Cost-benefit analysis of flood management projects**
- **Model existing drainage system** utilizing updated rainfall data to evaluate flooding conditions under projected climate change conditions
- **Place cap on incinerator site** and implement Select Board approved post closure uses
- **Improve electrical resiliency** of the Town and critical facilities through new generators or renewable microgrids
- **Develop an Emergency Response Plan**, include a wellness check for elderly populations
- **Increase education on Reverse 911 system**

MEDIUM PRIORITY

- Study and assess the costs and benefits of **flood reduction strategies**, investigate overflow protection, and *enlarging pond outlets
- *Implement flood mitigation measures in **Tri-Community Working Group 2004 report**
- **Identify low impact development** stormwater management opportunities and reduce impervious surfaces
- Implement a stormwater utility fee or a building permit **fee**
- Create **more transit options** to get people to shelters in an emergency
- *Document **emergency flood preparation**, emergency response capacity, and **ensure shelters are properly stocked with essentials**.
- Develop a **comprehensive tree management plan** and *increase tree maintenance efforts and funding.
- **Improve preparedness outreach and education** for vulnerable populations

MEDIUM PRIORITY

- Increase participation in the **HeatSmart Program**
- ***Develop a brush fire prevention maintenance** program for Town owned conservation properties
- **Develop FireWise Program** to help educate residents on fire prevention and hazardous materials
- Install low impact development and **green infrastructure in parks**
- **Adopt a wetlands bylaw**
- **Restore wetlands** impacted by poor water quality and development
- ***Acquire priority parcels** for many uses including flood storage, stormwater infiltration, and conservation
- Increase alternative transportation routes by **building more sidewalks and completing the bike path**

Take the online survey to tell us which of these items should be a **top priority for MVP Action Grant funding**

SHARE YOUR FEEDBACK!

- Comment on the webinar by taking our survey! The survey will be available online from **April 22- May 6, 2020**

  https://tinyurl.com/BelmontMVPSurvey

- Review the draft HMP-MVP report online and provide comments

  Coming May 2020

THANK YOU

Weston & Sampson

Hazard Mitigation and Municipal Vulnerability Preparedness Plan Listening Session

April 22nd, 2020 6:30-8:00

In keeping with Governor Baker's Executive Order of March 12, 2020; "Order Suspending Certain Provisions of the Open Meeting Law" – All Participation for Town Residents will be through an online meeting platform. The meeting will be recorded and posted online for those unable to attend the meeting virtually. We are encouraging all residents to join the meeting through Zoom rather than through the phone. By joining online, you will be able to view the presentation and provide input. We apologize in advance for any technology issues. We will join the meeting fifteen minutes early to try to help resolve any issues. Please email or call Jon Marshall, jmarshall@belmont-ma.gov, if you have other barriers to participation.

To join via computer or smartphone:

- Go to tinyurl.com/BelmontMVP
- Follow on-screen instructions
- Enter your full name under participant

Questions and comments will be accepted through the chat feature. If you would like to verbally ask a question, please message the moderator who will then call on you by name.

Agenda

Introductions	5 minutes
Municipal Vulnerability Preparedness (MVP) Program Overview	10 minutes
Climate Change in Belmont	15 minutes
Strengths in Belmont	15 minutes
Vulnerabilities in Belmont	15 minutes
Summary of Existing Mitigation Measures in Belmont	10 minutes
Priority Action Items in Belmont	15 minutes
Wrap-up	5 minutes

Attendance – at least 27 people, plus viewers on Belmont Media

Questions:

- What have you learned re: COVID that might apply to climate preparedness?
  - We are still learning and hope to document our lessons learned.
- Are the reports you referenced easily available on the same url?
  - The report will be available in mid-June. The Town's previous report is available online.
- Are urban heat islands included?
  - Although not a major focus of the plan, heat was discussed.
- What kinds of green parks are done with the MVP program?
  - Increasing tree canopy, creating urban heat island refuges (splash pads), and incorporating low impact development stormwater controls.
- While we did raise the ground floor of the new Middle and High School project, the potential for Clay Pit Pond to flood continues to exist. Within what was listed in the presentation, are mitigation measures for Clay Pit Pond flooding being studied?
  - Yes, the cost-benefit analysis for areas that may experience flooding priority action item.
- Can you say more about the cost benefit analysis?
  - Several places in Town have been identified as areas with potential flooding. This analysis would examine the solutions for each of these areas and determine what solution is best for each location.
- What about islandable street lights? and traffic lights?
  - Solar energy resilience is fundable though the MVP program.
- Just a comment--it seems like Belmont is starting from a place of a lot of strengths, both in terms of what the town has done already, and its geographical location.
- You mention as an infrastructure strength the bike path? Is that the proposed community path yet to be built or an existing bike path?
  - The priority action item relates to expanding the bike path to Cambridge. The Infrastructure strength would be the existing paths in Belmont.
- Can you relay how the state review the priorities of the applicants? I.e., are there certain areas they are more interested in funding than others?
  - Nature-based solutions, regional projects, project that provide multiple co-benefits and projections, and have a robust community engagement approach.
- What would be a solution for transit to emergency shelters?
  - Creating a plan to use vehicles that would no longer be in use, such as town-owned vans or school buses.
- Do you anticipate that the state will still be able to fund the program beyond this cycle? Is there any talk of more money going in or out?
  - Yes, this is a priority of the current administration.
- Is funding available for weatherizing buildings in order to be more appropriately used in heat events?
  - Project like this would possibly be funded through the MVP program, but with the current scoring criteria nature-based climate adaptation solutions are prioritized. The Green Communities program may be a better fit for this type of work.

- Any stand-out communities?
    - Millbury is an example of a community that leveraged federal grant funding and in-kind match to secure $1 million in funding for green infrastructure projects in their downtown.
    - Here is the press release that lists the towns, amount, and project titles that were most recently awarded earlier this year: https://www.mass.gov/news/baker-polito-administration-awards-116-million-in-climate-change-funding-to-cities-and-towns
- What is the total $ amt of grant $ available to Belmont ?
    - $2 million dollars per grant cycle and $5 million for a regional grant.
- How would a shared project like the Trapelo Culvert, shared with Waltham be divided financially, is it considered regional?
    - Regional projects financial match is determined by the communities. There would be one "champion" community, but the match funding could come from either community or both. Private foundations have also funded regional projects in the past.
- Will the State be more flexible in grant timing because of the pandemic (e.g., does this year's grant need to be completed by June 30th?
    - The project will need to be completed by June 30th. There is discussion about potential extensions, but Belmont is in a good place to finish on time.
- Could you review the next steps again?
    - The report will be available in May for a public comment review. Please take the follow up survey at: https://tinyurl.com/BelmontMVPSurvey. The project will be finished by June 30th, 2020.
- Where is that recording?
    - https://www.belmontmedia.org/watch/mvp-listening-session-04222020

55 Walkers Brook Drive, Suite 100, Reading, MA 01867
Tel: 978.532.1900

Belmont MVP Survey

Summary of Survey Results and Public Comments

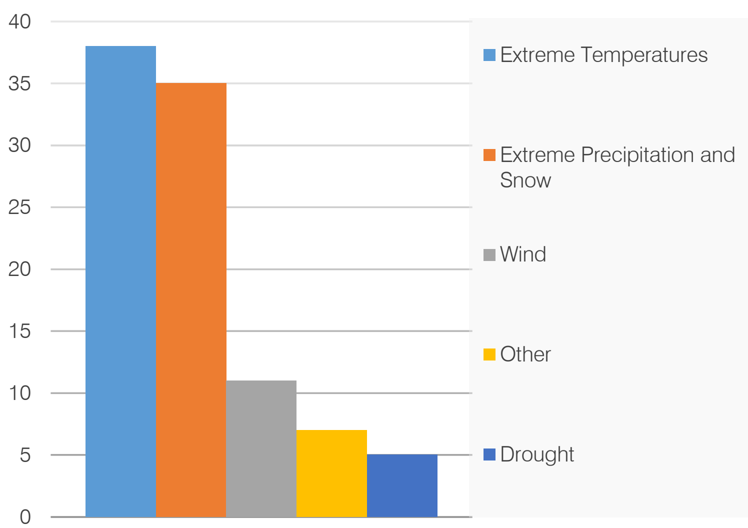
Introduction

The Town of Belmont was awarded a Municipal Vulnerability Preparedness (MVP) Planning Grant to improve the Town's resilience to climate change and to mitigate natural hazards. The MVP Program aims to provide technical and financial support for cities and towns across the Commonwealth to plan for, and mitigate the impacts from, climate change. As part of the virtual Public Listening Session, the project team shared a survey to collect public feedback related to climate hazards, strengths, vulnerabilities, and priority adaptation action items. Key information related to the results of this survey are summarized below:

- The survey was accessible on the Microsoft Forms website from April 22-May 6, 2020.
- A link to the online survey was shared on April 22nd in the MVP Listening Session and was also displayed on Belmont Media Center webpage under "Gov Access Coverage" (https://www.belmontmedia.org/). The Town also posted the link in its Website and Social Media page. Some local groups also shared the link in their pages.
- The project team received 97 online responses.

The following summary provides an overview of the survey responses, along with key findings and recommendations for using this information. A spreadsheet of short-answer responses from survey participants, along with a copy of the original survey, are included as attachments to this document.

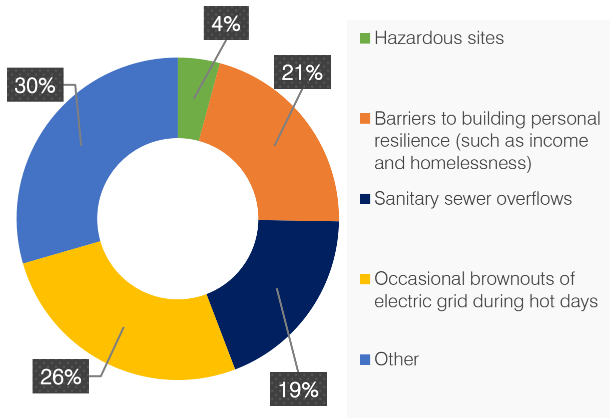
Survey Results



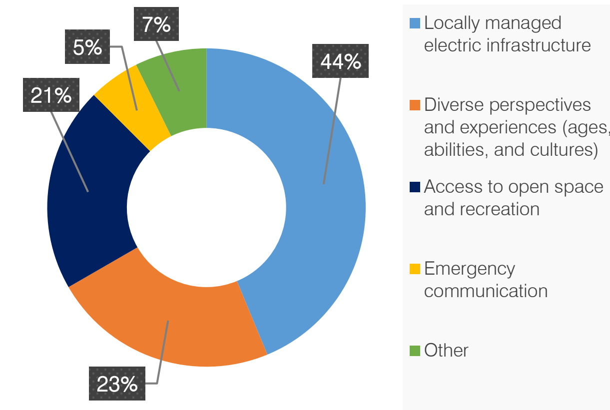
What hazard most concerns you?

- Survey results suggest that extreme temperature, extreme precipitation, and snow are hazards of most concern.
- Wind, drought, and others are hazards that are of relatively less concern among the residents

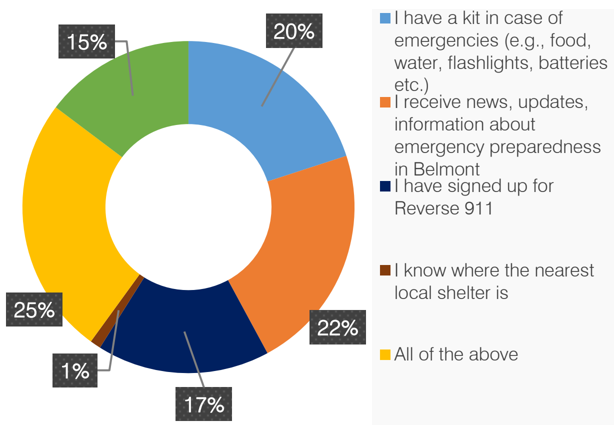
What would you consider Belmont's greatest vulnerability?



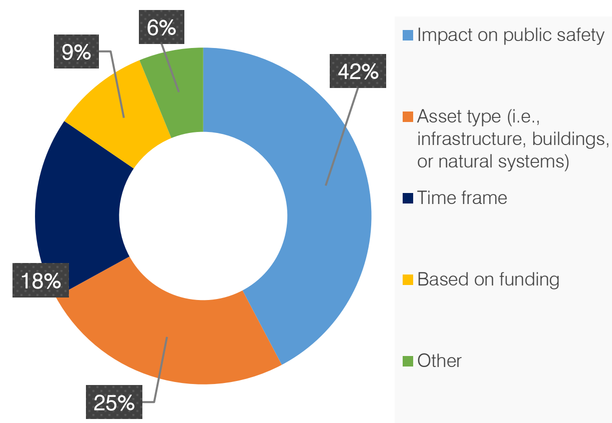
What is Belmont greatest strength considering climate resilience?



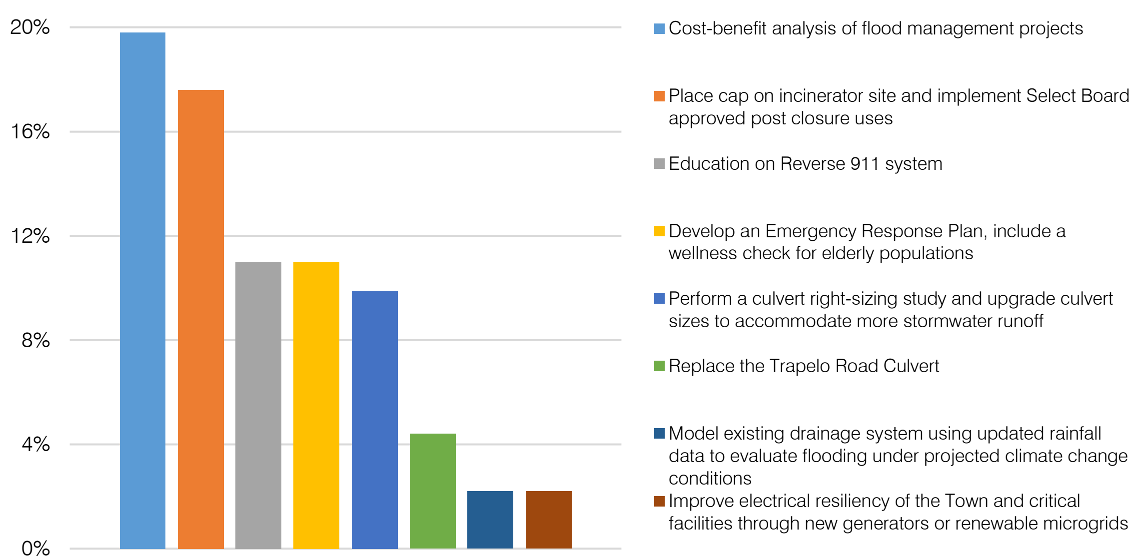
What steps have you already taken to prepare for extreme events?



How should Belmont prioritize climate adaptation measures?



Rank the following priorities from highest priority to lowest priority.



Based on responses on prioritizing actions, cost-benefit analysis of flood management projects, and placing cap on incinerator site and implementing Select Board approved post closure uses appear to be the top two priorities for town people. Whereas modeling existing drainage system to evaluate future flooding and improving electrical resiliency in the Town are of lowest priorities.

Summary of short-answer responses:

How have any of the hazards above impacted you personally or the broader community?

- Hazards having the most impact both personally and the broader community in Belmont is flooding (53 out of 89 responses). Flooding causes property damage both residential and commercial and according to some poor drainage system enhances the issue. Extreme temperature (both heat and cold) is also another major concern among residents. Some residents mentioned that they have noticed more hot days in the recent past and that have caused health issues. Downed trees and associate power cut due to high wind is also mentioned by a lot of participants (31 out of 89).

What resources do you need to feel more prepared?

- Most of the responses are centered around a better town-level organization on climate adaptation and more constant communication from the Town via social media, mail and email. The participants mentioned that more efficient emergency communication (such as shelter location, food sources, contents of emergency kit, transit option to shelters, reverser 911) system is needed in the Town. They suggested advanced warning, information on available Town resources, public education of hazard mitigation preparedness may help with coordinated community response to emergencies. Few residents propose battery backup of the electricity system, use of solar panels in more places, flood mitigation actions as part of the preparedness.

What other climate adaptation or hazard mitigation measures should be taken in Belmont in the next five years?

- The primary measures according to the participants should include the following:
    - Increasing tree canopies to reduce effect of extreme heat is the most popular one. This was followed by other measures such as,
    - Reducing carbon footprints. Adding solar panels in schools and other buildings (getting tax incentives for doing so), increasing the number of electrical car charging stations throughout the Town, changing building code to require more energy efficiency in the new buildings, completing unfinished sidewalks or restoring old sidewalks to encourage walking rather than driving are some of the examples.
    - Stormwater and sewer management to mitigate flooding. Replacing culverts, controlling development footprints, planting more native trees, and controlling flow in and out of Claypit Pond to increase water storage are some of the measures that the residents have suggested.
    - 5 of the participants also mentioned that the Town needs a more efficient emergency management program that involves a better communication system to reach the

residents in times of emergencies. Most of the residents are not aware where the local emergency shelters are.

Do you have any other questions or comments? Did you answer "Other" on any of the questions above? If so, please describe below.

- Additional comments are the summary of most of the points that have been mentioned in the previous replies. Participants emphasized the vulnerabilities in Town (over developments but not enough infrastructure to support it, lack of emergency communication, significant flooding issues, not having enough green infrastructure etc.). Belmont's educated and well-aware population is the strength of the Town. Two participants mentioned that transportation, and sea level rise should be included in the hazard mitigation proposals.

Key Findings & Next Steps

As the pie charts and bar graphs indicate, heavy precipitation and flooding, along with extreme heat are the main concerns for residents. The responses suggest a need for better drainage infrastructure and stormwater management, along with a more efficient emergency communication system. Zero net emission in the new developments (new high school for example), eventually in the entire Town along with more tree canopies throughout the Town are also suggested.

The project team should use the findings of this survey to:

- Pursue funding for climate adaptation projects related to heavy precipitation and flooding, including addressing culverts, drainage infrastructure, and stormwater management.
- Share more information with the public related to areas and infrastructure in Town vulnerable to climate hazards, as well as more information on evacuation routes and shelters.
- Share more information online, including through the Town's website and social media platforms.
- Use the email addresses collected to start a climate resilience listserv. Additionally, the next public meeting should be advertised via email to respondents who shared their contact information.

<u>Summary of Public Comments</u>

Do you have any suggestions or recommendations on how to improve the draft of Belmont's HMP-MVP Plan?

- There were two responses. One of them mentions to include public health in the draft plan in the light of current Covid-19 scenario. Other response is more infrastructure related around Claypit Pond area. The participant suggests that Claypit Pond needs priority attention to culverts draining since it receives most of the runoff of the entire town. Most of the storm pipes drain into same existing culvert and thus are not efficient enough to handle stormwater during heavy rain

Do you have other questions or comments about hazard mitigation planning or climate adaptation in Belmont?

- One respondent for this question mentions that flooding issues have been going on for decades and increased greatly in severity. Another key concern seems to be tree maintenance and removal. According to the surveyor, many of the trees are old and need removing and pruning. In addition, overuse of salt during winter, leads to inadequate root development and results in weakening the trees.

Attachments

- Attachment A: Short Answer Responses Spreadsheet
- Attachment B: Belmont Community Feedback Survey

BELMONT SHORT ANSWER RESPONSES FROM THE SURVEY									
ID	How have any of the hazards above impacted you personally or the broader community?	What resources do you need to feel more prepared?	What other climate adaptation or hazard mitigation measures should be taken in Belmont in the next five years?	Do you have any other questions or comments? Did you answer "Other" on any of the questions above? If so, please describe below.	Do you have any suggestions or recommendations on how to improve the draft of Belmont's HMP- MVP Plan?	Do you have other questions or comments about hazard mitigation planning or climate adaptation in Belmont?	First Name	Last Name	Email (in you'd like to receive updates)
1	Personal property damage due to wind.		Plant more trees! Stop obsessing about the sidewalks and get some trees replaced.	I don't see anything about transportation. Encouraging more walking and use of public transportation is environmentally friendly.			Anne Marie	Mahoney	
2	High electric costs in summer! And my kids are so hot in school that they can't concentrate during the school day.	The daily updates from the governor on the radio has been the most reliable guidance currently. I don't look at Belmont for guidance.	Nature-based solutions address more frequent high temperature days. Increase shaded areas where the most people live and around homes and buildings.	Emergency management communications is the biggest vulnerability in addition to the ones mentioned, and quality of low-income and affordable housing. Belmont should prioritize climate adaptation measures in the combination of ways listed, but also with regard to what will the cost be to residents if a project is delayed or unable to operate					
3	flooding of High School		About 75% of the Town's stormwater runoff flows to Clay Pit Pond. Presently there is no means to control the flow into or out of the Pond. Frequency and magnitude of extreme precipitation events are expected to increase. The budget for the new Middle and High School is $295M. To protect this investment and the adjacent neighborhoods, flow into and out of the Pond should be controlled. For example, if controls were in place, the Pond could be lowered in advance of a precipitation event to provide more storage capacity.	related to #3, see response to #9			Joel	Mooney	joelmooney57@gmail.com
4	High water table and reliance on sump pumps to keep house dry.		Traffic diversion away from concord and brighton ave				Trish	Kapur	vaccapa@gmail.com
5	Wind damage to trees and fences								
6	When it's too hot I am just miserable and unproductive.	basic information as to what an emergency kit would contain and where our nearest shelter is	Let's reduce our carbon footprint as much as possible by increasing solar panels on municipal buildings and improving insulation, adding heat pumps. Providing incentives to residents to install heat pumps, plant green roofs or install a lightly colored roof, install solar panels, plant vegetable gardens, buy electric vehicles and ovens and ranges. Address flooding for hazard mitigation	I'm so glad the town has undertaken this project. The meeting last night for the overview of the program was helpful.			Christine	O'Neill	
7	Wind seems to create lots of downed limbs and leads to power loss.	Town mitigation plan for a forest fire	Maintenance to the power grid and upgrading/replacing culverts				Fred	Treseler	682concord@gmail.com
8	extreme temperatures, wind, extreme precipitation						E	Malliris	emalliris@yahoo.com
9	all, to some degree	Need own-wide fire drill					Tom	Neel	nathorne@msn.com
10	Not yet, but I feel loss of potable water is the most severe risk we face.	Alternate water supply	Create one or more alternatives to existing RR crossings/bridge	Our greatest vulnerability is a long period loss of water supply. Almost everything else is survivable.			Paul	Santos	paulsantos@usa.net
11	Other than worrying about the future of the planet, I have not felt the impact of global warming personally.	By the time the town is responding to global warming crises, I am worried it will be too late. I don't think Belmont can think about what it needs to do--by itself--in a crisis of global proportions. Anything we do to protect our citizens will be a temporary stop gap, to be followed by more extreme self-protections. We need to address this, at a minimum, at the state level, to put pressure on the federal government to take steps to reduce warming and to rejoin coalitions with other like minded countries to change behavior world wide		#4. I think our greatest strength is that we have an affluent and educated citizenry, although I doubt we are all like minded about how to spend money (indeed, when the time comes, even whether to spend money) on mitigating behaviors. Still, we are in a position to do the right thing because we have the resources to.			Harvey	Kaufman	hkaufman@fishbowl-consulting.com
12	Very poor drainage, all sump pumps on my street constantly running during storms, roads flooded						Jackie	Pulvirenti	
13	Trees falling on houses	Emergency shelter							
14	Unable to commute to work	A better understanding of vulnerabilities from extreme heat, flooding and precipitation and infrastructure for our community. Where are there undersized culverts?	Increasing community cohesion by neighborhoods makes communities more resilient to bounce back	Is there information available about the current state of Belmont's preparedness?			Jeri	Weiss	Weiss.jeri@gmail.com
15	All		Update the Town CEMP plan to include continuity of operations for all town departments and town boards				Rick	Nohl	rnohl@belmont-ma.gov
16	It's more about climate change and how it will effect all of us	I am not a senior citizen...but I worry about their ability to stay cool beyond the 4pm hour when the town closes. I don't think there are enough shelters in case of an emergency	Limit the number of large construction projects per year to reduce the town's expose to huge diesel construction trucks. ALSO LIMIT diesel trucks on roads with schools to reduce exposing children to their pollution noise and excess speed.						
17	falling trees	help with tree trimming and planning	update the sewer system including pipes to/from houses	electrical / internet / phone wires everywhere overhead					
18	The last ten years or so has produced some serious swings in weather events. In our business we must be prepared for the worst but it becomes a financial struggle to do so when the opposite occurs.						Frank	French	franksr@fefrench.com
19	Yes						Rahul	Ramakrishnan	
20	Floods & covid19	Covid19	Covid19 needs	Covid19 needs are priority, then public safety including electric & floods & roads			Amy	Kirsch	amycoh@gmail.com
21		More secure supply of key utilities, like electricity. Would like to the town to consider batteries for town, homes or both.		My answer of "Based on Funding": I feel we shouldn't build a list of Belmont's priorities, but always win grant monies when there are opportunities. In particular the State seems have prioritized meaningful and impactful grants Belmont should take advantage of			Travis	Franck	travis.belmont@travler.net
22	Wind	Know what emergency kits I should have							
23	All of these concern me. Extreme temperatures usually cause a strain on our power grid, and may coincide with poor air quality. Impacts my lung function.	Do not need more personal resources. Mitigate flooding. Belmont should be requiring any new ground coverage to be permeable.	Robust effort to improve air quality; ban outdoor fire pits, require catalytic converters on woodstoves. Massive tree-planting.	What has become of the CERT? (I was a member, thought it was a good program.)			Nancy	Davis	nhdavis3@gmail.com
24	I've definitely see impact of flooding and wind.	More communication on these issues.					Veera	Mylapore	veera.mylapore@gmail.com

25	I am 75 years old and very sensitive to high temperatures.	I live in Belmont, my business (Smart Software on Brighton Street) is in Belmont, but we have a foster child on the cape and spend significant time there, traveling regularly is an issue for me because I can't drive (seeing/hearing issues)	I installed Solar Panels on my house in 2006, we need to make this town-wide.				Nelson	Hartunian	nelsonh@smartcorp.com
26	Town loss of trees from microbursts. Heat stroke risk if too hot in summer. Snowed in if too heavy precipitation in winter.	Multiple answers for 3,4,5. Flooding now, expect more in future. Need more tree cover, for cooling. Keep town open space.	Need to know more. Seems Trapelo Rd culvert already picked, so culvert study is for the rest of town. Solar panels for electrical resiliency. More public transit crosstown to reduce traffic.	Check up on all previously approved plans, because a court can hold the town to them. .			V	Jordan	
27	Tree crashed into our house a few years ago.								
28	Snow damage to roof.						John p	Goodman	
29	Tough to get through very hot summers.	Information distributed periodically and on a recurring schedule, an updated website.	Incentive for buying electric cars, encourage and promote lawn replacement with environmentally sensible grass such as Pearl's Premium.				Adriana	Poole	apoole@poolweb.com
30	Road damage or damage to property						Linda	Frias	
31	Concerned about the impact of protracted weather incidents on DPW/Belmont Public Light resources and budget as well as strain on the staff.	Would love to have solar and a generator attached to it, but it's cost prohibitive	Invest in the DPW and PD/FD. They are the first responders in all protracted weather events and all are understaffed and overstrained with insufficient resources and share of the town budget.	Other for first question:Deeply concerned about the impact a hacker type attack could have on weak areas such as power grids.					
32			Change building codes to require more energy reduction in new buildings. Close Belmont center to fossil fuel cars. Implement traffic calming measures and obstacles to reduce thru traffic. Add public transportation options to all parts of town and for thru traffic.				Martin	Plass	Mplass@yahoo.com
33							Debora	Hoffman	deboraruthhoffman@gmail.com
34	Our house was damaged by the heavy snowfall a few years ago. Extreme temperatures have made us have to invest in air-cooling. Costs are significant and increase the already expensive cost of living in Belmont. Climate change affects us all beyond these immediate hazards, and in much more profound ways, and I think it is a mistake to focus only on immediate hazards.	A sense that we have better town-level organization on climate adaptation (see below	Prioritization should be conducted on the basis of considering, for each action: 1) how much will taking this action move us toward our goal? how impactful is it? (we need to have a clearly defined goal, which reflects our vision for the future); 2) the likelihood of success of the action (is it easy or hard to do?) and 3) the urgency of the action - do we have the opportunity to take the action now that will disappear in the future? Ie, how time-limited is it. Priority should be the product of these three things - we should first do the things that are impactful, easy, and urgent and last do the things that are unimpactful, hard, and not urgent - and then everything else should happen in an order in between those two things. There is a science of prioritization that has been proven to give the best outcomes if used.	I think our greatest vulnerability is the fact that we are not very cohesive as a town, and so our ability to take and support the collective actions necessary to respond to climate change is impared. So doing things to bring us together as a community around these issues is crucial - A more prominent climate action team at a town level, better and more frequent communication from them and with them via the town newspaper, email, and the town website, Better and more inclusive ways for everyone to participate in it and feel like they have a way to actively take part in the solution. Our greatest strength is that we as a town believe in science and in the power of planning. That has not been effectively harnessed by the town yet.			Kate	Rodriguez-Clark	kmrodriguezclark@gmail.com
35	NO						Hannah	Liberty	hannerlib@gmail.com
36	Flooded playgrounds and playing fields - potential for private property destruction.	Backup generator or battery storage	Broader energy resiliency	General flooding , flooding at critical infrastructure			Dave	Beavers	Dzbeavers@gmail.com
37	flooding	Town emergency response effort? Stock pile of basic supplies for residents in case of shortages. (bottled water, etc)	increase tree canopy, maintain green space, improve public transport	question 1, Belmont has a high water table. Flooding is a concern			Emily	Peterson	
38	flooding	directions (link to website) on info to all the steps to #5 above; clarification on the belmontmaconnect website for reverse 911. I am signed up for non-emergency info, but nowhere is there a place to sign up for reverse 911. Is that automatic?	flood related works				Sarah	Wang	eggplantiris@gmail.com
39	flooding of basement during heaviest storms	Battery backup of the electric system town-wide and in each home.	Phased under-grounding of all utility wires now on poles				Roger	Wrubel	roger_wrubel@msn.com
40	It is getting hotter, yet some of the densest neighborhoods in our town are asphalted over without any trees being replanted or replaced. Many receive no care, yet other parts of town are regularly kept up?! It is very concerning policy especially due to steady temperature rise and hotter longer summers. Despite very good soundbites many town areas are left to their own devices as taxes paid don't serve population equally well. Special interests and influences rule much of town politics.	Better managed government and departments with clear town wide policies and better, more transparent communication and its priorities straight. Special interests shouldn't drive this town.	Sewer should be no brainier. So the storm water management and drainage including low hanging fruits like more trees and less asphalt, stricter fines for dog poop polluting our waterways and general pollution/littering.	We need uniform and clear town policies across all departments and whole town. It is very infuriating that we have made policy change on out of control asphalting over grass buffers not just for for pedestrian safety and separation of road and sidewalks but to preserve trees and curb appeal only to see our own DPW still asphalting over buffers including recently cut tree spots and doesn't really abide by stated policy and town goals. If we cant manage this little across the town what give us assurance that even more pressing issues will be resolved in an efficient, uniform and equitable fashion? Overbuilding without infrastructure to support influx will be very hard for Belmont to manage as well. There cant be two Belmonts one for well off and other for everyone else.			Azra	Nelson	azrabart@yahoo.com
41		more information from local leadership					Kelly	Chiu	kelachiu@gmail.com
42	Lack of water will affect every one of us		Water supply security						
43			need a wetlands bylaw				Mark	Davis	
44	I can only choose 1 concern? Drought, extreme weather and temperatures								
45	Extreme temperatures can kill people with asthma	Solar panels plus batteries	Promotion of solar energy and wind in town, plus storage for key services (e.g. police)				Claus	Becker	
46	Abnormal winters, wildly fluctuating temperatures and the now we have bomb-cyclones that take out trees.	information about the nearest shelter; preparedness guidelines	Study of electrical grid vulnerabilities and gas line vulnerabilities				Barbara	Bushey	Barbara.bushey@gmail.com
47	Yes	Batteries to support critical loads in our home, such as refrigerator/freezer and a few lights.	Battery and renewable microgrid				Jacob	Knowles	jacobwknowles@gmail.com
48	higher electric costs	water, cash	flood control				Phil	Thayer	pkt123@gmail.com
49							Michael	Mullet	Momulle@yahoo.com
50									

51	My parents house had our tree come down due to severe weather	More constant communication from the Town for each resident in Belmont via social media, mail and email	Working to build a town wide emergency plan, and synchronize it with the state's plan; increase emergency safe guards and update and build more emergency building(s)				Michael	McNamara	McNamara.michael10@gmail.com
52	I am very worried about the long terms effects of climate change. Right now, right here, it is manageable, barely.	knowledge	Make sure new school is carbon neutral, or as much as possible.				Anne	Quirk	aequirk@aol.com
53	Increase in storm intensity	Continuing information on what measures we can take to reduce carbon emissions	Continue measures to reduce carbon emission				Suzanne H	Robotham	suzanne.robotham@gmail.com
54	Damage roof, snow days	A new president	Something like our own fema with our own PpE, food , water for town				VERA L	ISKANDARIAN	viskandarian@hotmail.com
55	Flooded basement.	Working on storm water problem	Eliminate carcinogens on public property	We're not doing enough in any of above areas.			Michael	Chesson	chesson65@gmail.com
56	Rain and snow storms have caused house flooding and difficulties walking around outside/dangers of slipping which I experienced last winter.	Evacuation plan, town clearing of sidewalks, and more communication	More solar on town buildings, and businesses.						
57	We felt it necessary to install a French drain around the full perimeter of the basement due to the increasing frequency of high intensity precipitation events.	Backup electrical power	Consider air conditioning in the schools	Belmont's residents in general have huge knowledge and skills on many topics, which may be able to be brought to bear.			Alexandra	van Geel	avangeel@alum.mit.edu
58	Live in an all electric home without AC and if there are power outages in winter, there is no heat or ability to cook.	The Town's website seems to indicate that only in an emergency will shelter locations be broadcast. Why not in advance and listed on the website.	set and meet ZNE goals	Question 5 is problematic--I could say yes to all but the Belmont lacks comprehensive, permanent (briefly a staff member during McLean land reuse time; earlier someone dismissed by BoS), planning professional(s)--a problem that has existed for decades. This survey's #5 question is problematic. Does any resident know his/her nearest emergency shelter? Have lived here a long time and am not aware of mine			anonymous	Doe	
59	There is a huge pill of eager that fluids the street next to my house when it rains hard		Support zone in new high school building, apply for hazard grant money				Kerri	Klugman	
60	Damages on the house	ZNE home	Get rid of natural gas, increase sustainable energy	Some questions are difficult to answer as I don't know all the whereabouts.			Frederique	Rigoulot	fredrig@gmail.com
61	Sea level rise -- already a major risk factor in the Seaport district	I am considering adding a battery-tied inverter to my solar power setup		Yes. I found this questionnaire difficult to answer, because it doesn't seem to focus on major climate change issues that Belmont and the Boston area face, such as sea surface rise, but it does mention issues like temperature rise that, while important globally, are not affecting the NE U.S.			Eric	Jones	
62	Increased use of air conditioning, which has its own red flags; rolling brownouts due to energy consumption and the fear it puts in people dependent on powered health aids; elderly who do not have or cannot afford air conditioning	Better neighborhood central communication websites; stronger sense of commitment to climate change from town leaders; knowledge that not everyone in this town can handle the economic downturn	Make it clear to everyone what the financial risk is to local homes and businesses if a plan is not put in place.				Terry	Murphy	TLMurphy01@gmail.com
63	Flooding......vulnerability below: flooding.....note the number of residences that require sump pumps!	for the Town to commit finances and engineering to dealing with flood prevention	for any town project or as requirement for private projects: LEED Certified Platinum, ZNE standards; recognize and mitigate flooding	Survey design: Other: should have an immediate option for "specify", (re, #5. "steps" but cannot choose more than one step), through actions of the past, many properties are now impacted with flooding, largely due to overdevelopment downstream. In the past 40 years, flooding has become a serious problem for many home owners. In addition, huge municipal projects ignore environmentally sound options and wise advice, choosing frills....we are VERY lucky to have Mr. Dorrance and yet his wise advice is often ignored when decisions are made, re.per ex. BMHS, Wellington etc. While the Town has its millionaires, about 1/3 of Town is multifamily homes, not mansions. Incidentally, an option for anonymous responses might bring out more valid concerns....entries can be keyed to avoid dupes. thank you!			Carolyn	Bishop	cbishopma@icloud.com
64	The risks of serious, regular fooding are all around us, and Belmont is not immune	Regular information from the tow on climate resilience					Dave	Deese	deese@bc.edu
65	I'm concerned about the potential for flooding, which has not affected me yet.	More attention to our aging infrastructure for managing drainage during extreme precipitation	Require solar panels on all new commercial and residential construction and significant rehabs of existing properties. Retrofit town public use buildings for solar.	We need to install solar panels on the Chenery School and the new middle and high school project.			Michael	Crowley	mcrowley@gmail.com
66	100+ year old downed tree in storm.								
67	Limitations on outdoor activities to promote health	Town should stockpile key supplies that may be constrained in cases of natural emergencies (e.g. pandemic, weather events, drought, etc)	(1) Incentivize solar power, mandate Belmont Light to have net metering, (2) increase number of electric car charging stations, (3) Allow houses with solar panels to generate energy during a power outage, (4) provide a tax incentive on local taxes for houses installing environmentally friendly utilities (e.g. solar panels, flash heat systems, heat pumps)				Matthew	Henn	matt.henn@gmail.com
68	The entire spread of climate chance events threaten my family's future						Randy	Bak	
69	Extreme temperatures have caused increased use of energy at peak times.	I would like to see a coordinated community response to emergencies.	We should do what is necessary to protect our investments in new infrastructure, such as the high school. For instance, we should protect from possible flooding.				Maria	Bollettino	
70	flooding and wind		ensure new high school is zero net emissions (solar and other clean energy), same comment for other new buildings in town				William	Filler	
71	Downed trees interrupting electrical during storms, increased heating and cooling costs	NA	NA	NA			Steven	Muson	
72	I just don't like hot weather, and we're getting a lot more of it.		I don't know.	I apologize but this survey assumes that I have more knowledge than I in fact possess.			Wesley	Kelman	wkelman@gmail.com
73	This hazard will continue to get worse and will impact elderly and those more vulnerable disproportionately.	information about town resources							claushenn@yahoo.com
74	Trees down, flooding in basement		Make all Belmont town buildings zero net energy, including solar panels on high school and junior high school buildings						

75	Increase in damage to property as changing temperatures set in motion more frequent weather events that include damaging windstorms and and increase in precipitation and flooding	A list of local shelters might be helpful. Communications from Town officials (public safety most often but not exclusively) have improved lately. This should continue so that citizens understand and are helpful as the community faces challenges going forward.	Adopt climate adaptation measures for new construction and renovation that require use of renewable energy and decrease permeable surfaces / improve rainwater infiltration	We conduct "business as usual" as we plan infrastructure and permit building at our peril. The greatest challenge for us is to cqninutally question the "usual", to re-evaluate and consider how climate change may impact the town going forward and to adjust our practices to adapt. We need to be mindful of new and upcoming climate challenges. We need to be forward thinking and proactive in evaluating our energy needs, use, and sources. We need to consider where flooding will occur and make adaptations to protect citizens and property from flooding using ground infiltration, requiring well functioning drainage systems, minimizing the installation of impervious surfaces, etc. We should not rely on outdated flooding models as we plan and build for Belmont's future.			Martha	Moore	marmoor@aol.com
76	rising global temperatures threaten water levels, and food security		increase solar				William	Kimberly	
77	Yes, hotter summers have made this house uncomfortable for more weeks during the summer for starters.	microgrid connectivity, battery storage, vehicle to grid tech, local food sources	all buildings should be NZE; homes need resiliency retrofitting				Ian	Todreas	ian@todreas.com
78			Solar Panels on all town-owned buildings (schools, municipal buildings)				Katherine	Oates	katherineoates@gmail.com
79	1) We have underground brooks on our property. We have experienced increased dampness in our basement due to this. 2) In 2015, impacted by extreme snowfall.	More information on what the immediate threats to Belmont are.					Miriam	Baker	
80	Excessive rain creating water in the basement more common; last year's heatwave in July was extremely uncomfortable as we don't have AC		Plant more trees; create cooling shelters for people to go to in extreme heat						
81	Flooding, water pollution	Knowing where flood zones are in the town	solar panels for the new school, rain barrels free, town wide compost service paid for by taxes, ban on plastic bags				Eliza	Filler	
82	have not	advanced warnings	town buildings in flood plain				Brian	Saper	briansaper@yahoo.com
83	Can't afford or too old to clear walks	Flood abatement near middle School	Flooding is outrageous. Control development footprints and encourage groundwater return via driveways	Replacement of granite curbing did not improve water coming from Middle school footprint or springs. It made it very dangerous to walk though (hello 6 months in a wheelchair!)			Claire	DeVore	darwinsom@gmail.com
84	Several trees have blown down in and around our neighborhood	More general communication about resources and town planning	Preparation for large storms. Better handling of flooding, power outages, wind damage.				Ken	Lind	ken.lind@gmail.com
85	No	Continued good communication and quick fixes when there is an issue					Lori	Koehn	
86	Flooding which makes recreational sites (fields and open space) unusable	Education of major risks, such as flooding during major storms, and how the community as a whole can prepare.	Clear steps and goals for reducing carbon footprint				Julie	Crockett	juliejill77@gmail.com
87									
88	Temperature extremes have begun to effect me	Doing above	Not sure				Sarah	Fujiwara	Sarahpfujiwara@gmail.com
89	yes						Marcia	Sugrue	
90	For whatever reasons, our vegetable garden has seen decreasing yields.	Advance indications of food shortages	Use public resources to minimize consumer waste. Help residents to grow their own food and connect to local growers.	I don't understand the question. How do culverts provide climate resiliency? It annoys me that wastewater concerns are couched as climate concerns.			Geoff	Dutton	
91	Ability to maintain native species repopulation programs decreases with drought.	Better access to affordable, energy efficient housing		Encourage more walking by completing unfinished or restoring worn sidewalks			Katherine	Lonergan	katherine.lonergan@gmail.com
92	Flooding of wetlands area die to die off of trees and construction of Belmont Manor	Food resources in an emergency	Flood and clean water management in wetlands areas	Look to the series, "Sinking Cities" especially episode 3, to generate ideas on flood management.			Priscilla	Hunt	Priscilla.hunt@gmail.com
93							Susan	Marsh	
94	the street behind our house floods when rainfall exceeds carrying capacity of storm system	I should know more about some of the resources listed above	Storm drainage assessment and associated projects; renewable microgrids; emergency response plan				Michelle	Oishi	architectoishi@gmail.com
95	My #1 concern is loss of biodiversity and the healthy ecosystems that support all life on Earth. This loss and the mass extinction facing our planet is the result of man's widespread destruction of habitats and dominance over natural resources and all living species. Humans should work with nature to solve the environmental issues that exacerbate societal and economic problems. The coronovirus pandemic has laid bare what happens when man destroys habitats and exploits other living species	Candles, Head lamp, First aid kit, Water, quinoa & canned food, toilet paper, several face marks, couple bottles of wine and good books	Plant native trees, shrubs, flowers and grasses. This is integral to a healthy ecosystem and also mitigates the impact of climate change. Roots absorb excess rainwater and prevent stormwater runoff (and also filter water before entering the aquifer). Roots sequester carbon. Plants and trees give us the air we breathe and cool our backyards so we need less A.C. Last but not least, native plants provide food for native insects & pollinators (bees and butterflies), which in turn are food for birds, and help to restore biodiversity, essential to all life on Earth.	MVP succeeds when it truly engages public input and people are encouraged to think and plan outside the box. Don't use this money to compile a list of basic deferred maintenance items that Belmont (and Waltham) should have already addressed. Think hard about the future - make Belmont a sustainable, thriving and inviting community for generations to come. There ain't no jobs/no future on a Dead planet.			Jean	Devine	jeanm.devine@verizon.net
96	I have lived in the same Belmont house for 40+ years. This year, I feel it necessary to invest in an A/C system because there are so many hot days in a row, ad the window A/C units we have can no longer keep up with the extreme heat	transit options to shelters	flood/rainwater management	no			Marsha	Knoll	
97	Exhaustion working yardwork, gardening. Concern for crops and global community if crops can't be adapted	More land and agreement about focus on local self-reliance	Wood heating--legalize rocket mass heaters in the town building codes (after Portland, Oregon)	It's not just about us. Every bit of carbon footprint we contribute to harming any country on earth adds to the probability of more pandemics. Local resiliency with global conscience is the only direction we can go. thanks for your service!			Joshua	Myrvaagnes	Inspiringtutorboston@gmail.com
98					Include virus infection control. This scenario will happen again in the next < 10 years. Look at how Hong Kong responded to Covid-19 in their nursing homes for exemplary practice to adopt.		Betsy Lipson	betsylipson2014@gmail.com	

99					Appreciate hours of work on this but many concerns: Alewife Brook is not in town, Wellington is, Claypit Pond receives MOST of the runoff of the entire town thus needs priority attention to culverts draining there, sedimentation impacting storage, and key is improving drainage to the entire downstream system. MOst priority seems to be given to Trapelo Road Culvert. Note on the GIS map: many storm drains, especially most recent additions only drain into the same existing culverts...totally pointless since they cannot actually function as drains when needed. Amazing number of homes need sump pumps due to high water table, culverted streams, and downstream development impacting previously pervious surfaces. Even homes at higher elevations from the pond need pumps to avoid flooding. Vital to recognize the impact of the limits of ClayPit.	MANY of the results of identified concerns are for "Studies", "Planning", and very few marked as completed. Understand that hiring pros is expensive, volunteers are valuable, but the flooding issues have been going on for decades and increased greatly in severity. Another key seems to be 'tree maintenance'. This has proven to be tree removal. Many are old and need removing but neglect through the years, inappropriate pruning devolved to no pruning but key is the overuse of SALT by the Town. Added to the paving over the roots means trees are failing, unsteady with inadequate root development. Many towns have warning signs of "no salt area" Belmont could adapt that to warn traffic . Trees absorb water that otherwise adds to runoff and as well are vital against climate change.	Anonymous		

Belmont MVP Survey

The Town of Belmont was a awarded a grant from the Commonwealth's Municipal Vulnerability Preparedness (MVP) Program to create a list of priority action items to advance the community's resilience to projected climate change impacts and to update the Town's Hazard Mitigation Plan. In January, a group of stakeholders met to identify strengths, vulnerabilities, and actions to further build the Town's resilience. In April, we hosted an online presentation to receive feedback from the community.

A recording of the summary presentation is available here:
https://www.belmontmedia.org/watch/gov-access-coverage

Questions from the survey

We recommend watching the video, if you haven't already, and then we'd like to hear your thoughts for the report through the survey below.

1. What hazard most concerns you?

- ○ Extreme Temperatures
- ○ Extreme Precipitation and Snow
- ○ Wind
- ○ Drought
- ○ Other

2. How have any of the hazards above impacted you personally or the broader community?

Short answer response:

3. What would you consider Belmont's greatest vulnerability?

- ○ Occasional brownouts of electric grid during hot days
- ○ Barriers to building personal resilience (such as income and homelessness)
- ○ Hazardous sites
- ○ Sanitary sewer overflows
- ○ Other

4. What is Belmont's greatest strength considering climate resilience?

- ○ Access to open space and recreation
- ○ Diverse perspectives and experiences (ages, abilities, and cultures)
- ○ Emergency communication
- ○ Locally managed electric infrastructure

○ Other

5. What steps have you already taken to prepare for extreme events?

○ I have a kit in case of emergencies (which may include food, water, flashlights, batteries, and other supplies)

○ I receive news, updates, and information about emergency preparedness in Belmont

○ I know where the nearest local shelter is

○ I have signed up for Reverse 911 (https://belmontmaconnect.bbcportal.com/)

○ All of the above

○ None of the above

6. What resources do you need to feel more prepared?

Short answer response:

7. How should Belmont prioritize climate adaptation measures?

○ Based on funding

○ Time frame

○ Asset type (i.e., infrastructure, buildings, or natural systems)

○ Impact on public safety

○ Other

8. Rank the following priorities from highest priority to lowest priority.
   - Replace the Trapelo Road Culvert
   - Perform a culvert right-sizing study and upgrade culvert sizes to accommodate more stormwater runoff
   - Develop an Emergency Response Plan, include a wellness check for elderly populations
   - Education on Reverse 911 system
   - Cost-benefit analysis of flood management projects
   - Place cap on incinerator site and implement Select Board approved post closure uses
   - Improve electrical resiliency of the Town and critical facilities through new generators or renewable microgrids
   - Model existing drainage system utilizing updated rainfall data to evaluate flooding conditions under projected climate change conditions

9. What other climate adaptation or hazard mitigation measures should be taken in Belmont in the next five years?

Short answer response:

10. Do you have any other questions or comments? Did you answer "Other" on any of the questions above? If so, please describe below.

Short answer response:

11. First Name

Short answer response:

12. Last Name

Short answer response:

13. Email (in you'd like to receive updates)

Short answer response:

<u>Questions from the Public Comments:</u>

1. Do you have any suggestions or recommendations on how to improve the draft of Belmont's HMP- MVP Plan?

2. Do you have other questions or comments about hazard mitigation planning or climate adaptation in Belmont?

3. Name (optional)

4. Email (optional)

APPENDIX E

Town Approval

TOWN OF BELMONT
OFFICE OF THE SELECT BOARD
455 CONCORD AVENUE
BELMONT, MASSACHUSETTS 02478

Selectboard@belmont-ma.gov

455 CONCORD AVENUE
BELMONT, MA 02478-2573
PHONE (617) 993-2610
FAX (617) 993-2611

SELECT BOARD
ADAM DASH, Chair
ROY EPSTEIN, Vice Chair
MARK PAOLILLO, Member

TOWN ADMINISTRATOR
PATRICE GARVIN

ASSISTANT TOWN ADMINISTRATOR
JON MARSHALL

CERTIFICATE OF ADOPTION
TOWN COUNCIL
TOWN OF BELMONT, MASSACHUSETTS

A RESOLUTION ADOPTING THE
TOWN OF BELMONT
HAZARD MITIGATION PLAN - MUNICIPAL VULNERABILITY PREPAREDNESS PLAN
2020

WHEREAS, the Town of Belmont established a Committee to prepare the *Town of Belmont Hazard Mitigation Plan - Municipal Vulnerability Preparedness Plan 2020*; and

WHEREAS, the *Town of Belmont Hazard Mitigation Plan - Municipal Vulnerability Preparedness Plan 2020* contains several potential future projects to mitigate potential impacts from natural hazards as well as climate change in the Town of Belmont, and

WHEREAS, a duly-noticed public meeting was held by the local Community Development Department on April 22nd, 2020 and

WHEREAS, the Town of Belmont authorizes responsible departments and/or agencies to execute their responsibilities demonstrated in the plan, and

NOW, THEREFORE BE IT RESOLVED that the Town of Belmont Select Board adopts the *Town of Belmont Hazard Mitigation Plan - Municipal Vulnerability Preparedness Plan 2020,* in accordance with M.G.L. 40 §4 or the charter and bylaws of the Town of Belmont.

ADOPTED AND SIGNED: May 17, 2021.

____
Adam Dash, Chair

____
Roy Epstein, Vice Chair

____
Mark Paolillo, Select Board Member

APPENDIX F

FEMA Approval

U.S. Department of Homeland Security
FEMA Region I
99 High Street, Sixth Floor
Boston, MA 02110-2132

FEMA

June 2, 2021

Samantha C. Phillips, Director
Massachusetts Emergency Management Agency
400 Worcester Road
Framingham, Massachusetts 01702-5399

Dear Director Phillips:

The U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA) Region I Mitigation Division has approved the Town of Belmont 2020 Hazard Mitigation – Municipal Vulnerability Preparedness Plan effective **June 1, 2021** through **May 31, 2026** in accordance with the planning requirements of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), as amended, the National Flood Insurance Act of 1968, as amended, and Title 44 Code of Federal Regulations (CFR) Part 201.

With this plan approval, the jurisdiction is eligible to apply to the Massachusetts Emergency Management Agency for mitigation grants administered by FEMA. Requests for funding will be evaluated according to the eligibility requirements identified for each of these programs. A specific mitigation activity or project identified in this community's plan may not meet the eligibility requirements for FEMA funding; even eligible mitigation activities or projects are not automatically approved.

The plan must be updated and resubmitted to the FEMA Region I Mitigation Division for approval every five years to remain eligible for FEMA mitigation grant funding.

Thank you for your continued commitment and dedication to risk reduction demonstrated by preparing and adopting a strategy for reducing future disaster losses. Should you have any questions, please contact Brigitte Ndikum-Nyada at (617) 378-7951 or brigitte.ndikum-nyada@fema.dhs.gov.

Sincerely,

PAUL F FORD Digitally signed by PAUL F FORD
Date: 2021.06.02 12:05:21 -04'00'

Paul F. Ford
Acting Regional Administrator
DHS, FEMA Region I

PFF:bnn

cc: Jeffrey Zukowski, Hazard Mitigation Planner, MEMA

Marybeth Groff, CFM, Hazard Mitigation & Climate Adaptation Coordinator
Beth Dubrawski, Hazard Mitigation Contract Specialist, MEMA