Town of Winchendon

Tarbell Brook. Photo by John Phelan, via Wikimedia Commons

HAZARD MITIGATION AND MUNICIPAL VULNERABILITY PREPAREDNESS PLAN (HMP/MVP)

March 2021

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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 Winchendon 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 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 Planning and Development Department coordinated the Hazard Mitigation Plan and Municipal Vulnerability Preparedness Plan (HMP-MVP Plan) and completed through the following steps:

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

Hazard Mitigation and Climate Adaptation Goals

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

- Develop programs and mitigation measures to protect the following from current natural hazards and future impacts anticipated from climate change:
  - Vulnerable populations and residents
  - Economic development, commercial, industrial, and residential property
  - Cultural and historic resources

  - Critical infrastructure and the built environment
  - Essential services, such as electric power delivery and drinking water supply
  - Conservation land, open space, and other natural assets.
- Develop hazard mitigation and climate adaptation measures that employ nature-based solutions and protect the natural environment.
- Incorporate climate adaptation strategies and climate change projections as an integral factor in all Town departments, committees, and boards.
- Incorporate climate adaptation and hazard mitigation measures into local plans, bylaws, regulations, and other planning tools to protect critical infrastructure and property, and to encourage resilient development.
- Stay up to date on emerging risks associated with climate change.
- Prioritize payment for all phases of the emergency management cycle, including mitigation, preparation, response, and recovery.
- Increase awareness and provide resources for hazard mitigation to businesses and residents through outreach and education.
- Identify and seek funding for measures to mitigate or eliminate each known significant hazard area and reduce the impacts of climate change.
- Facilitate collaboration in hazard mitigation planning and climate adaptation with local businesses, institutions, non-profits, surrounding communities, and state, regional, and federal agencies.
- Prevent and reduce the loss of life, injury, public health impacts, and property damages from natural hazards and the anticipated impacts of climate change.

Vulnerability and Risk

Among the communities of Worcester County, hazard mitigation and climate adaptation planning tend to focus on flooding because it is one of the most likely natural hazards to impact these communities. However, the Winchendon's HMP-MVP Plan assesses the potential impacts from a variety of natural disasters including:

Flooding

Severe Winter Storms

High Wind Events

Extreme Temperatures

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

Hazard Mitigation and Climate Adaptation Strategy

Through the planning process, thirty-four high priority hazard mitigation and climate adaptation measures were identified covering the following topics:

- Dam Safety
- Evacuation routes
- Road and bridge safety
- Erosion Control and Critical Facilities Protection
- Internet connectivity
- Vulnerable neighborhoods
- Municipal Buildings and Services
- Needs in the agricultural community.

Next Steps

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

1.0 INTRODUCTION

The Town of Winchendon prepared a joint Hazard Mitigation Plan and Municipal Vulnerability Preparedness Plan (HMP-MVP Plan) to create an action plan to reduce the impacts of natural hazards and climate change within the community and the region. The Winchendon HMP-MVP Plan was adopted by the Board of Selectmen on DATE to update and replace the Montachusett Region Natural Hazard Mitigation Plan 2015 Update, of Winchendon is a part of.

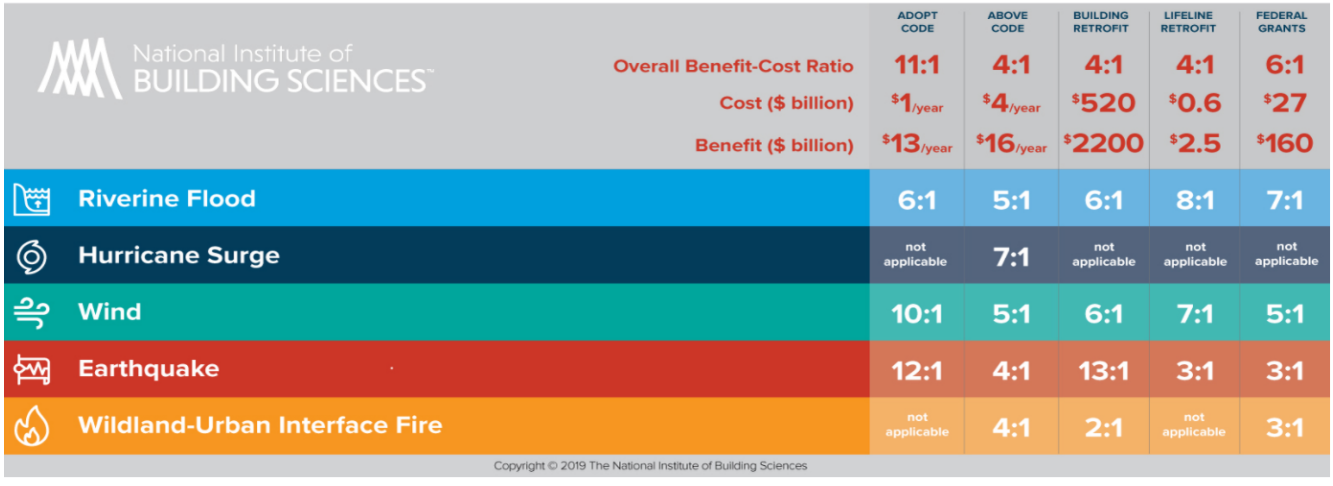
1.1 What is a Hazard Mitigation Plan (HMP)?

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 impacts through community planning, policy changes, education programs, infrastructure projects, and other activities (FEMA, 2020a). Hazard mitigation planning uses a stepped process that involves participation of a wide range of stakeholders to:

1. define local hazards,
2. assess vulnerabilities and risks,
3. review current mitigation measures, and
4. develop priority action items.

The resulting plan and its implementation save 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.

By completing an HMP, municipalities also become eligible for specific federal funding and allow potential funding sources to understand a community's priorities. Hazard mitigation funding is available through the Federal Emergency Management Agency (FEMA). To be eligible for FEMA Grants, local governments are required to prepare an HMP meeting-requirements that were established in the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended by the Disaster Mitigation Act of 2000. A summary of disaster assistance programs offered by FEMA is included in Table 1-1 on the following page.



Source: National Institute of Building Sciences, Natural Hazard Mitigation Saves: 2019 Report

Table 1-1. FEMA Grants	
FEMA Grants	Purpose
Hazard Mitigation Grant Program (HMGP)	Funds the implementation of long-term hazard mitigation planning and projects after a Presidential major disaster declaration
Pre-Disaster Mitigation (PDM) Program	Offers annual funding for hazard mitigation planning and projects
Flood Mitigation Assistance (FMA) Program	Offers annual funding for planning and projects that reduce or eliminate flood damage to buildings insured under the National Flood Insurance Program (NFIP)
Public Assistance (PA) Grant Program	Facilitates recovery after disasters by providing communities with funding for debris removal, life-saving emergency protective measures, and restoring public infrastructure
Fire Management Assistance Grant (FMAG) Program	Funds mitigation, management, and control of fires on forests or grasslands, to prevent major disasters

1.2 What is a Municipal Vulnerability Preparedness Plan (MVP)?

In 2017, the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) initiated the Commonwealth's Municipal Vulnerability Preparedness (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 based on a guidebook developed by the Nature Conservancy 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 Plan. Since these action grants are only distributed to Massachusetts municipalities, they are much less competitive than similar grants awarded at the national level.

1.3 Hazard Mitigation and MVP Planning in Winchendon

The Town of Winchendon received an MVP Planning Grant to simultaneously prepare an MVP plan and an HMP. Many of the required steps of the MVP process also satisfy requirements for updating an HMP. As a result, the Town prepared this joint HMP-MVP Plan in accordance with FEMA guidelines for hazard mitigation planning (Title 44 Code of Regulations (CFR) 201.6) and with the Massachusetts Executive Office of Energy & Environmental Affairs' (EEA) requirements to follow the Community Resilience Building (CRB) Workshop Guidance, developed by The Nature Conservancy. This enabled Winchendon

to consider the impacts of climate change in its hazard mitigation planning, following the lead established by the Commonwealth when it adopted the first-ever Massachusetts State Hazard Mitigation and Climate Adaptation Plan (EEA and EOPSS, 2018). Winchendon convened a Core Team of municipal leaders to lead the process and provide local expertise. The Core team met, corresponded via email, and contributed through interviews. Stakeholder engagement was conducted through the CRB Workshops, an online webinar and listening session, and an online survey. Chapter 3 provides more information about the overall process and outcomes.

1.4 Planning Process Summary

To prepare for the development of this MVP-HMP Plan, the Town of Winchendon followed the process described in the Community Resilience Building Workshop Guidebook, which was developed by The Nature Conservancy. 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 of Winchendon's values and priorities is likely to produce greater community support and result in greater success in implementing mitigation strategies that reduce risk.

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 three 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.

Facilitating discussion among stakeholders about creating a safer, more resilient community is an important aspect of the natural hazard and climate change impact mitigation planning process. The involvement of a variety of stakeholders in the development of a plan leads to results that better reflect Winchendon's values and priorities. Additionally, the plan is more likely to have greater community support and success in implementing mitigation strategies that reduce risk. The planning and outreach strategy used to develop this MVP-HMP Plan had three tiers:

- The **Core Team**, with representation from municipal leadership at the Town of Winchendon.
- **Stakeholders** who could be vulnerable to, or provide strength against, natural hazards and/or climate change.
- The **Public**, who live and work in Winchendon.

1.4.1 Core Team

The Town of Winchendon convened the Core Team to act as a steering committee for the development of the HMP-MVP Plan. The Core Team met on March 5, 2020 to discuss the planning process and the CRB Workshop. More information on these meetings is included in Appendix A.

The Core Team 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. Winchendon's Core Team

Name	Title
Tracy Murphy	Director, Planning & Development
Albert Gallant	Director, Department of Public Works
Jim Abare	Health Agent, Board of Health, Emergency Management
Alison Manugian	Planning Agent, Conservation Commission/Planning
Tom Smith	Fire Chief, Fire Department
Dave Walsh	Police Chief, Police Department
Keith Hickey	Town Manager
David Connor	Director, Housing Authority
Sheila Bettro	Director, Council on Aging

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 schools, other local jurisdictions, regional organizations, and state government. The Core Team also suggested or made available reports, maps, and other pertinent information related to natural hazards and climate change impacts in Winchendon. These suggested resources included:

- Montachusett Region Natural Hazard Mitigation Plan: 2015 Update (MRPC2015)
- Montachusett Regional Population Projections (MRPC2016)
- Massachusetts Climate Change Projections (NECSC, 2018)
- Massachusetts Climate Change Adaptation Report (EEA, 2011)
- Massachusetts State Hazard Mitigation and Climate Change Adaptation (EEA, EOPSS 2018)
- Local Mitigation Plan Review Guide, October 2011 (FEMA, 2011)

- National Flood Insurance Program (NFIP) Flood Insurance Rate Map (FIRM) for Winchendon, Worcester County, Massachusetts (FEMA, 2016)
- National Center for Environmental Information (NOAA)
- National Water Information System (USGS)
- US Census, 2019 and American Community Survey, 2013-2017 Estimates
- Complete Streets Funding Program Project Prioritization Plan: Winchendon (MassDOT, 2016)
- 2007 Open Space and Recreation Plan (Town of Winchendon, Open Space and Recreation Committee, Tighe & Bond, 2007)
- Winchendon Master Plan 2001 and updates 2005 (Winchendon Planning & Development Committee, 2001, 2005)
- 2014 Downtown Winchendon Revitalization Study (Carousel Consulting, 2014)
- Winchendon, Massachusetts, Zoning Bylaw, 2019 (Winchendon Planning & Development Committee, 2015)
- Rules and Regulations for the Review and Approval of Site Plans and Site Development in Winchendon, Massachusetts (Winchendon, Planning Board, 2008)
- Rules and Regulations Governing the Subdivision of Land in Winchendon, Massachusetts (Winchendon, Planning Board, 2013)
- Town of Winchendon Emergency Preparedness Handbook (Winchendon Department of Public Health, 2011)

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 (CRB) Workshop, held on November 17th and 18th, 2020. During the first part of the workshop, Weston & Sampson provided information about natural hazards and climate change and participants identified top hazards; infrastructural, social, and environmental features in Winchendon 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 Winchendon's resilience to natural and climate-related hazards. Community representatives who were invited via email by Tracy Murphy, Town Planner, and those who participated in the process are presented in Table 3-2 in Appendix C and organized by category. Additional materials from the workshop are also included in Appendix C.

This broad representation of local and regional entities ensures the HMP-MVP Plan aligns with operational policies and hazard mitigation strategies at different levels of government and implementation. A summary of key participants at the Workshop is included below:

- Staff members of the Town Planning Department, Engineering Department, Police Department, Fire Department, and Department of Public Works, along with many other municipal officials
- Representatives from the Council on Aging and Board of Health
- Winchendon Master Plan Committee

1.4.3 Listening Sessions

To gather information from the general public and to educate the public on hazard mitigation and climate change, the Town hosted an online listening session webinar with an accompanying online survey to collect comments on April 30, 2020. The Town received 20 public comments through this survey. The draft Plan was posted on the Town's website and public comments were received between March 24, 2021 and April 9, 2021. The webinar was publicized in accordance with the Massachusetts Public Meeting Law (see public meeting notice in Appendix C).

During the webinar listening session, the project team presented information related to the MVP program, climate change in Winchendon, local strengths and vulnerabilities, existing mitigation measures, and priority action items for future climate adaptation. More information about the webinar and public comments are available in Appendix C.

1.4.4 Report Layout

The report presents the results of the planning process, which was informed by input received from the Core Team and during the CRB Workshop and Listening Sessions. This report is organized as follows:

- Chapter 1: Project introduction and overview
- Chapter 2: Hazard mitigation and climate adaptation goals
- Chapter 3: Community profile; societal, economic, infrastructural, and environmental features; land use and development, critical facilities, and vulnerable populations
- Chapter 4: Detailed assessment of the Towns vulnerability and strengths by hazard type. The hazard types include flooding, wind-related risks (such as hurricanes, tropical storms, tornadoes, nor'easters, and severe thunderstorms), winter storms, geological hazards (such as earthquakes and landslides), brush fires, extreme temperatures, and drought. Each profile also describes the hazards historic occurrences and impact, frequency, level of risk, and climate change projections.
- Chapter 5: Summary of the existing mitigation measures the Town is currently undertaking.
- Chapter 6: An update of the progress made since the last HMP.
- Chapter 7: An action plan for next steps .
- Chapter 8: Plan adoption, maintenance, and implementation.

1.5 Planning Timeline

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

Information related to meetings associated with this timeline is included in more detail below:

1. **Local Hazard Mitigation Planning Team / Municipal Vulnerability Preparedness Core Team**
   Meeting 1: March 5, 2020 – Project Kickoff

2. **HMP Stakeholder Meeting / MVP Community Resilience Building Workshop**
   2 Meetings: November 17 & 18, 2020.

3. **Public Listening Sessions**
   Online Webinar, Survey, and Public Comment Period: April 30, 2020 – June 30, 2020
   Draft Plan Public Review and Comment Period: March 24, 2021-April 7, 2021

2.0 HAZARD MITIGATION AND CLIMATE ADAPTATION GOALS

The 2015 update of the Hazard Mitigation Plan for the Montachusett Region included six regional mitigation goals. This list provided a starting point for Winchendon's more focused and localized set of seven hazard mitigation goals. These goals were informed by feedback shared by the Core Team, CRB Workshop participants, and other stakeholders, and are included in more detail below.

1. Protection - Prevent and reduce the loss of life, injury, public health impacts and property damages resulting from all identified natural hazards and projected hazards under climate change.
2. Capacity - Enhance local mitigation capabilities to reduce damage, facilitate access to vulnerable areas, and ensure continuity of emergency services through increased staff and volunteer training.
3. Coordination - Increase cooperation and coordination among private entities, Town officials and Boards, neighboring communities, State agencies and Federal agencies.
4. Public Outreach - Increase awareness of the benefits of hazard mitigation and personal resilience through public outreach and education.
5. Policy - Integrate hazard mitigation planning and climate change projections as an integral factor in all Town municipal departments, committees, and boards to reduce the impacts of natural hazards
6. Finance - Identify and seek funding for measures to mitigate or eliminate each known significant hazard area and reduce the impacts of climate change.

3.0 COMMUNITY PROFILE, LAND USE, AND DEVELOPMENT TRENDS

3.1 Community Profile

Winchendon is located in north-central Massachusetts, sharing its border with Rindge and Fitzwilliam, New Hampshire. The town is bisected by Millers River and includes important geographic features like Lake Dennison, and Lake Monomanac. Geographically, the town is isolated from major highways like Route 2 or interstate highways like Interstate 91, or Interstate 495. However, the town sits at the junction of Routes 202 and 12, and therefore serves as an important corridor to and from New Hampshire, Vermont, and Boston.

Winchendon is historically an industrial town with a history dating back to the 18th century. The town was part of a plantation that was received by proprietors from Ipswich in 1735 and was officially established in 1764. The town experienced the peak of its success during the industrial era after the convergence of two major rail lines in the town-center and thrived as a wealthy industrial town until the early 20th century. Several dams were built on Millers River (such as Whitney Pond, Tannery Pond, and Whites Mill Pond). They provided electricity to the flourishing manufacturing industries, especially the mills. Wood products, textiles, leathers, plastics were among the town's major industries during that time. It was also home to the famous "Converse Toy Company" and earned its nickname "Toy Town"[12]. The town may have lost its industrial era glory, but it hosts several heritage landscapes adding significant charm to the current community character.

Winchendon has active community spaces and events, including the public library and annual celebrations like the Fall Festival, and community outreach programs like Earth Day Cleanup. Winchendon is also working towards reducing its carbon footprint by building energy efficient infrastructure such as solar landfills, wind energy systems in the Hillview Business Park, and other private solar energy projects. Winchendon is governed by a Town Manager and a Board of Selectmen and operates under the open Town Meeting system. The Town maintains a website at https://www.townofwinchendon.com/. The Town committee is also active on social media and posts town events or other updates on a regular basis.

Figure 3-1. Images of Local Features. Photos from the Town of Winchendon and Lake Monomonac.

3.2 Societal Features

Winchendon has approximately 11,000 residents and in several respects mirrors Massachusetts as a whole (US Census Bureau, 2014-2018). The Town of Winchendon is similar to the State's demographic averages for age distribution, residents with disabilities, and poverty statistics. Winchendon differs from the state's demographic averages for race and ethnicity representation, educational attainment, and

renter occupancy. Winchendon is home to more residents who are white and fewer people of color than Massachusetts overall. The town's median household income is nearly $5,000 less than the state average. The number of Winchendon residents with a bachelor's degree or higher is approximately half that of the Commonwealth. More information is included in the table below.

Table 3-1. Winchendon Demographic Characteristics

2018	Winchendon	Massachusetts
Population (July1, 2019)	10,905	6,892,503
Under the Age 18	24%	20%
Over Age 65	14%	17%
White	92%	71%
Black or African American	1%	9%
Asian	1%	7%
Two or More Races	2%	3%
Hispanic	3.5%	12%
Bachelor's degree or higher	21%	43%
Median household income	$71,895	$77,378
Poverty Rate	11.5%	10.0%
With a Disability	7.8%	7.9%
Limited English-Speaking Skills	5%	6%
Housing Units	1,922	2,882,739
Renter-Occupancy Rate	48%	38%
Burdened by Housing Costs (Renters)	31%	40%

Source: US Census Bureau
Note: population burdened by housing costs is defined as housing costs above 35% of income

Residents who are at a high degree of risk during their day-to-day lives are also more vulnerable during an extreme event. In Winchendon, seniors, youth, people with disabilities, and low-income residents are considered vulnerable. Vulnerable populations may be at a greater risk of isolation for a variety of reasons, including lack of access to personal transportation, lack of social support, and limited English fluency (if emergency communications are shared in English). Residents with barriers to building personal resilience may also be vulnerable, including those with limited income. According to Massachusetts Department of Environmental Protection (MassDEP, 2010), Environmental Justice (EJ) neighborhoods have one or more of the following characteristics:

- Income: block groups where annual median household income is equal to or less than 65 percent of the statewide median ($62,072 in 2010).
- Minority: 25% or more of the residents identify as a race other than white.
- English Isolation: 25% or more of households have no one over the age of 14 who speaks English only or very well.

Winchendon has EJ neighborhoods due to their income criterion. The Commonwealth has defined these neighborhoods in recognition that extreme events have historically disproportionally impacted vulnerable communities. Engaging vulnerable residents in decision making is a critical part of an equitable climate change planning processes.

3.2.1 CRB Workshop Discussion of Societal Features

CRB Workshop participants identified key societal features of Winchendon that are most vulnerable to, or provide protection against, natural hazards and climate change impacts. Please refer to Table 3-2 for more information.

Table 3-2. Societal Features in Winchendon

Both Vulnerability and Strength	Strengths	Vulnerabilities
• Winchendon School (private) • Communication System (CODE Red/211 System)	• The Clark Memorial YMCA	• EJ Population • Senior Population • Disabled Population • Vulnerable Neighborhoods

3.3 Economic Features

Employment rate in Winchendon grew by 10.7% between 2017 and 2018 (US Census Bureau ACS 5-year Estimate). Most of the people in the town are employed in the Office and Administrative Support category, followed by Production related occupations and Management occupations (see Table 3-3, below). Communication between businesses and the Town will be key in advancing hazard mitigation planning efforts and ensuring that large employers are aware of local risks and have emergency protocols in place.

Table 3-3. Winchendon Labor Data

	Winchendon	Massachusetts
Labor Force	5860	3,815,400
Unemployment Rate	3.4%	3.3%
Employed in Top Employment Industry	83.2%	70.7%
Commuters with > 30 min travel time to work	18%	11.1%

Source: United States Census Bureau, 2010, ACS, 2018

3.4 Infrastructure

No significant highways are located in Winchendon. Local roads have been impacted by snow, ice, downed trees, and flooding. The Town also has two pump stations, twelve dams, two water storage tanks (Winchendon Open Space and Recreation Plan, 2016). Winchendon has a history of concerns related to water supply and it has been identified by the Town as a critical issue. The Town does not have an existing active municipal groundwater supplies, relying solely on a surface water reservoir in Ashburnham, Upper Naukeag Lake, for its drinking water supply. Winchendon and Ashburnham jointly constructed a treatment plant for the surface water reservoir, which the towns share for their water

Figure 3-2. Whitney Pond Dam, Winchendon
(Source: Town DPW office)

supply. The town's water system serves approximately 2,100 customers. These include both homes and businesses. The Department of Public Works estimates that approximately 5,600 individual residents are served by the system, leaving approximately 4,700 residents in outlying areas to depend on private wells for their water. The village center in Winchendon is serviced by sewer facilities but several areas of moderately dense development outside of the center are not sewered. Winchendon completed a significant upgrade to its wastewater treatment plant in 2004, upgrading capacity to 1.1 million gallons per day (Winchendon Open Space and Recreation Plan, 2016).

3.4.1 CRB Workshop Discussion of Existing Infrastructure

Participants at the CRB Workshop identified key infrastructure features in Winchendon that are vulnerable to, or provide protection against, natural hazards and climate change impacts. As shown below, most of the infrastructure features were determined to be both a vulnerability and a strength.

Table 3-4. Infrastructure Features in Winchendon

Both Vulnerability and Strength	Strengths	Vulnerabilities
• Wastewater treatment system • Water treatment system • Senior Center upgrades • Fire station upgrades	• Police station upgrades • Evacuation routes/public safety access	• Dam infrastructure deficiencies • Local roads and bridges • Poor internet service • Electrical grid/interconnectivity

3.5 Land Use and Environmental Features

The Town of Winchendon is just over 44 square miles. Winchendon's current patterns of land use reflect the historical periods of agriculture, industrial production and decline, and suburbanization. Over time Winchendon has transformed from an industrialized mill town to predominantly suburban neighborhoods. Winchendon State Forest and Otter River State Forest, both managed by the Massachusetts Department of Conservation and Recreation (DCR), provide ample opportunities for outdoor recreation. Winchendon is abundantly endowed with water resources including lakes, rivers, aquifers, and wetlands. The Miller's River, Lake Monomonac, Lake Denison, Bailey's Brook, Whitney Pond, White's Mill Pond and Stoddard Pond are some of the major water bodies in town. Wetland systems border many of the water bodies, serving as important buffer areas to these sensitive habitats (Winchendon Open Space and Recreation Plan, 2016).

The graphic below illustrates a comparative breakout of land use in Winchendon. As seen in Figure 3-3, most of Winchendon's land is natural land, with only 7% as developed land (MassAudubon, 2020).

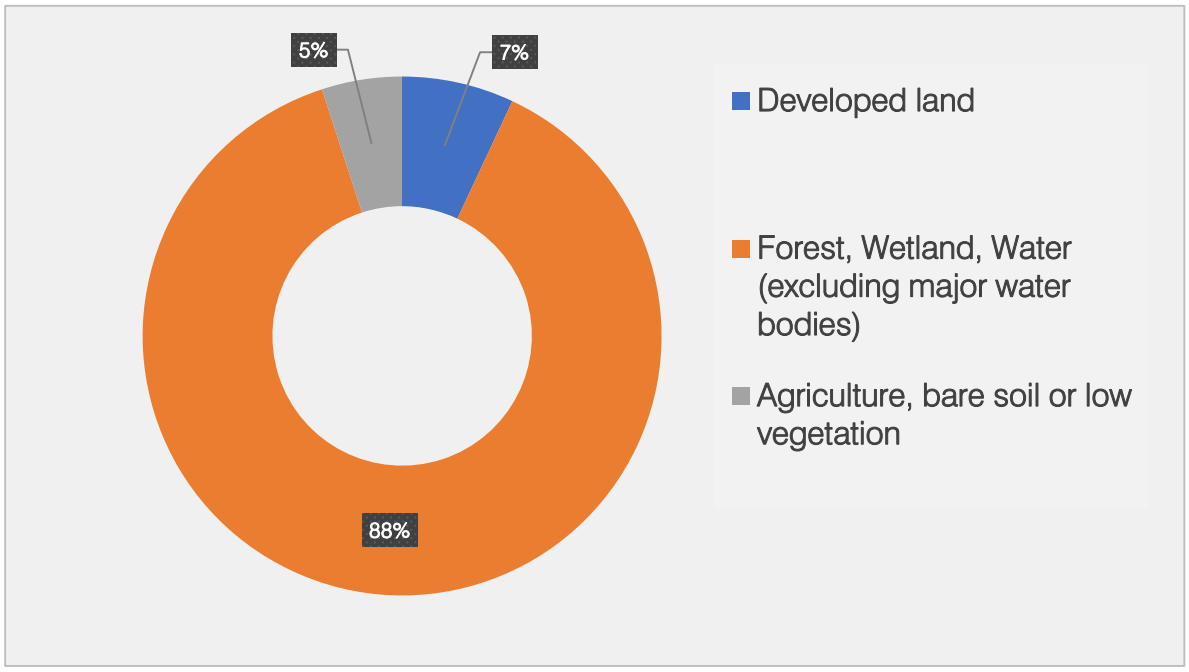


Figure 3-3. Land Use in Winchendon 2005-2013
Source. MassAudubon's Development Statistics

3.5.1 CRB Workshop Discussion of Environmental Features

Workshop participants identified key environmental features in Winchendon that are most vulnerable to, or provide protection against, natural hazards and climate change impacts.

Table 3-5. Environmental Features in Winchendon

Both Vulnerability and Strength	Strengths	Vulnerabilities
• Bike path	• Lake Dennison recreational area	• Town monuments/cultural resources • Agriculture/food economy • Water quality

3.6 Recent and Potential Developments

Table 3-6. Current and Future Development in Winchendon

3.7 Critical Facilities

Critical facilities are essential components to the Town's function and protecting them from natural hazards is paramount. Critical facilities range in function from:

- Resources that can be utilized to respond and recover from natural hazards.
- Facilities where additional assistance might be needed.

- Hazardous sites that could be dangerous if compromised during a natural disaster.

Based on information in the previous hazard mitigation plan, interviews with the Core Team and other experts, and input from stakeholders during the CRB Workshop, a list of critical facilities were identified for Winchendon. These facilities include emergency management buildings, Town facilities, shelters, hospitals, evacuation routes, critical intersections, water and sewer infrastructure, natural resources, religious centers, dams, schools, grocery and supplies stores, health centers, and other facilities.

Table 3-7. Category 1 – Emergency Response Facilities	
Police and Fire Department	
Winchendon Fire Station	405 Central Street
Winchendon Police Station	15 Pleasant Street
Emergency Shelters	
Murdock Middle/High School	3 Memorial Drive
Emergency Operations Center	
Winchendon Police Station	15 Pleasant Street
Emergency Dispensing Sites	
Murdock Middle/High School	3 Memorial Drive
Old Murdock Senior Center	52 Murdock Avenue

Table 3-8. Category 2 – Non-Emergency Response Facilities	
Town Facilities	
Winchendon Animal Shelter	637 River Street
Winchendon Town Hall	109 Front Street
Winchendon DPW Building	105 Glenallen Street
Beals Memorial Library	50 Pleasant Street
Winchendon Highway Department	101 Glenallen Street
Winchendon Communications Tower #1 (private)	40 Elmwood Road
Winchendon Communications Tower #2 (private)	26 Hale Street
Winchendon Communications Tower #3 (private)	Bemis Road
Winchendon Communications Tower #4 (private)	29 Happy Hollow Road
Radio Tower (public)	Hospital Drive
Schools	
Memorial School	32 Elmwood Road
Winchendon School	172 Ash Street
Murdock Middle/High School	3 Memorial Drive
Toy Town Elementary School	175 Grove Street
Marvin School	89 Ash Street
Water Supply System	
Winchendon Water Storage Tank	Elmwood Road
Winchendon Water Storage Tank	High Street
Water Pumping Station	Eagle Road
Water Pumping Station	Route 140 Gardner Road
Water Pumping Station	High Street
Wastewater Supply System	

Table 3-8. Category 2 – Non-Emergency Response Facilities	
Winchendon Wastewater Treatment Facility	637 River Street
Spring Street Sewer Pumping Station	Spring Street
Spring Place Sewer Pumping Station	Spring Place
Utilities	
National Grid Substation	Spring Street
National Grid Substation	Mill Glen Road

Table 3-9. Category 3 – Dangerous/Hazardous Materials and Facilities	
Hazmat Sites	
Eastern Propane Gas, Inc.	600 School Street
White's Mill Building	155 Mill Circle
Winchendon Wastewater Treatment Facility	637 River Street
RHI Building	212 Central

Table 3-10. Category 4 – Vulnerable Populations and Community Facilities	
Housing Authority Properties, Elderly Housing Communities, and Long-Term Care Centers	
Broadview, Inc.	547 Central Street
Winchendon Community Residence	105 Linden Street
Family Housing	Pearl Street and Ipswich Drive
Broadview, Inc.	547 Central Street
Hyde Park Elderly Housing	67 Hyde Park
Ipswich Drive Elderly Housing	108 Ipswich Drive
Family and Elderly Housing	1 Ready Drive
Elderly Housing	Glenallen Street
End of Life Facilities	
Snow-Ladeau Funeral Home Inc.	343 Central Street
Old Center Cemetery	High Street
Riverside Cemetery	50 Glenallen Street
Calvary Cemetery	Glenallen Street
New Boston Cemetery	New Boston Road
Riverside Cemetery Extension (no extension capabilities)	
Massachusetts Veteran Cemetery	111 Glenallen Road
Schools and Daycares	
Adams, Nikki	101 Lakeshore Drive
Haggett, Carla	7 Hale Street
Nadine, Boutelle	201b High Street
Ingman, Jane M.	46 Chase Lane
Kelley, Jolene	95 Krantz Road
Labarge, Angela	170 Teel Road
Black, Tracy Lee	445 Central Street

Table 3-10. Category 4 – Vulnerable Populations and Community Facilities	
Family Child Care Club	103 West Street
PreK Club (Jennifer Nelson)	34 Royalston Road N
Winchendon Family Child Care	208 Hale Street
Clark Memorial YMCA Afterschool	155 Central Street
Creative Care Learning Center	17 Whitney Street
Child Care (Susan Rocheleau)	36 Phyllis Road
Child Care (Cathleen Sevigny)	41 Hale Street
Child Care (Tina Sevigny)	209 Main Street
PreK Club (Felicia Burgess)	N Vine Street
PreK Club (Tonya Smutz)	187 Mill Glen Road
Healthcare Services	
Winchendon Health Center	55 Hospital Drive
Murdock Health Center Middle School	3 Memorial Drive 2nd Floor
Food and Supply Stores	
Cumberland Farms	32 Central Street
Smith Country Cheese	20 Otter River Road
One Stop Plaza Convenience	Main Street
Gateway Convenience	670 Spring Street
Family Dollar	49 Central Street
Not Just Produced	290 Central Street
Walgreen's Pharmacy	250 Central Street
Sports and Cultural Centers	
W.P. Clark Memorial YMCA	155 Central Street
Winchendon Community Park/Theater (to be built)	86 Ingleside Drive
Winchendon Historical Society	637 Front Street
Other Facilities	
Ahimsa Haven	Central Street

Table 3-11. Category 5 – Dams	
Dams in Winchendon	
Lake Monomonac Dam	Beaman Pond Dam
Whitney Pond Dam	Red Dam
Flis Pond Dam	Merrill Pond Dam
Norsky Dam	Town Pumping Station Dam
Brow's Pond Dam	Hunts Pond Dam
Stoddard Pond Dam	Tannery Pond Dam
Great Dam	Whites Mill Pond Dam

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 related climate change projections. The risk and vulnerability assessment examines both the frequency and severity of hazards and their potential impact to Winchendon. Each hazard risk and vulnerability assessment utilizes previous occurrences and climate projections to identify high risk areas and the likelihood that a hazard will occur. The vulnerability analysis looks at various factors in the community, including 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 also considered as part of the flood vulnerability assessment.

The hazard profiles were updated with information from the 2013 Massachusetts State Hazard Mitigation Plan (MEMA and DCR, 2013); the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP; EEA and EOPSS, 2018) and additional research and assessment conducted by the project team. 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 Winchendon on current and future development. FEMA's Hazus software was used to model the potential damage of hurricanes and earthquakes.

4.1 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 provides a further description of the Frequency and Severity characterizations.

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 (less than 1% per year)
- Low frequency: events that occur from once in 50 years to once in 100 years (1% to 2% per year)
- Medium frequency: events that occur from once in 5 years to once in 50 years (2% to 20% per year)
- High frequency: events that occur more frequently than once in 5 years (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.

Table 4-1 summarizes the frequency and severity of hazard risk in the overall state. These frequency and severity classifications for the state can inform the prioritization of mitigation actions for each hazard.

Table 4-1. Massachusetts 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 (Severe Weather)	High (43.5 events per year)	Minor to Extensive
Tornadoes (Severe Weather)	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 (Severe Winter Weather)	High (1 per year)	Minor to Extensive
Ice Storms (Severe Winter Weather)	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

Source: Table adapted from the 2018 SHMCAP and 2013 Massachusetts State Hazard Mitigation Plan

Not all hazards included in the 2018 State Hazard Mitigation and Climate Adaptation Plan or the 2013 Massachusetts State Hazard Mitigation Plan apply to Winchendon. Given Winchendon's inland location, coastal hazards and tsunamis are unlikely to affect the town. Given the type of fires that have occurred

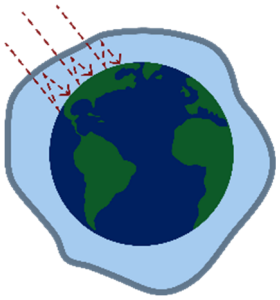
in Winchendon's history, Winchendon should focus on brush fires rather than wildfires. It is assumed all of Winchendon and its critical facilities are exposed to earthquakes, high wind events, hurricanes, winter storms, temperature extremes, and snow and ice, to a similar extent. Flood risk from riverine flooding is elevated in the vicinity of 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 occur in Massachusetts, and more specifically Worcester County, helps planners understand the possible extent and frequency of hazards. Historically, Massachusetts has experienced multiple types of hazards, including flooding, blizzards, and hurricanes. Since 2000, there have been twenty-nine storms in Massachusetts that resulted in federal or state disaster declarations. Twenty-two disaster declarations occurred in Worcester County. Federally declared disasters present additional FEMA grant opportunities for regional recovery and mitigation projects. The hazard profiles included in this chapter contain more information about federally declared disasters.

4.1.3 Impacts of Climate Change

Many of the hazards that Winchendon 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 (CO2) that capture heat and contribute to the regulation of the Earth's climate. When fossil fuels (including 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. Due to these changes, the future climate in Massachusetts is expected to resemble historic climate patterns of Southern New England or Mid-Atlantic States more closely, depending upon GHG emission scenarios. Climate change has already started to impact 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 is 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/climate change impacts that Winchendon faces. Extensive discussion led to the selection of the following:

- Flooding
- Severe Winter Storms
- Extreme Temperatures
- High Winds

The workshop was designed to bring stakeholders together to brainstorm action items that will facilitate a climate resilient future while also supporting the town's unique features and characteristics. Concerns related to hazardous events such as flooding, and snowstorms were topics of discussion. Stakeholders

cited the need for dam reconstruction and upgrades, as well as the need for public education around stream flooding. Workshop participants also reviewed challenges impacting electrical and internet infrastructure, water supply, vulnerable populations, and municipal infrastructure conditions. There was extensive discussion about winter storms and high wind events, wind causing power outages, and the potential for future events to worsen in frequency and severity. Stakeholders described how power outages from severe storms can leave many residents without power for extended periods. It was discussed that a proper tree education and maintenance program could lessen the severity of impacts for many residents. Workshop participants highlighted that access to power and backup power sources during natural hazard events is a pressing issue, as is reliable internet service.

Stakeholders found a reoccurring theme related to the adequacy of shelter facilities with regards to most if not all the top hazard events identified. Discussion centered around access to shelter facilities for vulnerable populations and the need to increase public communication surrounding hazard events. Stakeholder identified evacuation plans, proper evacuation route signage, and public educations as high priorities related to shelter facilities.

4.2 Flood-Related Hazards

Flooding was among the four main hazards identified by participants during Winchendon's CRB Workshop. Flooding can be caused by various weather events including hurricanes, extreme precipitation, thunderstorms, nor'easters, and winter storms. Flooding can be both riverine (topping the banks of streams, rivers, ponds) and from stormwater that is not properly infiltrated into the ground. While Winchendon experiences these events, the impacts of climate change will likely lead to increasingly severe storms and increasingly severe impacts. The impacts of flooding include injury or death, property damage, and traffic disruption. The winter and spring thaw can also bring challenges to the town, with clogged catch basins or ice flowing into dams. Flood hazards are directly linked to erosion, which can compromise receiving water quality, slope stability, and the stability of building foundations. This puts current and future structures and populations located near steep embankments at risk. Erosion can also undercut streambeds and scour around stream crossing, creating a serious risk to roadways. Figure 4-1 shows the impact of precipitation on the State.

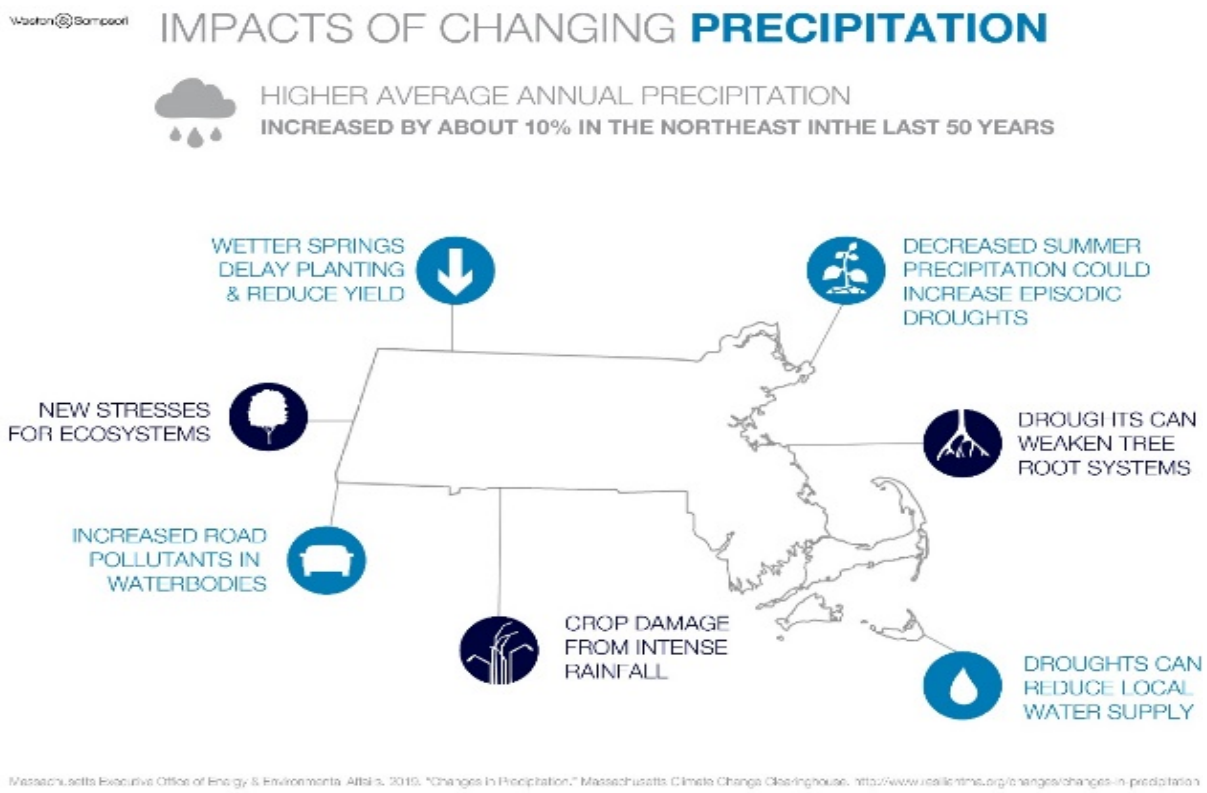


Figure 4-1. Impact of changing precipitation in future on the State of Massachusetts

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. The vulnerability assessment of flood hazard areas was informed by the FEMA NFIP Flood Insurance Rate Maps (FIRMs) and a GIS vulnerability analysis. Flooding events in Winchendon have been classified as a high frequency event. According to the 2013 Massachusetts State Hazard Mitigation Plan, this hazard occurs more frequently than once in 5 years or greater than 20% per year.

Flood Insurance Rate Map Zone Definitions

Zone A (1% annual chance): 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): 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): 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.

Source: FEMA, 2019b, https://www.fema.gov/flood-zones

4.2.1 Areas Vulnerable to Flooding

Riverine Flooding

There are numerous rivers, streams, ponds, wetland crossings, lakes, and reservoirs in the town. All of Winchendon is located within the Millers River Watershed; the river enters the town from the west and heads north before turning to the east and flowing into Ashburnham. Other rivers/brooks that flows through the town are North Branch that originates at Lake Monomonac, Otter River that flows north from Templeton, Bailey's Brook, and Tarbell Brook. The notable ponds and lakes in town are Lake Monomonac, Lake Denison, Whitney Pond, White's Mill Pond and Stoddard Pond. Wetland systems border many of the water bodies in the town. FEMA Flood Zones, areas prone to flooding, are closely associated with the Millers River and its tributaries (Winchendon Open Space and Recreation Plan, 2016).

FEMA Flood Insurance Rate Maps (FIRM) designate areas likely to experience flooding. The FIRM delineates both the special flood hazard areas and the risk premium zones 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 flood insurance 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"). The definitions of these flood zones are provided below. FEMA-designated flood zones for Winchendon (FEMA, 1991) are included in Appendix B.

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, 2019e). There are no repetitive loss properties in Winchendon (DCR, 2020a). It is important to point out that repetitive loss data only includes buildings that qualify for the repetitive loss designation, which does not represent all losses due to flooding. The number of buildings that experience losses due to flooding is higher than what is reported above related to repetitive losses.

Stormwater Flooding

Stormwater flooding occurs during a precipitation event where the rate of rainfall is greater than the capacity of the stormwater management system. 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. In Winchendon, the combined stormwater sewer system causes additional capacity and public health concerns. The town has many old culverts that are often undersized and structurally deficient.

Most stormwater systems in Massachusetts are aging and have been designed with rainfall data that is no longer accurate. Figure 4-2 shows how anticipated rainfall during design storms 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 demand on the existing stormwater system by increasing infiltration on-site. Rain gardens and pervious pavement are two examples of possible strategies. Upsizing culverts with new rainfall data is also recommended.

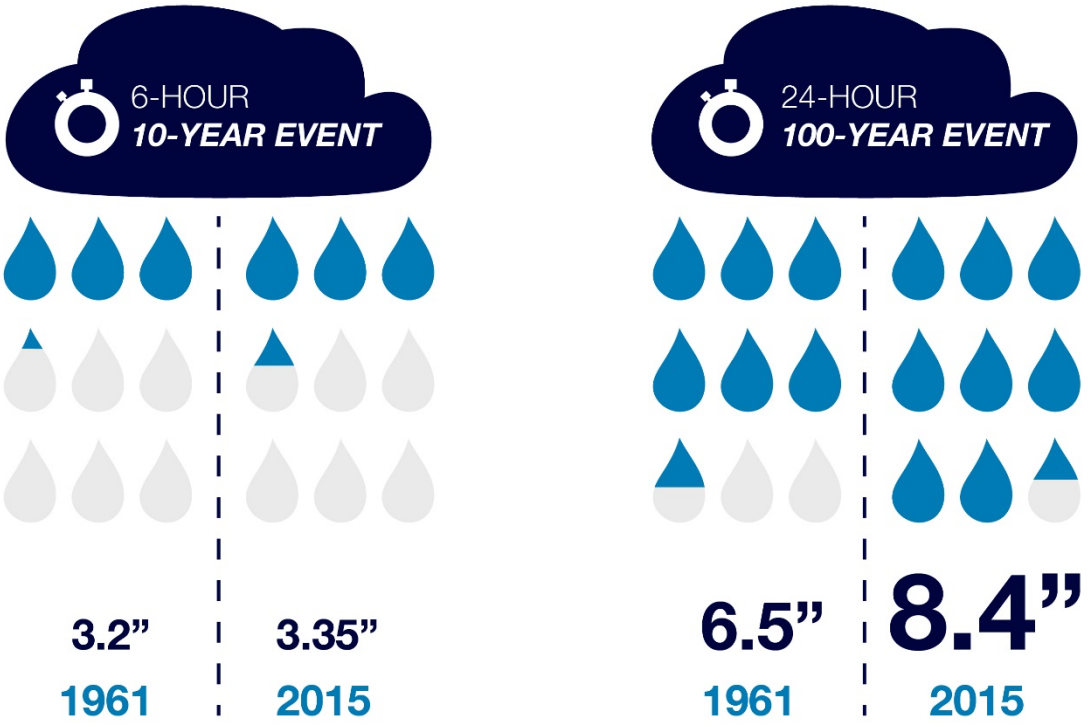


Figure 4-2. Stormwater Design Standards (NOAA TP 40, 1961 and NOAA, 2015)

Hydrographs, or graphs of the streamflow, can be used to illustrate the impact of impervious surface and stormwater runoff. Hydrographs of natural streams generally see a gradual increase in the amount of flow during rain events as stormwater flows into the waterways via the surface and groundwater. Hydrographs of urban streams generally have a large spike, which indicates stormwater rushing into the waterbody through conveyance systems and off impervious surfaces.

The U.S. Geological Survey (USGS) manages a streamflow gauging station on Millers River near Winchendon. As Figure 4-3 indicates, the discharge exceeded five hundred cubic feet on May 2, 2020 (USGS 01162000 Millers River Near Winchendon, MA, as of May 10, 2020) after a large spike in the flow. The large spike could indicate that much of the stormwater is not being infiltrated into the ground, but rather directed into the Millers River. Winchendon’s terrain is gently rolling with soils that are stony, relatively poorly drained, and shallow to bedrock or hard pan layers, which can create high volumes of runoff and challenges for groundwater recharge.

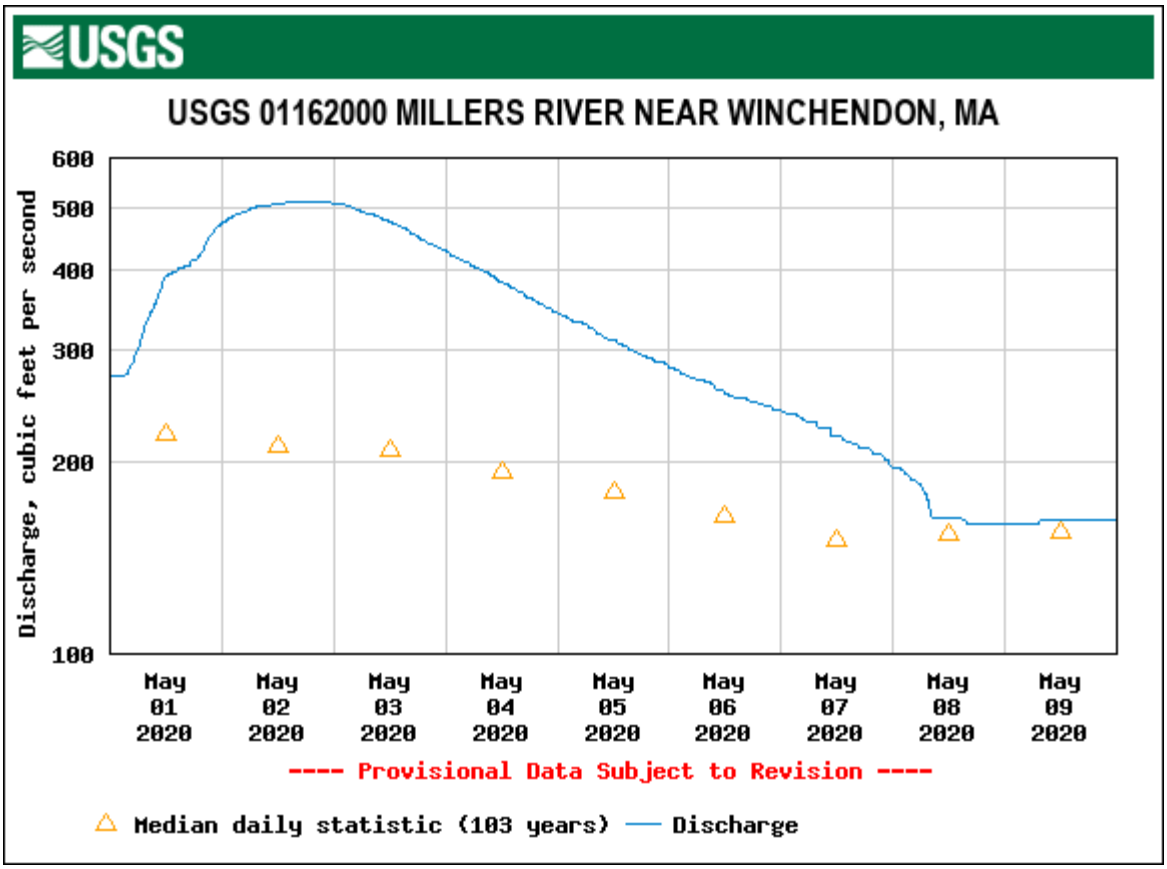


Figure 4-3 USGS Streamflow Discharge (USGS water data as of May 10, 2020)

Locally Identified Areas of Flooding

Winchendon Town staff and CRB Workshop participants helped identify local areas of flooding. 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. The Town has recently made some repairs to the flood reduction system in the downtown area, improved drainage on Columbia Road, and made several other updates to reduce the impact of flood events. Table 4-2 below identifies the local areas that are prone to flooding.

Table 4-2: Winchendon Potential Areas for Future Flooding

Location	Description
Spring Street	
Route 12	No flood controls. Needs study and repairs.
High Street Bridge	Repaired, but needs further review.
Route 202	In need of repairs.
River Street Bridge	Needs safety review and repairs.
Brown Street Bridge	In need of repairs.
Maple Street Bridge	(Culvert). In need of repairs.

4.2.2 Historic Flood Events

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 Winchendon, dated 1991. For purposes of this exposure analysis, the following special flood hazard areas as identified in Winchendon's current FIRMs were included:

- Flood Zone A – 1% Annual Chance Flood Hazard
- Flood Zone X – 0.2% Annual Chance Flood Hazard

The Town's existing tax parcel and property value data 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.

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.

To calculate the exposure of parcels and buildings to flood hazards, parcels with buildings that are located completely or partially within recognized hazard zones were identified using the ArcGIS overlay analysis (i.e., select by location using the intersect function). The number of parcels and buildings for each land use category was then totaled, along with the value of buildings and real estate properties associated with those parcels. These figures provide a strong indication of current hazard vulnerability, as well as potential future vulnerability as it relates to vacant and potentially developable parcels.

4.2.4 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). There are two types of dam failures that can occur. Catastrophic failure occurs when there is a sudden, rapid, uncontrolled release of impounded failure. The second type is design failure, which occurs as a result of minor overflow events. Dam overtopping occurs when floods exceed the capacity of the dam, which can be due to inadequate spillway design or other outside factors such as settlement of the dam crest or back of spillways. Thirty-four percent of all dam failures that occur in the United States are a result of overtopping (EEA and EOPSS, 2018). Many dam failures in the United States have been secondary results of other disasters. The prominent causes include earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage (MEMA and DCR, 2013). 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).

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 they can add additional stress on the dam infrastructure.

Dam failure 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. Dam failure is classified as a low frequency event in the town. As defined by the 2013 Massachusetts State Hazard Mitigation Plan, a very low frequency hazard may occur less frequently than once in 100 years (less than a 1% chance per year). A dam failure can still present a high level of risk, which is indicated through a dam's classification. These classifications are defined by DCR as:

> *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.

As of February 2017, all dams classified as high hazard potential or significant hazard potential were required to have an Emergency Action Plan (EAP) (DCR, 2019a). This plan must be updated annually and submitted to the Commissioner and the Massachusetts Emergency Management Agency. The plan should also be retained by the dam owner and the town in which the dam is located. Guidelines and a template were established by the Office of Dam Safety to ensure that all EAPs follow the proper format.

According to Town officials and the Massachusetts Department of Conservation and Recreation's (DCR) Office of Dam Safety, there are 13 dams in Winchendon. Information related to these dams is summarized in Table 4-11. All the dams owned by the Town are high hazard dams with inspections due in November 2020.

Table 4-11. Inventory of Dams in Winchendon

Dam Name	Dam Owner	Hazard Potential Classification
Whites Mill Pond Dam	Brandywine Farms, Inc.	High Hazard
Lake Monomonac Dam	Town of Winchendon, Department of Public Works	High Hazard
Whitney Pond Dam	Town of Winchendon, Department of Public Works	High Hazard
Hunts Pond Dam	Winchendon Hydroelectric LLC	Low Hazard
Stoddard Pond Dam	Mill Glen Pond Campers Association	Significant Hazard
Flis Pond Dam	Unknown	N/A
Tannery Pond Dam	French River Land Co., Inc.	Low Hazard
Beaman Pond Dam	DCR - Dept. of Conservation & Recreation	Low Hazard
Merrill Pond Dam	Phillip Beals	N/A
Norsky Dam	Unknown	N/A
Town Pumping Station Dam	Unknown	N/A
Brow's Pond Dam	Unknown	N/A

Table 4-11. Inventory of Dams in Winchendon		
Dam Name	**Dam Owner**	**Hazard Potential Classification**
Red Dam	Town of Winchendon, Department of Public Works	High Hazard
Great Dam	Town of Winchendon, Department of Public Works	N/A

Source: U.S. Army Corps of Engineers, 2020

4.2.5 Flooding and Climate Change

Winchendon's average annual precipitation is 47 inches (NEIC, 2019). Extreme rain and snow events are becoming increasingly common and severe, particularly in the Northeast region of the country (Figure 4-4). 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 the 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 4-4. Changes in Frequency of Extreme Downpours

Source: Madsen and Willcox, 2012, pp19

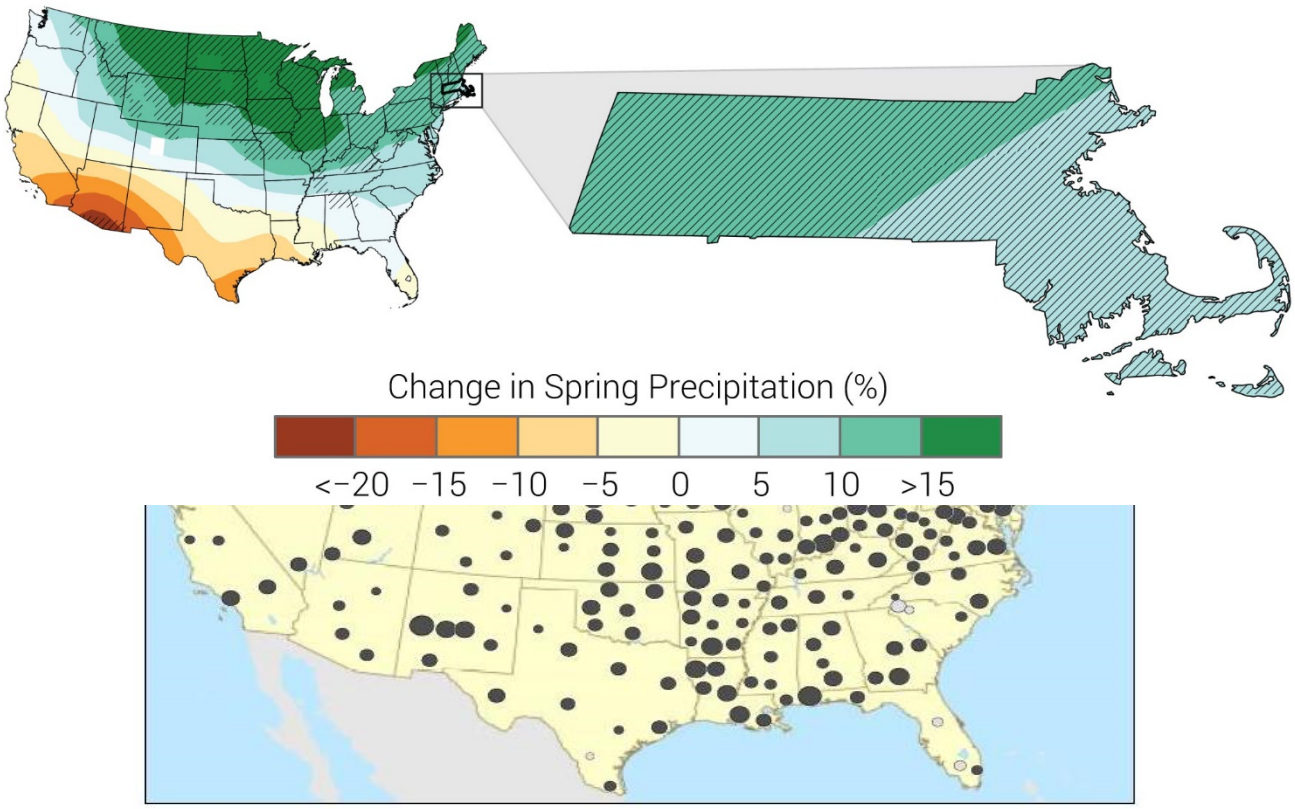


Figure 4-5. Projected Change in Spring Precipitation "Projected change in spring precipitation (%) for the middle of the 21st century relative to the late 20th century under a higher emissions pathway. Hatching represents portions of the state where the majority of climate models indicate a statistically significant change. Precipitation in the spring is projected to increase in Massachusetts by mid-century. Data from CICS-NC and NOAA NCEI"
Source: NOOA and Department of Commerce, 2017

4.3 Wind Related Hazards

High winds can occur during hurricanes, tropical storms, tornadoes, nor'easters, and thunderstorms. All of Winchendon is vulnerable to the impacts of high wind. Wind may down trees and power lines. High wind and storm events can cause property damage and hazardous driving conditions. While Winchendon's current 100-year wind speed is 95 Vmph, climate change will likely increase events and severity (ASCE 7 Hazard Tool).

The planning process identified vulnerabilities related to potential storm damage to power and phone wires from overhanging trees that have not been trimmed by the electric utilities (National Grid) or the phone or cable companies. The utilities' tree maintenance program should be upgraded to reduce the risk associated with tree damage to utility lines. High winds and heavy snow loads caused significant power line damages during nor'easters. Falling trees and branches can also block traffic and emergency routes. This is a regional issue that affects cities and towns beyond Winchendon.

During Winchendon's CRB Workshop in November 2020, attendees discussed the impact of past storms on power systems and service disruption.

Winchendon does have reliable communications towers that house equipment for the Police and several other Town departments. Town officials stated that their communications systems may be at risk during flooding and high wind events. The development of emergency communication plans for vulnerable populations should be developed, that includes an inventory of current resources and an identification of additional needs.

NOAA's National Centers for Environmental Information offers thunderstorm wind, high wind, and strong wind data for Worcester County. Between 2000 and 2019, 248 wind entries were uploaded into the database and 135 were related to thunderstorms. Other wind events were related to coastal storms, low pressure cells, rains, and other hazard events. During this time period, there was one death, seven injuries, and nearly $4.7 million worth of damages. Winds ranged from 39 to 65 miles per hour.

4.3.1 Severe Storms and Thunderstorms

Thunderstorms are typically less severe than other hazard events discussed in this section. However, thunderstorms can cause local damage and are a town-wide risk in Winchendon. 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. 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. Thunderstorms with little or no rainfall are rare in New England but have occurred (EEA and EOPSS, 2018). Thunderstorms are considered high frequency events in Winchendon. 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).

NOAA's National Centers for Environmental Information offers thunderstorm and hail data for Worcester County (NOAA, 2019a). Between 2000 and 2019, 135 thunderstorm events caused $3.2 million in

property damages in Worcester County. Five injuries and one death were reported. All the major thunderstorm events caused downed trees and powerlines, leading to roadblocks and power outages in parts of the County. Between 2000 and 2019, there were 80 hail events that caused $125,000 in property damage in Worcester County. No deaths or injuries were reported. The size of hail typically ranges from 0.75" up to 2" (NOAA, 2019a).

4.3.2 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. 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). The Saffir/Simpson scale (Table 4-14) categorizes or rates hurricanes from 1 (minimal) to 5 (catastrophic) based on their intensity. 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 (EEA and EOPSS, 2018).

Table 4-12. 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 are severe, there are extensive glass failures, and entire buildings could fail.

Source: MEMA and DCR, 2013, page 325 (table originally created by NOAA)

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). When hurricanes and tropical storms occur, they will impact the entire planning area. Vulnerable populations and all existing and future buildings, including critical facilities, are at risk to hurricane and tropical storm hazards. Hurricane events have a large spatial extent and could potentially affect all of Winchendon. Impacts include water damage to 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. Figure 4-6 shows the impacts of extreme events on the state.

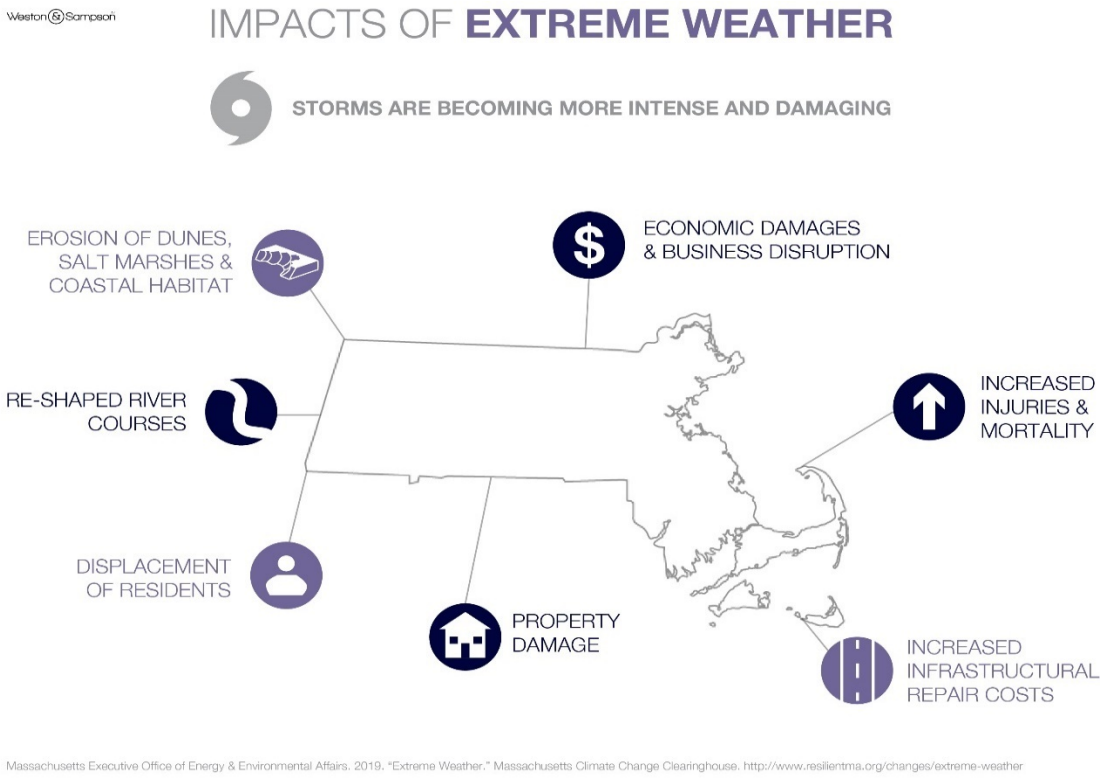


Figure 4-6. Impacts of extreme events and stronger storms on the State of Massachusetts.

The North East region has been impacted by hurricanes throughout its history, starting with the Great Colonial Hurricane of 1635. Massachusetts experienced 11 hurricanes and one named tropical storm between 1851 and 2012. This includes six category 1 hurricanes, two category 2 hurricanes, and three category 3 hurricanes (Blake et al., 2011). Worcester County faced three major tropical storms in the last 10 years. Hurricanes that have occurred in the region since 1938 are listed in Table 4-13.

Table 4-13. Hurricane Records for Eastern Massachusetts, 1938-2019

Hurricane/Tropical Storms 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 Grace	October 31, 1991
Hurricane Floyd	September 1999
Hurricane Katrina	September 13, 2005
Tropical Storm Hanna	September 6, 2008
Hurricane Bill	August 22, 2009

Table 4-13. Hurricane Records for Eastern Massachusetts, 1938-2019	
Hurricane/Tropical Storms Event	Date
Tropical Storm - Hurricane Earl	September 4, 2010
Tropical Storm Irene	August 28, 2011
Hurricane Sandy	October 29-30, 2012
Tropical Storm-Hurricane Arthur	July 4, 2014
Tropical Storm Hermine	September 5, 2016
Tropical Storm Jose	September 20, 2017
Hurricane Florence	September 18, 2018
Tropical Storm Dorian	September 7, 2019

Source: National Oceanic and Atmospheric Administration (NOAA, 2019a)
*Note: * Category 3*

Hurricane damage in Winchendon 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. The largest hurricane ever witnessed in Massachusetts was a Category 3 hurricane, 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 in Massachusetts, the storm was modeled to show the impact that could occur from an extreme scenario. A Category 4 hurricane could potentially occur in the future due to climate change.

In Massachusetts, the return period for a Category 2 hurricane is approximately 0.01 percent, and for a Category 4 hurricane it is approximately 0.005 percent. Hazus models hurricanes based upon their return period. Therefore, a Category 2 was modeled as a 100-year hurricane and a Category 4 was modeled as a 500-year hurricane. To model each of these hurricanes, the study region must first be defined. The Town of Winchendon was outlined by the Census Tracts in the Town and the probabilistic scenario was used. This scenario considers the associated impact of thousands of storms that have a multitude of tracks and intensities. The output shows the potential impact that could occur in Winchendon if either a Category 2 or a Category 4 hurricane passed by. Hazus is based on 2010 Census data and 2014 dollars. The table below show the estimated damage from both a Category 2 and a Category 4 hurricane in the municipality.

Table 4-14. Estimated Damages in Winchendon from Probabilistic Category 2 and 4 Hurricanes		
	Category 2	Category 4
Building Characteristics		
Estimated total number of buildings	4,284	4,284
Estimated total building replacement value (Year 2014 $) (Millions of Dollars)	$1,416	$1,416
Building Damages		
# of buildings sustaining minor damage	16	243
# of buildings sustaining moderate damage	0.87	21
# of buildings sustaining severe damage	0.06	0.93
# of buildings destroyed	0	0.1
Population Needs		
# of households displaced	0	0

Table 4-14. Estimated Damages in Winchendon from Probabilistic Category 2 and 4 Hurricanes		
	Category 2	Category 4
# of people seeking public shelter	0	0
Debris		
Total debris generated (tons)	7,245	45,848
Tree debris generated (tons)	7,151	44,978
# of truckloads to clear building debris (@25 tons/truck)	4	35
Value of Damages (Thousands of dollars)		
Total property damage	$3,190.61	$16,205.92
Total losses due to business interruption	$17.01	$598.27

In addition to the infrastructural damage, Hazus also calculates the potential societal impact of a Category 2 and Category 4 hurricane on the community. This calculation includes monetary wages, capital-related, rental and relocation costs, as well as expected damages to essential facilities and damages by building material type. A full Hazus risk report for each hurricane category can be found in Appendix B.

Hurricanes are a town-wide hazard in Winchendon 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). The average number of hurricane or tropical storm events is one every two years (MA EOEEA and EOPSS, 2018).

4.3.3 Tornados

A tornado is a narrow, 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 1995 Great Barrington, Massachusetts tornado occurred in May; and the 1979 Windsor Locks, Connecticut tornado 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 4-15 provides more detailed information on the EF Scale.

Table 4-15. Enhanced Fujita Scale						
Fujita Scale			Derived		Operational EF Scale	
F Number	Fastest ¼ mile (mph)	3-second wind gust (mph)	EF Number	3-second wind gust (mph)	EF Number	3-second wind 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

Source: MEMA and DCR, 2013, pp. 416

Massachusetts experiences an average of 1.7 tornadoes per year. The most tornado-prone areas of the State are the central counties. In 2018 there were three EF1 tornados that touched down in Worchester County causing damage to the surrounding areas. On June 23rd, 2015, a tornado with maximum winds estimated at 75 mph, wreaked havoc near the Wachusett Mountain which is close to Winchendon. Tornadoes are comparatively rare in eastern Massachusetts, although Worcester County is considered an at-risk location (EEA and EOPSS, 2018). There have been 33 recorded tornadoes in Worcester County since 1950 (NOAA, 2019a). Table 4-18 below provides additional information. The most devastating tornado in Massachusetts in the history of recorded weather occurred in Worcester County in 1953, it killed 90 people, injured more than 1,200, and caused more than $250 million in damages (NOAA, 2019a) (not adjusted for inflation).

Table 4-16. Tornado Records for Worcester County, 1950-2019				
Date	Fujita	Fatalities	Injuries	Property Damage
6/9/1953	F4	90	1228	$250,000,000
10/24/1955	F1	0	0	$2,500
6/1/1956	F1	0	14	$25,000
11/21/1956	F2	0	0	$2,500,000
6/19/1957	F1	0	0	$25,000
7/5/1957	F2	0	0	$2,500

Table 4-16. Tornado Records for Worcester County, 1950-2019

Date	Fujita	Fatalities	Injuries	Property Damage
7/11/1958	F1	0	0	$250
7/16/1958	F1	0	1	$2,500
7/29/1958	F1	0	0	$2,500
10/12/1962	F2	0	0	$25,000
5/20/1963	F2	0	0	$25,000
8/31/1966	F2	0	0	$0
7/17/1968	F1	0	0	$2,500
5/29/1969	F1	0	0	$2,500
10/3/1970	F3	0	0	$250,000
7/1/1971	F1	0	2	$25,000

11/7/1971	F1	0	0	$2,500
8/9/1972	F2	0	1	$25,000
5/3/1976	F1	0	0	$2,500
8/10/1979	F2	2	2	$2,500,000
6/22/1981	F3	0	3	$25,000
8/8/1986	F1	0	0	$2,500
7/10/1989	F1	0	0	$250,000
8/10/1990	F0	0	0	$30
6/17/2001	F1	0	0	$25,000
7/23/2002	F1	0	0	$50,000
7/19/2007	EF0	0	0	$0
6/1/2011	EF3	0	0	$0
8/31/2014	EF0	0	0	$100,000
6/23/2015	EF0	0	0	$25,000
7/26/2018	EF1	0	0	$25,000
8/4/2018	EF1	0	1	$5,000,000
10/23/2018	EF1	0	0	$0
Total		92	1,252	$260,922,780

Source: NOAA, 2019a

There have been no recorded tornadoes in the town. If a tornado were to occur in Winchendon, 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 Winchendon 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. However, it is predicted that the frequency of tornados in eastern Massachusetts will rise in the future due to climate change.

4.3.4 Nor'easters

A nor'easter is characterized by large counterclockwise 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. 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). These winter weather events are among the season's most ferocious storms, often causing beach erosion, flooding, and structural damage (EEA and EOPSS, 2018). Due to its inland location, Winchendon is not subject to the coastal hazards often associated with nor'easters. The Town of Winchendon 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. Some of the historic events described in the "Flood-Related Hazards" section of this report was preceded by nor'easters, including the 1991 "Perfect Storm." The Blizzard of '78 was a particularly notable storm. More recently, winter storms in 2015 and 2018 caused significant snowfall amounts.

Nor'easters generally occur on at least an annual basis, typically in late fall and early winter. Some years bring up to four nor'easter events. Nor'easters in Winchendon 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).

4.3.5 Climate Change and Severe 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).

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. Winchendon's hilly topography magnifies winter storms 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 Winchendon. 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. Table 4-17 provides information related to winter weather federally declared disasters that have impacted Worcester County.

Table 4-17. Previous Federal Disaster Declarations – Winter Weather

Disaster Name and Date of Event	Disaster Number	Type of Assistance	Counties Under Declaration
Snowstorm **March 05, 2001 - March 07, 2001**	EM-3165	FEMA Public Assistance	Middlesex, Essex, Norfolk, **Worcester**, Hampshire, Franklin, Berkshire
Snowstorm **December 6-7, 2003**	EM-3191	FEMA Public Assistance	Middlesex, Essex, Suffolk, Norfolk, Bristol, Plymouth, Barnstable, **Worcester**, Hampshire, Hampden, Franklin, Berkshire

Snowstorm **January 22 - 23, 2005**	EM-3201	FEMA Public Assistance	**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 **December 11-18, 2008**	EM-3296	None	Middlesex, Essex, Suffolk, Bristol, **Worcester**, Hampshire, Hampden, Franklin, Berkshire
Severe Winter Storm, Snowstorm, and Flooding **February 8-9, 2013**	DR-4110	FEMA Public Assistance	**All 14 Massachusetts Counties**
Severe Winter Storm, Snowstorm, and Flooding **January 26-28, 2015**	DR-4214	FEMA Public Assistance	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, **Worcester**
Severe Winter Storm and Snowstorm **March 13-14, 2018**	DR-4379	FEMA Public Assistance	Essex, Middlesex, Norfolk, Suffolk, **Worcester**

Source: FEMA, 2019d

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 to be classified as a blizzard. 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).

Winter storms pose multiple risks, including 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 and National Weather Service, 2019). Winter storms can be combined with the nor’easters discussed previously in the “Wind-Related Hazards” section.

There have been 41 winter storm entries between 2000 and 2019 totaling $1.5 million of storm damage in Worcester County (NOAA, 2019a). Two of the events were categorized as a blizzard. No injuries or deaths were reported. 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. Winter weather and

Figure 4-7. Winchendon after heavy 2ft snow.
Source: ABC 8News – WRIC Facebook Page

heavy snow also has caused significant damages (totaling up to $1.3 million) in Worcester County between 2000 and 2019 (NOAA, 2019a).

The Town provides standard snow plowing operations and clearing snow has not posed any significant challenges to date. However, Town officials acknowledged that due to steep areas, icing conditions can occur throughout the Town, making travel difficult. The spring thaw, with freezing conditions, is particularly difficult in these hilly areas.

Blizzards are classified as high frequency events in Winchendon. 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).

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. There were four ice storms in Worcester County between 2000 to 2019, during which $23 million worth of property damage came from just one ice storm on 12/11/2008. Up to six tenths of an inch of ice accumulated on exposed surfaces across southern Worcester County. Trees, large limbs, and wires were downed in Ashburnham, Gardner, Leominster, and Winchendon. Several trees landed on houses and one landed on a boat (NOAA, 2019a). Cities and towns were without power for days and school were canceled due to power outages.

Ice storms are classified as medium frequency events in Winchendon. 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).

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 4-18 summarizes Richter Scale magnitudes and corresponding earthquake effects (MEMA and DCR, 2013).

Table 4-18. 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.

Source: Louie, 1996

Earthquakes occur occasionally in New England compared to other parts of the country and are often so small that they are not felt. 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 Massachusetts is included in Table 4-19 below.

Table 4-19. Historical Earthquakes in Massachusetts and 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

Table 4-19. Historical Earthquakes in Massachusetts and Surrounding Area, 1727-2020		
Location	Date	Magnitude
MA - Wareham	4/25/1924	NA
MA - Cape Ann	1/7/1925	4
MA - Nantucket	10/25/1965	NA
MA - Boston	12/27/1974	2.3
MA - Nantucket	4/12/2012	4.5
MA – Newburyport	2/20/2013	2.3
MA – Freetown	1/9/2014	2.0
MA – Bliss Corner	2/11/2014	2.2
MA – off Northshore	8/18/2014	2.0
MA – Rockport Coast	6/1/2016	2.2
MA – Nantucket	8/18/2018	2.4
MA – Templeton	12/21/2018	2.1
MA – Gardner	12/23/2018	2.2
MA – Rockport	4/27/2019	2.1
MA – North Plymouth	12/3/2019	2.1

Source: 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.

A serious earthquake in Massachusetts is possible. Winchendon is located in an area with a PGA of 10-14%g with a 2% probability of exceedance in 50 years (Figure 4-8). This is the third highest zone in the state with two reported earthquakes of magnitude 3 in the past. However, none of the earthquakes have their epicenters recorded in Winchendon. Thus, Winchendon is a moderate area of earthquake risk. 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. These events can strike without warning and can have a devastating impact on infrastructure and buildings constructed prior to earthquake resistant design considerations. It can be assumed that all existing and future buildings and populations are at risk to an earthquake hazard. If an earthquake occurs, the entire region, not just the town, would face significant challenges.

Impacts from earthquakes can range 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 and Climate Adaptation Plan, 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). Earthquakes often trigger fires and the water distribution system may be disrupted, thus posing a risk for public health and safety.

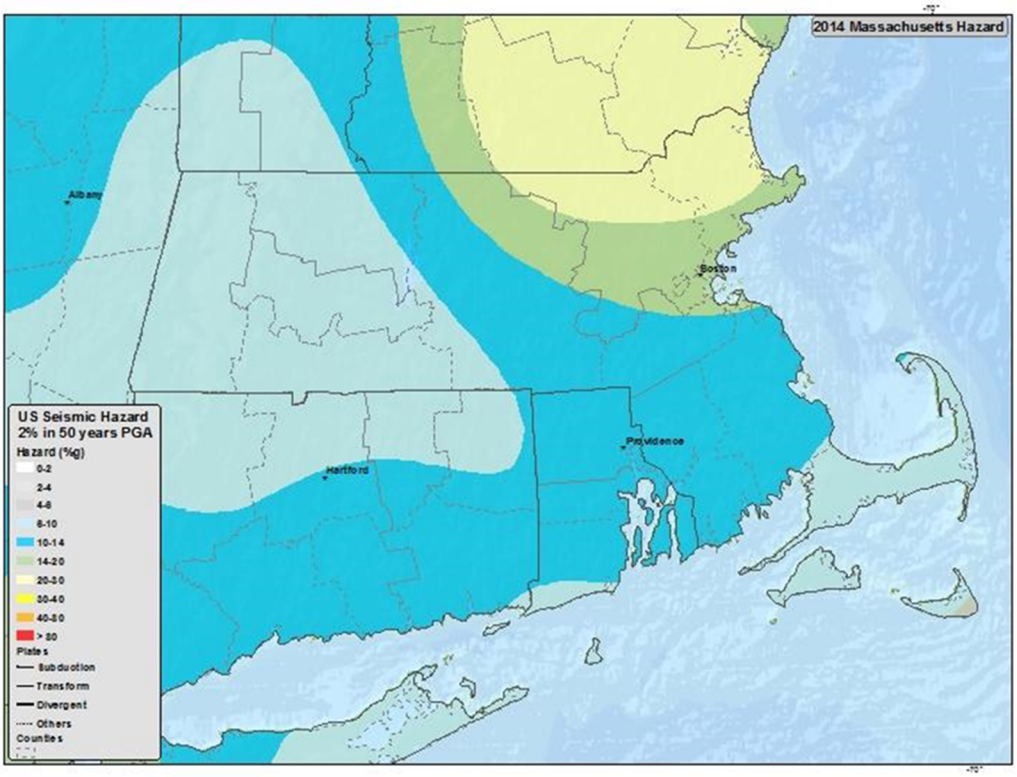


Figure 4-8. 2014 Seismic Hazard Map- Massachusetts
Source: USGS

Potential earthquake damage was modeled for Winchendon using Hazus. 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. The tables below show the estimated damage from both a magnitude 5.0 and a magnitude 7.0 earthquake in the municipality.

In addition to the infrastructural damage, Hazus also calculates the potential social impact of a magnitude 5.0 and magnitude 7.0 earthquake on the community. This calculation includes utility system inventory, building damage by construction type, damage to essential facilities and transportation systems, and casualty estimates. A full Hazus risk response report for each earthquake category can be found in Appendix B.

Table 4-20. Estimated Damage in Winchendon from Probabilistic Magnitude 5.0 and 7.0 Earthquakes

	Magnitude 5.0	Magnitude 7.0
Building Characteristics		
Estimated total number of buildings	4,284	4,284
Estimated total building replacement value (Year 2014 $) (Millions of dollars)	1,415	1,415
Building Damages		

# of buildings sustaining slight damage	1,216	221
# of buildings sustaining moderate damage	667	1,037
# of buildings sustaining extensive damage	198	1,187
# of buildings completely damaged	49	1,814
Population Needs		
# of households displaced	162	2,152
# of people seeking public shelter	93	1,234
Debris		
Building debris generated (tons)	33,000	268,000
# of truckloads to clear building debris (@25 tons/truck)	1,320	10,720
Building-Related Economic Loss (Millions of dollars)		
Income Losses	$23.46	$148.61
Capital Stock Losses	$148.97	$1131.30

Earthquakes are classified as a low frequency event in Winchendon. As defined by the 2013 State Hazard Mitigation Plan, these events occur from once in 50 years to once in 100 years, or 1% to 2% per year. According to 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

Landslides 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 4-21. Figure 4-9 shows the slop stability of Winchendon area.

Table 4-21. 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

Source: *Cardinali et al., 2002*

Map Color Code	Predicted Stability Zone	Relative Slide Ranking[1]	Stability Index Range[2]	Factor of Safety (FS)[3]	Probability of Instability[4]	Predicted Stability With Parameter Ranges Used in Analysis	Possible Influence of Stabilizing or Destabilizing Factors[5]
	Unstable	High	0	Maximum FS<1	100%	Range cannot model stability	Stabilizing factors required for stability
	Upper Threshold of Instability		0 - 0.5	>50% of FS1	>50%	Optimistic half of range required for stability	Stabilizing factors may be responsible for stability
	Lower Threshold of Instability	Moderate	0.5 - 1	≥50% of FS>1	<50%	Pessimistic half of range required for instability	Destabilizing factors are not required for instability
	Nominally Stable	Low	1 - 1.25	Minimum FS=1	_	Cannot model instability with most conservative parameters specified	Minor destabilizing factors could lead to instability
	Moderately Stable		1.25 - 1.5	Minimum FS=1.25	_	Cannot model instability with most conservative parameters specified	Moderate destabilizing factors are required for instability
	Stable	Very Low	>1.5	Minimum FS=1.5	_	Cannot model instability with most conservative parameters specified	Significant destabilizing factors are required for instability

Figure 4-9. Slope Stability Map of Massachusetts focusing on Winchendon.
Source: The Massachusetts Geological Survey, 2013

Winchendon is classified as stable and therefore having a low risk for landslides (Fig 4-9). No significant landslides have been recorded for Winchendon or Worcester County (Appendix B of EEA and EOPSS, 2018) There could be 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 Winchendon. According to the 2013 State Hazard Mitigation Plan, these events occur from once in 50 years to once in 100 years, or 1% to 2% per year.

4.6 Fire Related Hazards

Winchendon is more likely to experience a brushfire compared to a wildfire (or a fire with a large impact area). Wildfires and brushfires can occur in the vegetative wildland, including grass, shrub, leaf litter, and forested tree fuels. Fires can be caused by natural events, human activity or in an intentional controlled manner, as in the case of prescribed fire (MEMA and DCR, 2013, 252). 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."*

Brush fires are classified as medium frequency events in Winchendon and occur frequently in the town (Fig. 4-10). As defined by the 2013 State Hazard Mitigation Plan, these events occur between once in five years to once in 50 years (a 2% to 20% chance of occurring per year). Fire risk is influenced by fuel (the type of material), 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.

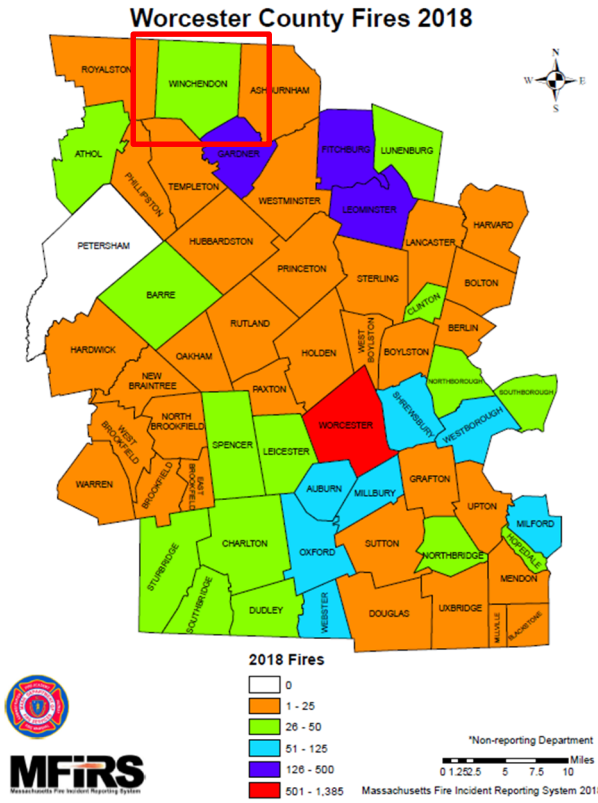


Figure 4-10. Fire related hazard areas in Worcester County. Winchendon is outlined in red.
Source: MFIRS, 2018

Brush fires can lead to property damage and injury. The areas most vulnerable to brush fire are primarily heavily wooded areas. The fire department has equipment and resources to respond to fires in the areas. Winchendon had 19 fire incidents in 2017, out of which 10 were structure fires. The number of fire incidents increased to 41 (19 structure fires) in 2018.

Brushfires can lead to death and property damage. All homes or workplaces located 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.

4.7 Extreme Temperatures

Massachusetts has four clearly defined seasons. Extreme temperatures are considered outliers, or temperatures that fall outside the typical range for each season. Extreme temperatures can last from an afternoon to a few days. Day and nighttime temperatures also play a role when considering the effect of temperature. For example, when the temperature does not cool off at night during an extreme heat wave, the risk of heat related illnesses is intensified. During extreme cold, pipes may freeze and burst in many buildings with unreinforced masonry.

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 4-11 on the following page provides more information. Extreme temperatures are considered a town-wide hazard in Winchendon and generally last from an afternoon to a few days. 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 Winchendon, 14% of the population is over 65 years old and 8% of the population has a disability (US Census Bureau, 2018). 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 2019, Worcester County experienced seven extreme cold and will chill events, which caused no deaths, injuries, or property damage.

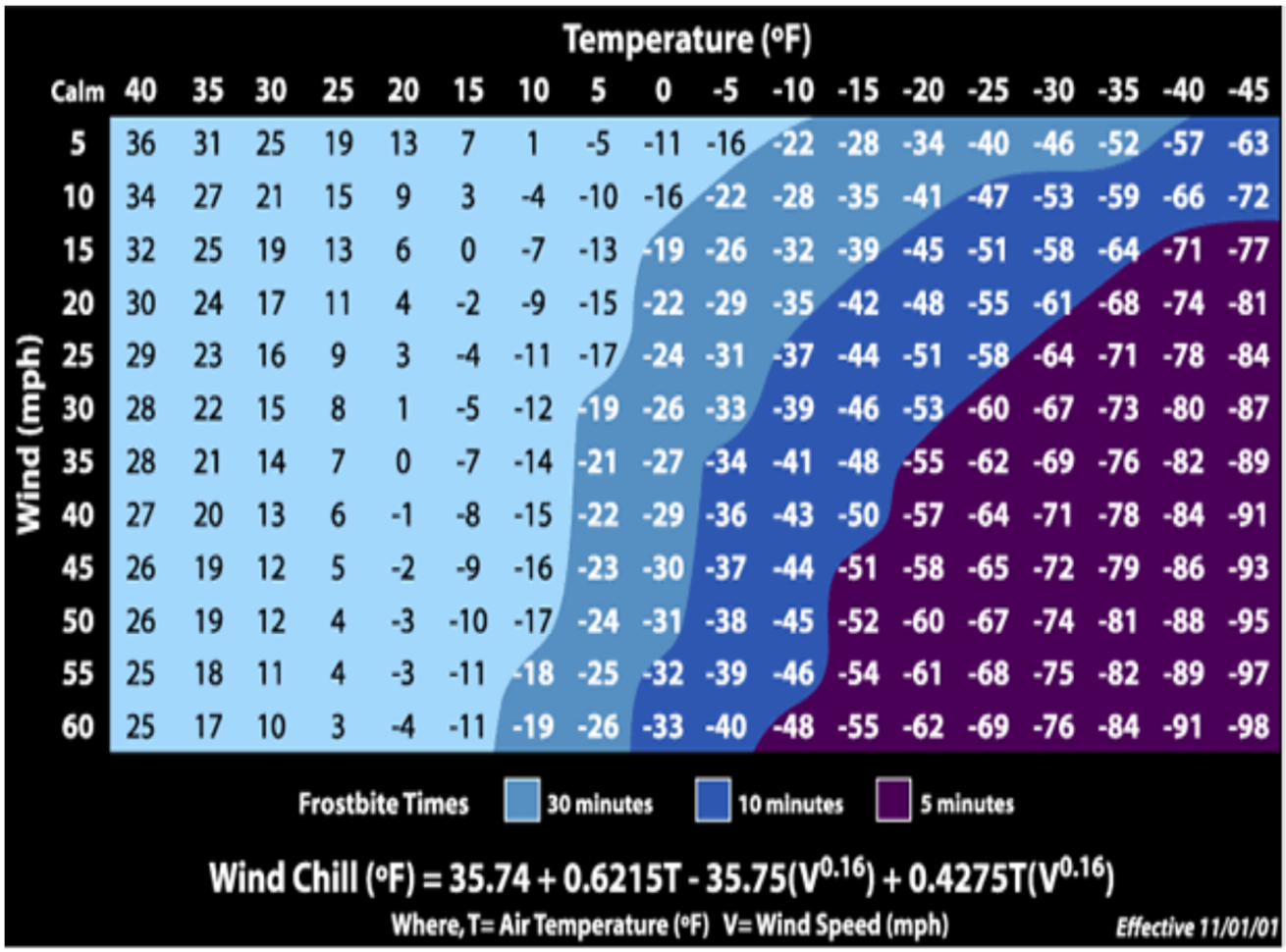


Figure 4-11. Windchill Temperature Index and Frostbite Risk
(Source: NOAA, n.d.)

4.7.2 Extreme Heat

Increased temperatures will impact all locations within Winchendon. Extreme heat is when the maximum temperature reaches above 90°F during the day. Projected heat days and heat waves can have an increased impact in densely settled urban areas. These can become "heat islands" as dark asphalt and roofs store the heat from the sun. Impacts from heat stress can exacerbate pre-existing respiratory and cardiovascular conditions.

The Town of Winchendon does not collect data on heat occurrences. July is the hottest month in Winchendon and average temperature in July is around 80°F (NEIC, 2019). NOAA's National Centers for Environmental Information Storm Events Database provides data on excessive heat. Between 2000 and 2019, Worcester County experienced three extreme heat days, which did not result in injury or property damage. An event in 2013 did result in a fatality. Extreme temperatures are classified as medium frequency events. As defined by the 2013 State Hazard Mitigation Plan, these events occur from once in 5 years to once in 50 years, or 2% to 20% per year. According to the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan, between four and five heat waves (3 or more consecutive days of 90˚+F temperatures) occur annually in Massachusetts.

The NWS issues a Heat Advisory when the Heat Index (Figure 4-12) is forecast to reach 100-104˚ F for two or more hours (NOAA, n.d.). 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. 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.

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 4-12. Heat Index Chart

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. 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.
- Children under the age of five.
- Individuals with pre-existing medical conditions that impair heat tolerance.
- Individuals without proper cooling.
- Individuals with respiratory conditions.
- Individuals that overexert themselves during extreme heat events.

Homeless people are increasingly vulnerable to extreme heat. The capacity of homeless shelters is typically limited. In Winchendon, children under five years old make up 7% of the population, and 14% 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, including 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 2014-2018).

Based on Figure 4-13 below, compiled by the Massachusetts Department of Public Health Bureau of Environmental Health (MA DPH, 2019), Winchendon has a population density of 253 people per square mile (US Census Bureau, 2018). The total number of population vulnerability measures in each Census Tract (2010) varies between 2 and 3. These population vulnerability measures include: low income, low English proficiency, non-white (Hispanic and non-Hispanic ethnicities), and elderly residents.

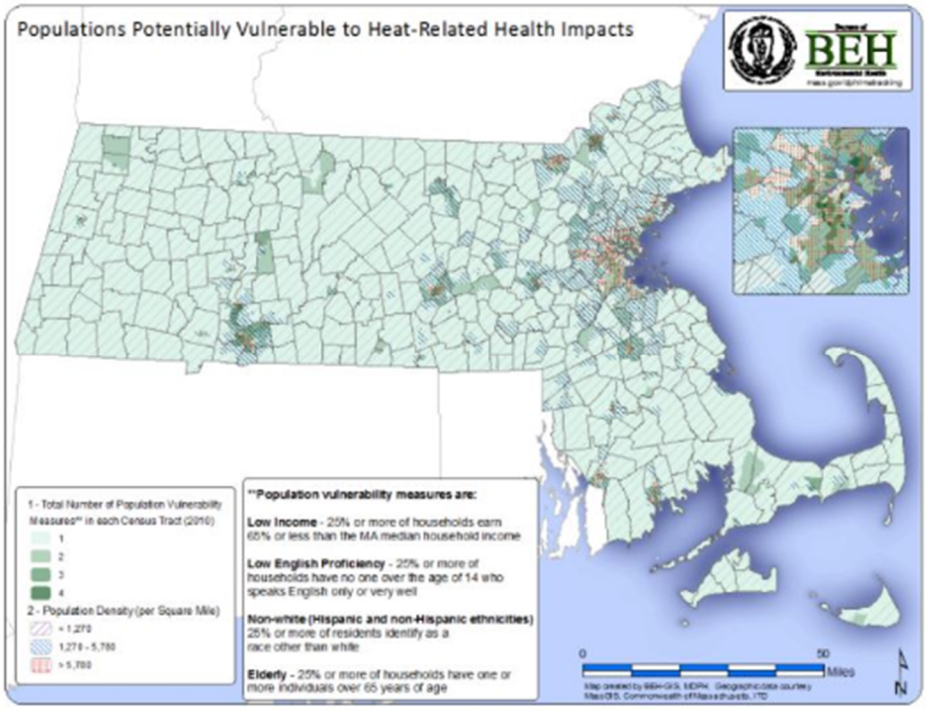


Figure 4-13. Populations Potentially Vulnerable to Heat Related Health Impacts
Source: Massachusetts Department of Public Health, Bureau of Environmental Health, 2019

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 could more closely resemble that of Maryland or the Carolinas (Figure 4-14). 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). 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

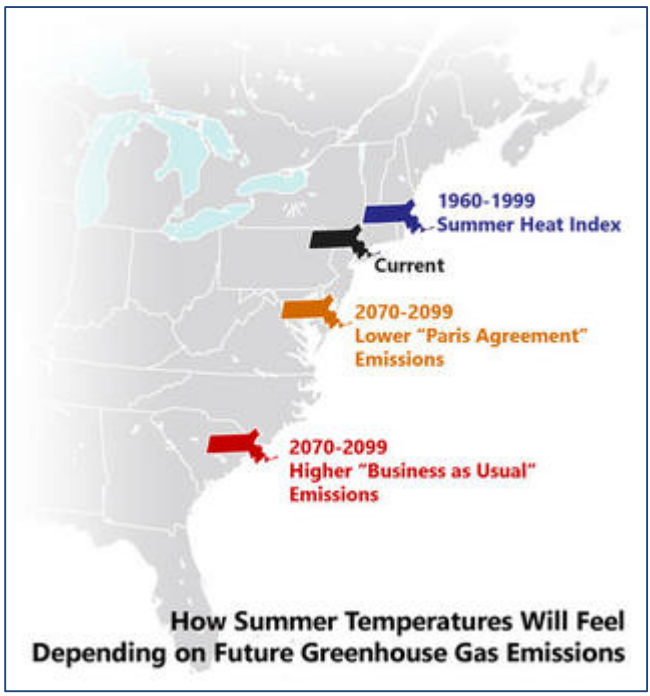


Figure 4-14. Massachusetts Extreme Heat Scenarios.
Source: Frumhoff et al., 2007

pollution, which can lead to negative health impacts such as respiratory problems.

4.8 Drought

Drought is an extended period of deficient precipitation and occurs in virtually all climatic zones. Since each region has a different baseline precipitation amount, the characteristics of drought vary significantly from one region to another. Agriculture, the water supply, aquatic ecosystems, wildlife, and the economy are vulnerable to the impacts of drought (EEA and EOPSS, 2018).

Although Massachusetts is relatively small, it has a number of distinct regions that experience significantly different weather patterns and varying impacts from changes in precipitation. In accordance with the Massachusetts Drought Management Plan, the Drought Management Task Force provides recommendations to the Secretary of Energy & Environmental Affairs about the location and severity of drought in the Commonwealth. The Drought Management Plan (2019) divides the state into seven regions: Western, Central, Connecticut River Valley, Northeast, Southeast, Cape, and Islands. Winchendon is located within the central region (EEA and MEMA, 2019).

According to the updated Drought Management Plan (2019) there are five levels of drought to characterize drought severity.

- Level 0 – Normal,
- Level 1 - Mild Drought,
- Level 2 - Significant Drought,
- Level 3 - Critical Drought, and
- Level 4 – Emergency Drought,

The drought levels are based on the severity of drought conditions and their impacts on natural resources and public water supplies.

Although the Town of Winchendon experienced water supply restrictions in 2015, the Town usually has adequate water supply. The drinking water supply system was built to support the paper mill industry, which was a significant water user. Since the mills are no longer in operation, there is typically abundant water supply in Winchendon.

The Drought Management Plan specifies agency response and interagency coordination and communication based on various drought levels. During normal conditions, data are routinely collected and distributed. There is 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 (EEA and MEMA, 2019).

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:

1. Standard Precipitation Index
2. Precipitation (percent of normal)
3. Crop Moisture Index

4. Keetch-Byram Drought Index (KBDI)
5. Groundwater levels
6. Stream flow levels
7. Index Reservoir levels

In the updated Drought Management Plan, the Drought Management Task Force has eliminated the precipitation index that is based on percent of normal precipitation.

Drought level is determined monthly, based on the number of indices that have reached a certain 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).

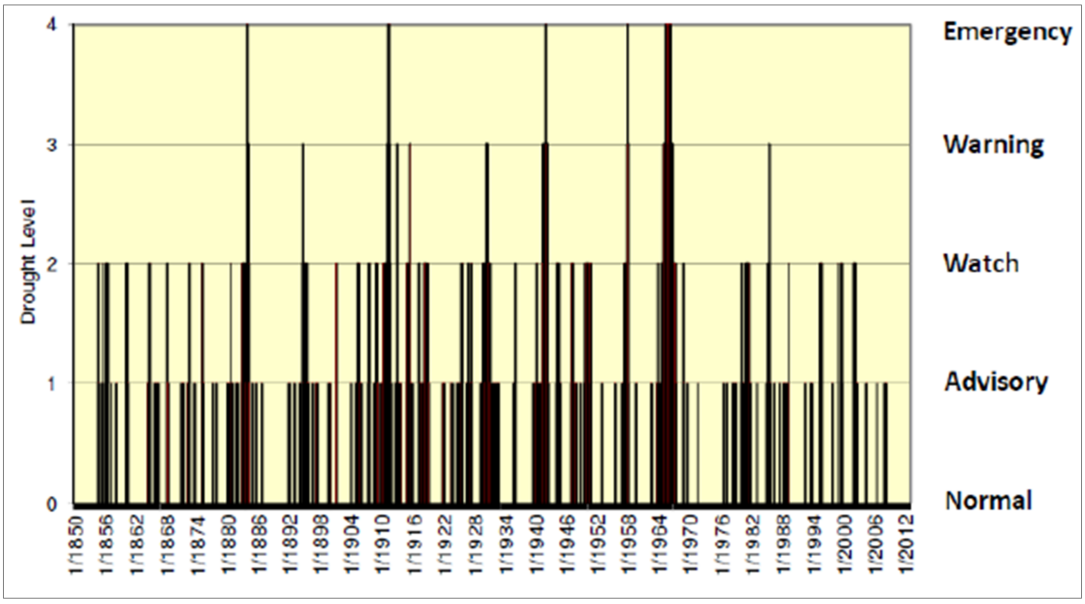


Figure 4-15. Statewide Drought Levels Using SPI Thresholds, 1850 to 2012.

Source: EEA and MEMA, 2013, pp. 37

Worcester county had 13 drought periods from 2000 to 2019, according to the National Center for Environmental Information. Six of these events were declared Extreme Droughts by The U.S. Drought Monitor (NOAA, 2019a). Figure 4-15 illustrates statewide drought levels in Massachusetts from 1850 to 2012, using the Standardized Precipitation Index (SPI). Table 4-22 below summarizes a history of Massachusetts droughts between 1879 and 2017.

Table 4-22. Droughts in Massachusetts Based on Instrumental Records

Date	Area Affected	Recurrence Interval (years)	Remarks
1879 to 1883	–	–	–
1908 to 1912	–	–	–

Table 4-22. Droughts in Massachusetts Based on Instrumental Records			
Date	Area Affected	Recurrence Interval (years)	Remarks
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.
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).

Source: EEA and EOPSS, 2018, page 4-45

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 more severe drought conditions, 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, 2019). There were six Drought Watches in Massachusetts in 2002, five Drought Watches in 2016, and two drought watches in 2017 (DCR, 2017b). Figure 4-16 presents an example of drought conditions in the six drought regions.

Drought is a potential town-wide hazard in Winchendon. 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 Winchendon's CRB Workshop in February 2020, 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.

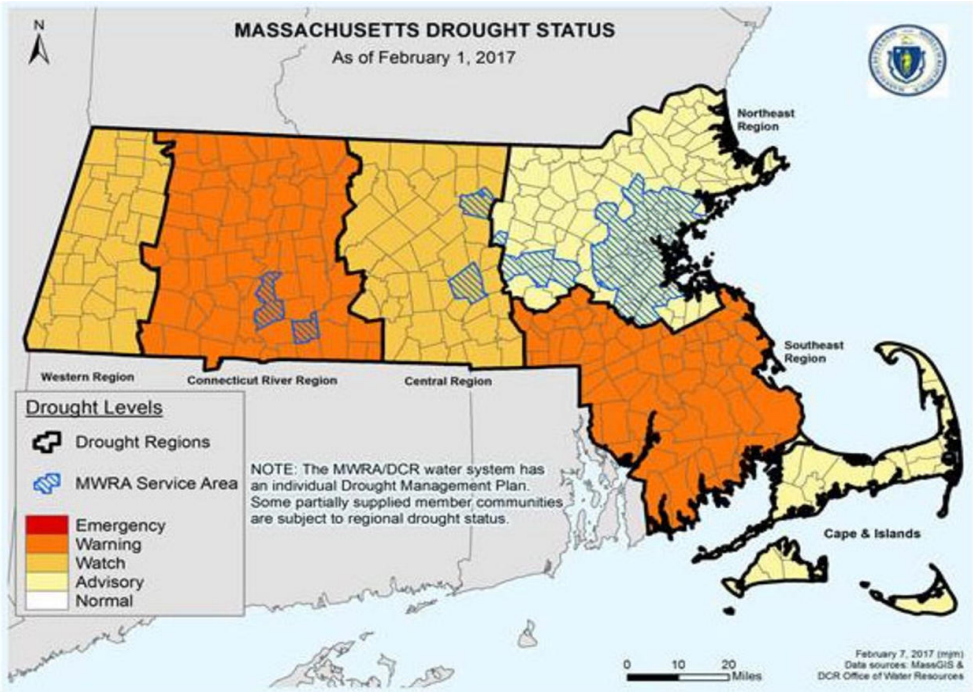


Figure 4-16. Massachusetts Drought Status, February 2017
Source: DCR, 2017b

A long-term drought could lead to impacts to Winchendon's wetlands and streams, Millers River and several drinking water reservoirs. Commercial, municipal, and residential water conservation is important during times of drought or low water levels. In a drought emergency affecting the water supply, water use restrictions would be implemented in Winchendon, which 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 in Winchendon. 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 Drought and Climate Change

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). the same report also mentions that 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 in the Northeastern States.

5.0 EXISTING MITIGATION MEASURES

The Town of Winchendon is already undertaking 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 below (FEMA, 2013). As this chapter will demonstrate, Winchendon already uses many of these tools.

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

Measure	Action	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 bylaws • Subdivision regulations • Development review • Building codes and enforcement • NFIP Community Rating System • Capital improvement program • 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

Table 5-1. FEMA's Types of Mitigation Actions		
Measure	**Action**	**Examples**
Education and Awareness Programs	These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential mitigation strategies. 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 for properties in the floodplain • Presentations to school groups or neighborhood organizations • Mailings to residents in hazard-prone areas. • Participation in the National Weather Service's StormReady community preparedness program • Participation in Firewise Communities through the National Fire Protection Association's community preparedness program

Source: FEMA, 2013

Numerous existing natural hazard mitigation measures are already in place in Winchendon. These measures were identified through feedback from the Core Team, CRB Workshop participants, interviews with local experts, and additional research by the project team. The hazard mitigation measures outlined below are organized by hazard type, including multi-hazards, floods, dam mitigation, wind, winter weather, drought, fire, extreme temperatures, and geologic hazards. The Town is also involved in sustainability measures that offer public co-benefits that include improved pedestrian and cycling conditions.

5.1 Existing Multi-Hazard Mitigation Measures

Wachusett Medical Reserve Corps (MRC) – The Wachusett MRC is a 501(c)3 nonprofit organization with a team approach of government. It is a 'nurse run' local network of public health, medical, safety, and other ancillary volunteers organized to improve the health and safety of their communities.

Local Emergency Planning Committee – Under the Emergency Planning and Community Right to Know Act of 1986, communities are required to establish Emergency Planning Committees to develop a response plan for chemical emergencies. Following this legislation, the Town has identified locations where hazardous materials are stored, used, and transported. This work is led by the local Emergency Planning Committee

RECOMMENDED IMPROVEMENTS

Continue to be a part of the Corps and follow the guidelines.

Consider regional collaboration and Regional Emergency Planning Committee

	RECOMMENDED IMPROVEMENTS
Comprehensive Emergency Management Plan (CEMP) – The Town of Winchendon has an Emergency Preparedness Handbook that was last updated in 2011. The plan needs to be updated with new contact information. Every community in Massachusetts is required to have a Comprehensive Emergency Management Plan. This plan addresses mitigation, preparedness, response, and recovery from a variety of natural and man-made emergencies. Included in this plan is important information regarding preparation for the first 72 hours of an emergency or disaster.	Update Emergency Preparedness Handbook.
List of Critical Facilities – The list of critical facilities was updated during this planning process. The Montachusett Regional Planning Commission offers an interactive mapping application to update critical infrastructure.	Use MRPC software to simulate real-time evacuation scenarios to mitigate hazards to the public.
Regional Support from Surrounding Communities – Winchendon has provided and received additional support from surrounding communities. The support is informally structured. The Winchendon Emergency Management Director maintains contact with surrounding communities.	Formalize or document support systems to retain institutional knowledge and increase transparency in case of an emergency when additional support from other departments and municipalities may be needed.
FEMA Deployment – FEMA can deploy vehicles in the case of an emergency.	Keep the FEMA contact information UpToDate.
Certified Emergency Response Team (CERT) – A team of trained volunteers organized by the Fire Department who can be called upon to assist and respond during emergencies. Winchendon does not have an official CERT program.	Expand the number of volunteers.
CodeRED – The Town of Winchendon has the CodeRED system, which provides Town officials the ability to deliver messages to targeted areas or the entire Town quickly through a reverse calling system. Residents may update their CodeRED information on the Town website.	Expand outreach to increase the number of residents receiving alerts.
Emergency Management – Town's website provides links to resources such as Mass.211 and Ready.gov under their emergency management.	Provide resources for vulnerable populations.

	RECOMMENDED IMPROVEMENTS
Emergency Shelters – Murdock Middle/High School is the Town's designated shelter. If needed, other schools and Town Hall could be used as a shelter.	Upgrade shelters so that they are ADA approved. Expand outreach about locations and accessibility of emergency shelters. Develop a shelter plan for pets.
Backup Generators – Most of the Town buildings have backup emergency generators, including the Police Department, Fire Department, Town Hall, Housing authority, two of the three schools, Radio towers, Wastewater Treatment Plant and Pumping stations, Winchendon Private School.	Install backup generators at the Senior Center, critical facilities, including private entities (gas stations and grocery stores)
Permits for Construction – Permits are required from the Building Department to ensure the building code and utility connections are properly made. Public Works requires permits to ensure safe excavation, sewer connections, and other stormwater regulations are met. The Fire Department inspects certain aspects of all new construction for fire prevention safety.	Develop an online permitting system to increase cross-departmental coordination, streamline the process, and set easier to understand expectations.
Multi-Department Review of Developments – Depending upon the type of development, the extent of construction, and location, multiple departments, including the Planning Board, Building Department, Board of Health, Department of Public Works, Conservation Commission, the Fire Department, and Zoning Board of Appeals, may review site plans before approval.	Streamline the system and increase coordination between departments.
Massachusetts State Building Code – The Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing, and snow loads.	None.
Open Space and Recreation Plan (OSRP) 2016 – The Town has a wealth of conservation areas and recreation spaces that help reduce urban heat island effects and provide flood storage, among other climate-resilient co-benefits. The OSRP aims to maintain, promote use, and increase the number of these spaces.	Update the OSRP in the next few years with climate resilience and hazard mitigation in mind.
Zoning Bylaw – Winchendon, Massachusetts Zoning Bylaw, regulates the land use of new and redeveloped parcels. Zoning allows, regulates, or guides landscaping, the siting of small energy systems, environmental performance, and safety standards for various land use types. Zoning can be used as a tool to promote affordable housing, proper communication facilities, and smart development. The Zoning Code includes a Floodplain Protection Overlay District and a Water Resource Protection Overlay District, which are further described in the following sections.	The zoning bylaw was last amended in 2019. Include smart growth policies in the next update.

	RECOMMENDED IMPROVEMENTS
Rules and Regulations for Special Permits & Site Plan Review – Procedures and guidelines set forth by the Planning Board corresponding to article 12 of the Winchendon Zoning Bylaw. Special permits are required for the construction of large residential, commercial, institutional, municipal, and industrial developments or expansions. The last update was made in 2008.	Consider updating the plan and incorporating climate resilience into the site plan review process through the completion of a climate resilience design guideline or scoring system.
Communication Infrastructure – The Town communications with residents through social media (including Facebook pages for the Town, Library, Police, and Fire Departments), and the Town website.	Continue to explore communication strategies through email blasts, distribution channels of community groups, and facilities to reach the residents especially vulnerable populations.

5.2 Existing Town wide Mitigation for Flood Related Hazards

Winchendon employs several practices to help minimize potential flooding, reduce impacts from flooding, and proactively maintain existing drainage infrastructure. Existing town wide mitigation measures include the following:

	RECOMMENDED IMPROVEMENTS
Participation in the NFIP – Winchendon participates in the National Flood Insurance Program (NFIP) (FEMA, 2019c). 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. Winchendon participates in the NFIP with 21 policies in force as of January 28th, 2020 (DCR, 2020). FEMA maintains a database on flood insurance policies and claims. This database can be found on the FEMA website.	Continue participation in the National Flood Insurance Program to enable property owners to purchase insurance protection against flood losses. Increase outreach to property owners with the floodplain. Participate in the Community Rating System.
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.	None.

	RECOMMENDED IMPROVEMENTS
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. As of May 2019, Winchendon is not currently participating in the CRS Program (FEMA, 2019c).	Consider participation in the CRS program.
FEMA FIRMS – Flood Insurance Rate Maps (FIRMs) denote areas of the 100-year and 500-year floodplain, which is used for the NFIP and other regulatory controls. For example, the Building Inspector and the Winchendon Conservation Commission enforce a federal law requiring elevation above the 100-year flood level of new and substantially improved residential structures in the floodplain. These floodplains are also used in wetland protection and floodplain control regulation. Winchendon's FEMA FIRMs were last updated in 1982. The next updates will be made in a couple of years.	Once the new FEMA FIRMs are finished, update regulations referencing the old map. Consider requiring regulatory controls out to the 500-year floodplain to account for climate change.
Street Sweeping – The Department of Public works is responsible for street sweeping, which occurs in spring/summer every year on all roads. Due to reduced uses of sand during winter, street sweeping does not cause major issues anymore.	None.
Stormwater System Maintenance – The Department of Public Works hires a company to clear debris from its catch basins, storm drains, and culverts regularly across the Town. 600 catch basins are cleaned each year with a total of 900 every other year. Flooding issues have been mitigated due to the regular cleaning of the culverts. In addition, the Town had received a grant for culvert replacement in Robins Road which is under the last phase of State's approval. Town has also replaced three pipes on Happy Hollow Road and one pipe on West Street last year to increase the culvert size.	Map and inventory catch basins, culverts, and outfalls. Include stormwater systems in private housing developments, especially the detention basins that have been turned over to the Town. Continue to upgrade and rehabilitate the stormwater system using climate projections and green infrastructure where possible.
Stormwater Sewer Management Program – The Department of Public Works' Wastewater Division leads the separation of the combined sewer overflow system in coordination with the Street (Stormwater) Division. The Town implements an Illicit Discharge Detection and Elimination (IDDE) Program to systematically find and eliminate illicit sources of non-stormwater discharges to its municipal separate storm sewer system and implement procedures to prevent such discharges.	Incorporate climate projections in the stormwater system upgrades.

	RECOMMENDED IMPROVEMENTS
NPDES Phase II Stormwater Program or Municipal Separate Storm Sewer System (MS4) Permit– 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. The Town continues to implement its NPDES Phase II stormwater program, which includes public education programs. In addition, the Town provides educational stormwater materials on the Town website and annual mailings. The Town also has a Stormwater Management Plan as part of its Small Municipal Separate Storm Sewer Systems (MS4) permit.	None.
Maintenance of Public Water Bodies – The Town clean rubbish from the sides when needed. The waterways are rarely cleaned due to a lack of personnel and funding.	Apply for grants to hire more personnel to keep up with the maintenance
Massachusetts Stormwater Management Standards and Handbook – Massachusetts administers stormwater standards through provisions of the Wetlands Protection regulations, 310 CMR 10.00 for wetland notices of intent, and surface water discharge permits. The local Conservation Commission and Planning Board regulates this at the local level. The Massachusetts Stormwater Handbook provides guidance on how to meet the regulations and manage stormwater pollution.	The Massachusetts Stormwater Handbook is currently being updated by MassDEP.
Flood Plain Conservancy Districts (FPCD) – The Town's FPCD (Section 4.4 of the Zoning Bylaw) is defined by the 100-year floodplain as designated by FEMA. The Floodplain Conservancy District regulates certain activities within a flood zone enhancing federal/state laws. The Floodplain Conservancy District is enforced by the Building Inspector (municipal staff) and regulated by the Board of Appeals.	Considering increased the FPCD to the 500-year floodplain to accommodate the anticipated impacts of climate change.
Massachusetts Wetlands Protection Act and Local Wetlands Conservancy District – The Commonwealths' Wetlands Protection Act (Chapter 131, Section 40 MGL) regulates the protection of resource areas in and around wetlands, including land subject to flooding. This regulates development and activity within a 100-foot buffer around wetlands, and a 200-foot buffer around riverfront areas. The Wetlands Protection Act is locally enforced by the Conservation Commission and Department of Community Development. The Town further regulates wetlands through the Local Wetlands Conservancy District (Section 4.3 of Zoning Bylaw).	The local Wetlands Protection Bylaw and corresponding Rules and Regulations could consider the incorporation of climate change.

Beaver Management – Beavers are not a major concern. The Town hires beaver trappers to mitigate flooding caused by beaver dams. When necessary, beavers are removed from the site. Board of Health takes care of the permitting and the paperwork.

RECOMMENDED IMPROVEMENTS

None.

5.3 Existing Dam Mitigation Measures

Dam Maintenance – The Department of Public Works manages regular dam maintenance. Maintenance of Whitney Pond is done every six months because it is a high hazard dam. Town outsources the maintenance. The rebuilding of Whitney Pond is in the permit phase. Once the final permit is approved, it will move into the rebuilding phase. Rebuilding will include cleaning up the trees and brush off the backside of the dam and planting grass there, and in the front side to install some riprap, geotextile, and rocks.

RECOMMENDED IMPROVEMENTS

Inspect and complete regular dam maintenance.

DCR Dam Safety Regulations and Inspections – 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. Whitney Pond dam, being a high hazard dam, is inspected every six months. Red dam and Great dams were built in the 1990s. They are in relatively better shape. Inspections on those dams are done every two years. The last inspection was done in 2018 and the report was satisfactory according to the last inspection. Some minor fixes are needed.

Ask private dam owners for the most recent emergency action plan and inspection reports.

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

None.

5.4 Existing Town-Wide Mitigation for Wind-Related Hazards

Massachusetts State Building Code (Ninth Edition, 2018) – 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, damages would depend on the track of the tornado and would most likely be high due to the prevalence of older construction and the density of development.

RECOMMENDED IMPROVEMENTS

None.

Tree Maintenance – National Grid does tree maintenance and removal every year to keep the branches off the power lines. Town very seldomly loses power. During the installation of new solar farms bunch of trees were cleared.	Expand the maintenance program.

5.5 Existing Town-Wide Mitigation for Winter-Related Hazards

	RECOMMENDED IMPROVEMENTS
Winter Parking Ban – Town's winter parking ban goes into effect between the hours of 11:00 p.m. and 6:00 a.m., every year from December 1st through April 15th (Section 7.18 of the Town's Bylaws). This ban prohibits overnight parking of motor vehicles in any public way. This parking ban allows the Town to plow and open roads in a more efficient and timely manner. Illegally parked vehicles are ticketed.	None.
Snow Removal Requirements in the General Bylaw – Section 7.19 of Town Bylaws requires no person, other than an employee of the Town acting in an official capacity, shall direct, discharge, dump, plow, blow, shovel, or deposit snow, ice, or water subject to freezing onto, into, or across any sidewalk or public way, or cause, direct, sanction, or authorize any such activity involving snow, ice, or water on a sidewalk or public way. "Enforcing persons" for purposes of this Bylaw shall be the Public Works Director and any police officer of the Town of Winchendon. (May 21, 2012).	None.
Snow Plowing and De-icing Operations – The Public Works Department provides standard snow plowing operations on main arterials, including salting. Town's Snow and Ice Informational Booklet has detailed information on this. The Department of Public Works vehicle fleet is aging, which causes a high level of breakdowns, especially under harsh weather conditions.	Replace old aging equipment.
Fuel Assistance – The Town has a fuel assistance program. Residents can access that program through the Town's website. Fuel assistance is also available to renters and homeowners meeting income guidelines through the New England Farm Workers' Council.	Expand programs to assist low-income households by providing fuel assistance.

5.6 Existing Town-Wide Mitigation for Drought-Related Hazards

	RECOMMENDED IMPROVEMENTS
Groundwater Protection Overlay District (GPOD) – The purpose of the GPOD is to protect public health by preventing the contamination of existing and potential public and private water supplies and to protect the general welfare by preserving limited water supplies for present and future use.	None.
Water Restriction – The Mandatory Water Restriction Program runs from May 1st through October 1st every year. This includes restrictions on outdoor water use and outdoor watering.	DEP instructed the Town to enforce stricter rules in its water restriction plan.
Backup water supply – Winchendon does not have a backup water supply. In case of emergency, the Town can receive supply from Templeton for basic minimal needs.	Look for a more sustainable source of backup water supply in case of emergencies

5.7 Existing Town-Wide Mitigation for Fire-Related Hazards

	RECOMMENDED IMPROVEMENTS
Open Burning Permits Required – Following state regulations, the Town allows controlled open burning of only brush, branches, cane, driftwood, and forest debris that is on the land closest to the source of material from January 15 to May 1st between 10 AM to 4 PM.	None.
Review of Construction – The Fire Department and Building Department review buildings for proper fire protection systems, alarms, and sprinklers.	None.
Public Education – The Fire Department educates residents about fire prevention through outreach at schools, distribution of pamphlets in local gatherings, fair.	Continue public education efforts and update materials, as necessary. Expand outreach into new forums.
Backup Supplies – The Fire Department does not have backup firefighting supplies and does not have a Master List of current supplies. However, mutual aid with neighboring towns helps in case of emergencies.	Develop an inventory of supplies to identify current resources and needs.
Statewide Fire Mobilization Plan (Massachusetts Fire and EMS Mobilization Plan, 2018) – The state has a fire mobilization plan. Winchendon falls under Central Region 3, District 8 (Southern Worcester). The fire mobilization plan includes a plan of actions in	None.

case of structure fires, wildfires, arranging ambulances, and details about alarm run cards.

"SAFE" and "Senior SAFE" program – Winchendon received grant funding for the SAFE and Senior SAFE Program, which aids in providing fire safety to seniors through the fire department. It also aims to improve safety in senior housing.

Brush Clearing – National Grid does limited brush clearing to provide access to Emergency Service vehicles.

RECOMMENDED IMPROVEMENTS

Look to secure other grants for continued outreach to vulnerable populations.

None.

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

Winchendon does not have any local measures to mitigate extreme temperature-related hazards.

RECOMMENDED IMPROVEMENTS

- Develop a tree-planting program and plant trees in areas with less tree canopy
- Use reflective material for municipal building rooftops and other large impervious areas
- Add cooling centers, and drinking water resources at multiple locations for hot summer days
- Consider renewable energy powered infrastructure to reduce the Town's carbon footprint
- Provide public education on extreme heat effects and how to mitigate them; by staying hydrated for example

5.9 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 Table 1612.2.5. Group II includes buildings that have a substantial public hazard due to occupancy or use and Group III are those buildings having essential facilities that are required for post-earthquake

RECOMMENDED IMPROVEMENTS

None.

recovery, including fire, rescue, and police stations, emergency rooms, power-generating facilities, and communications facilities.

5.10 Existing Town-Wide Sustainability Measures

	RECOMMENDED IMPROVEMENTS
Complete Street Implementation Plan – The Town has developed a list of priority projects to encourage walking and biking, which will reduce greenhouse gases. Funding from the Complete Streets Program will be used to redesign Blair Square and improve pedestrian traffic, pending approval.	None.
Green Communities Program – Winchendon was designated as a Green Community in 2017. As part of this designation, The Town is committed to adhering to several different criteria to help improve efficiency and reduce carbon footprint. Winchendon has received funding for energy efficiency improvements in the Town.	None.
Montachusett Regional Planning Commission Unified Planning Work Program –This work will involve identifying projects that will improve the accessibility and safety of various modes of travel in the Town to complement Complete Streets Policies. The proposed methodology includes a focus on improving walkability and cycling.	None.

5.11 Mitigation Capabilities and Local Capacity for Implementation

Under the Massachusetts system of "Home Rule," the Town of Winchendon is authorized to adopt and, from time to time amend, local bylaws and regulations that support the Town's capabilities to mitigate natural hazards. These include the Zoning Bylaw, Stormwater Bylaw, Subdivision and Site Plan Review Regulations, and Wetlands Bylaw. Local bylaws may be amended to improve the Town's capabilities, and changes to most regulations simply require a public hearing and a vote of the authorized board or commission. The Town of Winchendon 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 2015 DRAFT PLAN

6.1 Implementation Progress on the Previous Plan

The 2015 Montachusetts Regional Hazard Mitigation Plan listed several priority action items specific to the Town of Winchendon. Winchendon staff and Core Team members reviewed these previous mitigation measures for completion and to determine if the measures were still a priority. As indicated in Table 6-1, the Town completed several mitigation measures. Some of the measures have become continual operation and maintenance and are captured in Chapter 5. Some actions were deferred because of the lack of funding or capacity. The measures that were not completed were evaluated with the Core Team. The decision on whether to remove or retain a particular measure was based on the members' assessment of continued relevance or effectiveness. Table 6-1 summarizes the status of the mitigation measures and their priority.

Table 6-1. Status of Mitigation Measures from the 2015 HMP

Description of Action	Implementation Responsibility	Carry forward?
Identify Existing Shelters with Red Cross generators that are Earthquake Resistant as well as Outside of Floodplain (and Dam Inundation) Areas to ensure that adequate shelters are available to the public during hazards to reduce or eliminate risk to human life.	Emergency Management Director	Include, the 2021 HMP-MVP Plan includes a hazard map identifying critical infrastructure within the 100- and 500-year floodplains. The 2021 Plan also completed a Hazus risk analysis to assess the potential impact of magnitude 5.0 and 7.0 earthquakes in Winchendon. More information is included in Chapter 4 and Appendix B.
Increase awareness by educating property owners on actions that they can take to reduce risk to properties by hosting an Open House at the Fire Department, Develop and Distribute an Educational Pamphlet on Fire Safety and Prevention (SAFE PROGRAM that includes information on wildfire prevention and provide outreach to elderly and schools.	Fire Department	Remove, education completed through the Student Awareness of Fire Safety (SAFE) and Senior SAFE Programs and can be continued through the operation section of the plan. Various forms of community engagement will be included in the next plan.

Table 6-1. Status of Mitigation Measures from the 2015 HMP		
Description of Action	Implementation Responsibility	Carry forward?
Increase hazard education and risk awareness to the public by collecting, updating, and disseminating emergency Information on 211, Cable Access, and Webpage - to educate the public and alert them of emergency information including shelter locations and other instructions related to all-natural hazards.	Emergency Management Director	Include, The Town shared information with the public related to climate hazards during the MVP Planning process. This is an ongoing action.
Maintain Supplies at Existing Shelters, develop a Needs List, and identify and find additional Storage to mitigate the effects of all hazards on the general population. Supplies must be adequate to eliminate or reduce risk to human life.	Emergency Management Director	Include, there is no updated inventory of supplies or needs list.
Develop a Mitigation Plan to provide access to water, information, shelter, and food stores to people in remote locations of the town and integrate this information into community comprehensive plans.	Emergency Management Director	Include, need to document institutional knowledge of emergency response, for example from the 2008 ice storm.
Maintain and Update the "Code Red" pre-disaster warning system that effectively, efficiently and in a timely fashion warns citizens and business owners of impending weather events to reduce or eliminate risk to property and human life.	Fire Department Police Department	Remove, this has been addressed. Move to the operation and maintenance section of the plan.
Identify all structures throughout the town that need to be elevated above the base-flood elevation. Once identified educate those property owners regarding their options for mitigation.	Building Department	Include, structures need to be identified and education on flood mitigation options for property owners is still needed.

Table 6-1. Status of Mitigation Measures from the 2015 HMP		
Description of Action	Implementation Responsibility	Carry forward?
Educate property owners regarding options for mitigating their properties from flooding through outreach programs that address measures that residents can take (i.e. installing backflow valves, securing debris, etc.)	Building Department	Include, will be combined with the above action.
Develop a priority list and possibly seek funding through the Hazard Mitigation Grant Program (HMGP) for the replacement of undersized culverts throughout the Town to reduce or eliminate flooding risk.	Public Works	Include in the next plan. Fixed two problem areas, but culverts need repair.
Continue participation in the National Flood Insurance Program to enable property owners to purchase insurance protection against flood losses.	Conservation Commission, Planning Board	Remove, the Town received updated information from DCR related to Winchendon's NFIP participation as part of conducting the MVP Planning process. Move to the operation and maintenance section of the plan.
Evaluate and relocate furnaces, water heaters, and electrical equipment in municipal-owned buildings that are located in areas prone to flooding to reduce flood damage.	Building Department	Include, evaluations and relocations are needed.
Identify shelters and publicize through the Town website the locations to ensure that shelters are available to the public during these types of hazards to reduce or eliminate risk to human life.	Emergency Management Director	Include, the 2020 HMP-MVP Plan includes an updated list of shelters. This action will be combined with the third action listed in this table.
Utilize interactive mapping applications prepared by MRPC/CMRPC to update critical infrastructure and simulate real-time evacuation scenarios to mitigate hazards to the public.	Emergency Management Director, Police Department mostly responsible for an emergency evacuation plan.	The critical infrastructure list is up to date. Add simulation to the next plan.

Table 6-1. Status of Mitigation Measures from the 2015 HMP		
Description of Action	Implementation Responsibility	Carry forward?
Install "beaver diverters" and water control devices to mitigate flooding caused by beaver dams.	Public Works	Remove, this has been addressed. Move to the operation and maintenance section of the plan.
Hire trapper for the removal of beavers to mitigate flooding caused by beaver dams.	Public Works	Remove, this has been addressed. Move to the operation and maintenance section of the plan.
Implement recommendations regarding natural hazard mitigation in existing planning documents including the implementation element of the master plan, the five-year action plan of the open space and recreation plan, and the emergency evacuation plan.	Conservation Commission, Select Board, Planning Board, Emergency Management Director, Fire Department, and Police Department	Include, master plan, a five-year action plan of the open space, and recreation plan are being currently updated along with emergency evacuation plans.

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 a multi-faceted approach. Strategies were discussed and developed upon review of the:

- Community profile, including the Town's strengths and vulnerabilities
- Hazard and climate change risk assessment
- Existing measures
- Updates to the previous mitigation plan
- Input from stakeholders.

Stakeholders were engaged through Core Team meetings, the CRB Workshop, and the virtual public listening sessions. The full list of action items from the CRB Workshop is available in Appendix C and was integrated into the final list of action items vetted by the Core Team. Table 7-1 below represents the Town's high, medium, and low priority action items. Each of these action items was analyzed for its overall benefit, estimated cost, timeframe, and implementation responsibility, which informed prioritization. A description of each prioritization category is included below.

Priority – Designation of high, medium or low priority was based on overall potential benefits. A "high priority" action is very likely to have political and public support. A "medium priority" action may have political and public support and necessary maintenance may have the potential to occur following the project. A "low priority" action may not have political and public support for the implementation of the necessary maintenance support following the project. An "ongoing priority" action is one that will require continuing attention, at varying time periods, by those designated.

Mitigation Action – A brief description of each mitigation measure that was identified in this plan.

Primary Responsibility – Most mitigation measures will require a multi-department approach where several Town departments share responsibility. The designation of implementation responsibility in the table was assigned based on general knowledge of the responsibilities of each municipal department. The lead department for each action item is bolded.

Implementation Timeframe – The timeframes represented below are assigned based on the length of time necessary to complete the project. The timeframe is noted in years. Projects that involve multiple phases, maintenance, or do not have a definitive end date will are classified as "ongoing".

Approximate Implementation Cost – Approximate implementation costs are given for all mitigation measures. All cost data would need to be updated at the time of design and construction and is only provided as an estimate. Costs designated as "$$$" are estimated to be greater than $100,000. Those designated as "$$" are estimated between $50,000 and $100,000. Those designated as "$" are estimated to be less than $10,000.

Table 7-1. Proposed Mitigation Actions

Mitigation Action	Estimated Cost	Responsibility	Timeframe	Priority
	$ = <$10,000 $$ = <$50,000 $$$ = <$100,000	Lead indicated in bold	S = Short Term M = Medium Term L = Long Term O = Ongoing	H = High M = Medium L = Low
Dams				
Reduce the potential for overflow from the Whitney Dam by updating the spillway.	$$$	**DCR** DPW	S	H
Update the Whitney Dam design. Apply for funding to complete total reconstruction of spillway.	$$$	**DCR** DPW	S	H
Locate funding to upgrade West Monomonac Spillway	$$$	**DCR** **DPW**	S	H
Assess Great Dam to improve and/or expand the spillway.	$$$	**DCR** DPW	S	H
Secure funding to remove Mill Pond Dam.	$	**DCR** DPW	S	H
Assess potential for ice flow damage to dams and spillways and create design alternatives to control water levels.	$$$	**DPW** DCR	S	H
Roads and Bridges				
Identify emergency evacuation routes	$	**DPW** Fire Department/EMA	S	H
Improve Central Street drainage.	$$$	**DPW** Town Manager Board of Selectmen	O	H
Assess the ability to put small streams at North End underground.	$$	**DPW** Town Manager Board of Selectmen	M	H
Educate the public on stream flow and preventative measures for stream flooding, such as keeping streams clear of debris.	$	**Planning Department** DPW	S	H
Educate the public on evacuation procedures and emergency situations for vulnerable areas.	$	**Emergency Management** Planning Department DPW	S	H
Identify drainage projects for roads that ice over regularly (all dirt	$	**DPW**	S	H

Table 7-1. Proposed Mitigation Actions

Mitigation Action	Estimated Cost	Responsibility	Timeframe	Priority
	$ = <$10,000 $$ = <$50,000 $$$ = <$100,000	Lead indicated in bold	S = Short Term M = Medium Term L = Long Term O = Ongoing	H = High M = Medium L = Low
roads).		Town Manager		
Purchase additional sanders and salters to increase ability to clear roads in hazardous winter conditions.	$$$	**Board of Selectmen** DPW	M	H
Educate the public on tree maintenance to reduce street closures due to downed trees and limbs.	$	**Town Manager** DPW	S	H
Assess roads and bridges for prioritization as part of an ongoing effort to repair identified problem areas (in process).	$	**DPW** Town Manager	S	H
Internet Service				
Upgrade internet availability and quality throughout the Town and within Town buildings as needed.	$$	**Town Manager** DPW	H	S
Electrical Network				
Explore mutual aid agreements with surrounding communities to enhance and improve public safety response during hazard events.	$	**Fire Department** Police Department	S	H
Public education on tree maintenance around power lines to prevent limb breaks and subsequent outages.	$	**Town Manager** Planning Department DPW	H	L
Evacuation Routes/Emergency Access				
Ensure that evacuation routes are clearly marked with proper signage.	$	**DPW** Police	O	H
Environmental Justice/ Senior/Disabled Populations				
Increase shelter accessibility.	$$	**Emergency Management** DPW	S	M
Create evacuation/shelter plans by location.	$	**Emergency Management** EMS	S	M
Increase communications with the public on the availability of shelters.	$	**Emergency Management** EMS	S	M

Table 7-1. Proposed Mitigation Actions

Mitigation Action	Estimated Cost	Responsibility	Timeframe	Priority
	$ = <$10,000 $$ = <$50,000 $$$ = <$100,000	Lead indicated in bold	S = Short Term M = Medium Term L = Long Term O = Ongoing	H = High M = Medium L = Low
Pursue the purchase of generators for installation in various cooling centers in Town.	$$	**Town Manager** DPW	S	H
Identify ways to increase inter-neighborhood communications and to create a supportive neighborhood network.	$	**Planning Department** Council on Aging	S	H
Plan for the mobility of disabled population and increase their mobility options.	$	**Council on Aging** Emergency Management	S	H
Municipal Infrastructure				
Upgrades to Town Hall emergency generator to ensure consistent services.	$$	**Town Manager** DPW	M	M
Fund the purchase of a pickup truck for the Police Department to increase their mobility and response during hazard events.	$$	**Board of Selectmen** Police	L	M
Assess and conduct structural upgrades to Fire Station as needed.	$$$	**Town Manager** Board of Selectmen Fire Department	L	M
Explore ways to access a large capacity vehicle to move people quickly during hazard events (through a contract or memorandum of agreement)	$$	**Town Manager** Emergency Management	M	L
Develop building-specific emergency action plans, ensuring that ADA issues are addressed, and create a building committee to keep the communication and schedules moving forward.	$$$	**Town Manager** Planning Department DPW	M	H
Examine and remedy heating issues at the annex and community center.	$$$	**Board of Selectmen** DPW Town Manager	M	L
Water/Wastewater				
Provide battery backup power at the wastewater treatment facility.	$$$	**DPW** Town Manager	L	L
Upgrade privately owned and obsolescent septic systems to reduce the possibility of contamination to surface and groundwater.	$$$	**Board of Selectmen** DPW	O	L

Table 7-1. Proposed Mitigation Actions

Mitigation Action	Estimated Cost	Responsibility	Timeframe	Priority
	$ = <$10,000 $$ = <$50,000 $$$ = <$100,000	Lead indicated in bold	S = Short Term M = Medium Term L = Long Term O = Ongoing	H = High M = Medium L = Low
Vulnerable Neighborhoods				
Develop a communications plan so that vulnerable neighborhoods are networked with information and resources through a system of neighborhood champions.	$	**Planning Department** Council on Aging	O	H
Ensure that vulnerable neighborhoods know their evacuation/response plans based on location and situation.	$	**Emergency Management** Council on Aging	O	H
Assess areas around vulnerable neighborhoods and develop associated measures to mitigate flood issues.	$$$	**DPW** Emergency Management	O	H
Agriculture/Food Economy				
Inventory agricultural land and food economy resources, such as food processors, distributers, etc. within town.	$	**Board of Health** Planning Department	O	H
Water Quality				
Create a means for communications with downstream communities and agencies prior to and after hazard events.	$	**Emergency Management** Planning Department	O	H
Plan for potential chemical releases.	$	**Emergency Management** DPW	O	H
Senior Center Upgrades				
Purchase and install a generator at the Senior Center to provide for backup power during hazard events.	$$	**Board of Selectmen** DPW	S	H
Complete structural upgrades to the Senior Center building as deemed necessary.	$$$	**Board of Selectmen** DPW	M	M
Conduct a capacity analysis for the building along with an assessment of opportunities to improve shower facilities, meal service, number of beds, public education on shelter benefits and availability, outreach to vulnerable populations, the ability to shelter pets, and implement measures to increase the ability to shelter families together.	$	**Council on Aging** DPW Planning Department	S	H

Table 7-1. Proposed Mitigation Actions

Mitigation Action	Estimated Cost	Responsibility	Timeframe	Priority
	$ = <$10,000 $$ = <$50,000 $$$ = <$100,000	Lead indicated in bold	S = Short Term M = Medium Term L = Long Term O = Ongoing	H = High M = Medium L = Low
Emergency Communications				
Establish and staff an Emergency Operations Committee.	$	**Board of Selectmen** Town Manager	S	H
Create a master plan that discusses the emergency communications among town departments, and between the town staff and the community. Include public outreach and education as part of the plan.	$$	**Planning Department** Town Manager	M	M
Emergency Shelters				
Evaluate staffing needs for emergency shelters and create a training program for new staff.	$	**Town Manager** Emergency Management	M	L
Vulnerable Populations/Group Homes				
Develop a plan that specifically addresses the needs of vulnerable populations during hazard events.	$	**Planning Department** Council on Aging	M	L
Ensure transportation to and from facilities in case of emergencies.	$$	**Emergency Management** DPW	M	M
Ensure that facilities are not located near dams or along roads that may washout.	$	**Planning Department** Emergency Management	L	M
Mitigation Measures Carried Over from 2015 HMP				
Identify existing shelters with Red Cross generators that are earthquake resistant as well as outside of the floodplain to ensure that adequate shelters are available to the public during hazards to reduce or eliminate risk to human life.	$	**Emergency Management** Police Fire	S	H
Increase hazard education and risk awareness to the public by collecting, updating, and disseminating emergency Information on 211, Cable Access, and Webpage - to educate the public and alert them of emergency information including shelter locations and other instructions related to all-natural hazards.	$	**Emergency Management** Town Manager	S	O
Maintain supplies at existing shelters, develop a needs list, and identify and find additional storage to mitigate the effects of all	$	**Emergency Management** Town Manager	S	H

Table 7-1. Proposed Mitigation Actions

Mitigation Action	Estimated Cost	Responsibility	Timeframe	Priority
	$ = <$10,000 $$ = <$50,000 $$$ = <$100,000	Lead indicated in bold	S = Short Term M = Medium Term L = Long Term O = Ongoing	H = High M = Medium L = Low
hazards on the general population. Supplies must be adequate to eliminate or reduce risk to human life.				
Develop a Mitigation Plan to provide access to water, information, shelter, and food stores to people in remote locations of the town and integrate this information into community comprehensive plans.	$	**Planning Department** Emergency Management	S	M
Identify all structures throughout the town that need to be elevated above the base-flood elevation. Once identified educate those property owners regarding their options for mitigation.	$	**Building Department** Planning Department Emergency Management	M	M
Develop a priority list and possibly seek funding through the Hazard Mitigation Grant Program (HMGP) for the replacement of undersized culverts throughout the Town to reduce or eliminate flooding risk.	$$	**DPW** Planning Department Town Manager	S	H
Evaluate and relocate furnaces, water heaters, and electrical equipment in municipal-owned buildings that are located in areas prone to flooding to reduce flood damage.	$$	**Building Department** DPW Town Manager	M	H
Utilize interactive mapping applications prepared by MRPC/CMRPC to update critical infrastructure and simulate real-time evacuation scenarios to mitigate hazards to the public.	$	**Emergency Management** Planning Department	M	H
Implement recommendations regarding natural hazard mitigation in existing planning documents including the implementation element of the master plan, the five-year action plan of the open space and recreation plan, and the emergency evacuation plan.	$$	**Conservation Commission** Select Board Planning Board Emergency Management Fire Department Police Department	M	M

7.2 Potential Funding Sources

The identification of potential funding sources is preliminary and may vary depending on numerous factors. These factors include (but are not limited to) whether or not a mitigation measure is conceptual or has been studied, evaluated, or designed. In most cases, the measure will require a combination of funding sources. The funding sources identified are not a guarantee that a specific project will be eligible for, or receive, funding. Upon adoption of this plan, the local representatives responsible for implementation should begin to explore potential funding sources in more detail.

Traditional funding sources within the Town of Winchendon, such as funding from the operating and capital budgets, may be able to cover some of the costs associated with the action items detailed in Table 7-1. The addition of a stormwater utility in Winchendon could provide funding for many stormwater-related projects. State revolving funds and no- or low-interest loans may also be of interest. 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 opportunities related to Action Items developed by Winchendon are listed in Table 7-2.

Table 7-1. Potential Funding Sources

Source	Grant	Description of Funding
Department of Housing and Community Development (DHCD)	Massachusetts Downtown Initiative	Offers services and assistance to communities seeking help on how to revitalize their downtowns
Executive Office of Housing and Economic 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
MEMA	Flood Mitigation Assistance Grant Program	Implements cost-effective measures that reduce or eliminate the long-term risk of flood damage
MEMA	Hazard Mitigation Grant Program	Provides funding after a disaster to significantly reduce or permanently eliminate future risk to lives and property from natural hazards
MEMA	Pre-Disaster Mitigation (PDM) Grant Program	Provides funds for hazard mitigation planning and the implementation of mitigation projects before a disaster event
Massachusetts Department of Energy Resources (DOER)	DOER Grants	The DOER provides grant funding for clean energy-related programs
Department of Conservation and Recreation (DCR)	Community Forest Grant Program	Funding to establish community forests

Table 7-1. Potential Funding Sources		
Source	Grant	Description of Funding
Division of Ecological Restoration	Culvert Replacement Municipal Assistance Grant Program	Grant to replace undersized, perched, and/or degraded culverts located in an area of high ecological value
EEA	Drinking Water Supply Protection Grant Program	Financial assistance to public water systems and municipal water departments for the purchase of land or interests in land
MA Department of Environmental Protection (DEP)	604b Grant Program	Water quality assessment and management planning
EEA	Land Use Planning Grants	Supports efforts to plan, regulate, and act to conserve and develop land consistent with the Massachusetts' Sustainable Development Principles
EEA	LAND Grant Program	Helps cities and towns acquire land for conservation and passive recreation
EEA	Massachusetts Land and Water Conservation Fund Grant Program	Funding for the acquisition, development, and renovation of parks, trails, and conservation areas.
EEA	MVP Program	Provides support in implementing climate change resiliency priority projects
DEP	MS4 Grant Program	Meeting the requirements of the 2016 MS4 permit and reducing stormwater pollution through partnerships
MEMA	Emergency Management Performance Grant (EMPG)	Reimbursable grant program to assist local emergency management departments to build and maintain an all-hazards emergency preparedness system
MEMA	Public Assistance Program	The state reimburses governments and other applicants for disaster-related costs
Department of Fire Services	Senior SAFE	Supports fire and life safety education for seniors
Department of Fire Services	Student Awareness of Fire Education (S.A.F.E.)	Grants for local fire departments to teach fire and life safety to schools

Table 7-1. Potential Funding Sources		
Source	Grant	Description of Funding
MA Department of Transportation (DOT)	Chapter 90 Program	Reimbursable grants on approved projects. Complete Street related programs for example
MA DOT	Community Transit Grant Program	Funding for the transportation and mobility needs of seniors and people with disabilities
MADOT	Complete Streets Funding Program	Technical assistance and construction funding
MADOT	Municipal Small Bridge Program	Funding for small bridge replacement, preservation, and rehab projects
EDA	Disaster Supplemental Funding	Funding available to communities impacted by natural disasters and flooding
USDA NRCS	Watershed and Flood Prevention Operations Program	Helps municipalities protect and restore watersheds
USDA NRCS	Emergency Watershed Protection Program	Funds to help communities quickly address serious and long-lasting damages to infrastructure and the land
USDA NRCS	Regional Conservation Partnership Program	NRCS seeks to co-invest with partners to implement projects that demonstrate innovative solutions
U.S. Department of the Interior	Land and Water Conservation Fund	Secures public access, improves recreational opportunities, and preserves ecosystem benefits for local communities (multiple funding options)
EPA	Healthy Communities Grant Program	Reduce environmental risk to protect and improve human health and the quality of life

7.3 Regional Partnerships

Mitigating natural hazards is not merely a local issue. The drainage systems that serve communities are often complex systems of storm drains, roadway drainage infrastructure, pump stations, dams, and other facilities owned and operated by a wide variety of agencies, including the Massachusetts Department of Transportation (MassDOT) and the Department of Conservation and Recreation (DCR). The planning, construction, operation, and maintenance of these structures are integral to the hazard mitigation efforts of communities. These agencies are the Town's regional partners in hazard mitigation efforts.

These agencies also operate with the same constraints as communities, including budgetary and staffing limitations. Similarly, to municipalities, these agencies must make decisions about numerous competing priorities. To implement many of the mitigation measures identified by the Town of Winchendon, all parties will need to work together towards a mutually beneficial solution.

8.0 PLAN ADOPTION AND MAINTENANCE

8.1 Plan Adoption

The Town of Winchendon 2020 HMP-MVP Plan was adopted by the Select Board on *[ADD DATE]*. See Appendix E for documentation. The plan was approved by FEMA on [*ADD DATE*] for a five-year period that will expire on [*ADD DATE*].

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. This can be achieved through a combination of two methods:

1. Meetings: The Core Team, coordinated by the Planning & Development Department, will meet once a quarter during regularly scheduled project meetings to monitor plan implementation. The Core Team will be amended as needed but will include representatives from the Department of Public Works, Police, Fire, the Building Commissioner, FEMA Coordinator, and others. These meetings will provide an opportunity for regular check-ins, identifying overlaps, and capital planning needs related to hazard mitigation and forward-looking discussions regarding the next steps.

2. Surveys: The coordinator of the Core Team will also prepare and distribute a survey every year. The survey will be made available to all Core Team members and any other interested local stakeholders. The questions in the survey will reference the tables of existing and proposed action items listed in the HMP-MVP Plan. The survey will assist in determining any necessary changes or revisions to the plan that may be needed. In addition, it will provide written documentation of status updates, accomplishments, and progress related to the action items listed in the HMP-MVP Plan. The surveys will also help document new hazards or problem areas that have been identified since the 2020 Plan. The information collected through the survey will be used to formulate an update and/or addendum to the plan.

8.3.2 Continuing Public Participation

The adopted plan will be posted on the Town's website. The posting of the plan on the Town's website 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.

8.3.3 Integration of the Plans with Other Planning Initiatives

Upon approval of the Town of Winchendon 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:

- Planning & Development
- Conservation Commission
- Police Department
- Fire Department
- Health Department
- Public Works Department
- Building and Zoning 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 Master Plan, Open Space Plan, Comprehensive Emergency Management Plan, and Capital Investment Program. Coordination with the Montachusett Regional Planning Commission, local organizations, businesses, watershed groups, and state agencies will be required for successful implementation and continuous updating.

8.4 Plan Update Process

By maintaining the 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 Winchendon 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.

9.0 LIST OF REFERENCES

American Society of Civil Engineers (ASCE). 2018. ASCE 7 Hazard Tool (ASCE/SEI 7-16, Fig. 26.5-1D and Figs. CC.2-1–CC.2-4). Winchendon, Massachusetts. asce7hazardtool.online/.

Blake, Eric S.; Landsea, Christopher W.; and Gibney, Ethan J. 2011. *The Deadliest, Costliest, and Most Intense United States Tropical Cyclones from 1851 to 2010*. NOAA Technical Memorandum NWS NHC-6. National Weather Service, National Hurricane Center. https://www.nhc.noaa.gov/pdf/nws-nhc-6.pdf.

Cardinali, M, P. Reichenback, R. Guzzetti, F. Ardizzone, G. Antonini, M. Galli, M. Cacciano, M. Castellani, P. Salvati. 2002. A Geomorphological Approach to the Estimation of Landslide Hazards and Risks in Umbria, Central Italy. European Geophysical Society. Natural Hazards and Earth System Sciences. 2: 57-72. https://www.nat-hazards-earth-syst-sci.net/2/57/2002/nhess-2-57-2002.pdf.

Commonwealth of Massachusetts, Massachusetts Emergency Management Agency (MEMA), and Massachusetts Executive Office of Energy & Environmental Affairs (EOEEA). "Massachusetts State Hazard Mitigation and Climate Adaptation Plan," September 2018b.

Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), and National Weather Service. "Storm Data Preparation." Operations and Services Performance, NWSPF 10-16., July 9, 2018a. nws.noaa.gov/directives/sym/pd01016005curr.pdf.

EPA, United States Environmental Protection Agency SDWIS. https://enviro.epa.gov.

Federal Emergency Management Agency (FEMA). 2020a. Hazard Mitigation Planning. https://www.fema.gov/hazard-mitigation-planning

Federal Emergency Management Agency (FEMA). 2020b.Grants. http://www.fema.gov/grants.

Federal Emergency Management Agency (FEMA). 2019a "Hazard Mitigation Grant Program." https://www.fema.gov/hazard-mitigation-grant-program.

Federal Emergency Management Agency (FEMA). 2019b. "Flood Zones," https://www.fema.gov/flood-zones.

Federal Emergency Management Agency (FEMA). 2019c. "NFIP Flood Insurance Manual Appendix F: Community Rating System," fema.gov/media-library-data/1559830308363-e690ed2aea6606fb81826904e4a7bd7f/app-f_crs_508_apr2019.pdf.

Federal Emergency Management Agency (FEMA). 2019d. "Disasters: Total Number of Declared Disasters," Accessed April 2020. fema.gov/disasters?field_dv2_state_territory_tribal_value_selective=MA&field_dv2_incident_type_tid=All&field_dv2_declaration_type_value=All&field_dv2_incident_begin_value%5Bvalue%5D%5Bmonth%5D=&field_dv2_incident_begin_value%5Bvalue%5D%5Byear%5D=&field_dv2

_incident_end_value%5Bvalue%5D%5Bmonth%5D=&field_dv2_incident_end_value%5Bvalue%5D%5Byear%5D=.

Federal Emergency Management Agency (FEMA). 2019e. "Definitions: Repetitive Loss Structure.". fema.gov/national-flood-insurance-program/definitions.

Federal Emergency Management Agency (FEMA). 2019f "The National Flood Insurance Program." fema.gov/national-flood-insurance-program.

Federal Emergency Management Agency (FEMA). 2013. "Local Mitigation Planning Handbook". https://www.fema.gov/media-library/assets/documents/31598?id=7209.

Federal Emergency Management Agency (FEMA). 1982. "Flood Map".

Frumhoff, Peter, James McCarthy, Jerry Melillo, Susanne Moser, and Donald Wuebbles. 2007. "Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions." Northeast Climate Impacts Assessment. Cambridge, MA: Union of Concerned Scientists.

General Laws of Massachusetts. Section 3A of Chapter 23A: "Economic development incentive program; establishment; definitions for Secs. 3A to 3G. Gateway municipality'". https://malegislature.gov/Laws/GeneralLaws/PartI/TitleII/Chapter23A/Section3A

General Laws of Massachusetts. Section 40 of Chapter 131: "Section 40: Removal, fill, dredging or altering of land bordering waters". https://malegislature.gov/Laws/GeneralLaws/PartI/TitleII/Chapter23A/Section3A

Kocin, P. J., and L. W. Uccellini, 2004: A snowfall impact scale derived from Northeast storm snowfall distributions. Bull. Amer. Meteor. Soc., 85, 177–194.

Louie, John. 1996. "What Is Richter Magnitude?" Nevada Seismological Laboratory.

Madsen, Travis, and Nathan Willcox. 2012. "When It Rains, It Pours: Global Warming and the Increase in Extreme Precipitation from 1948 to 2011." Environment America Research & Policy Center. environmentamerica.org/sites/environment/files/reports/When%20It%20Rains,%20It%20Pours%20vUS.pdf.

MassAudubon. 2020. Losing Ground Statistics. https://www.massaudubon.org/our-conservation-work/advocacy/shaping-the-future-of-your-community/publications-community-resources/losing-ground/statistics/town/winchendon

Massachusetts Department of Conservation and Recreation (DCR). 2020b. "Emergency Action Plans." Office of Dam Safety. mass.gov/service-details/emergency-action-plans.

Massachusetts Department of Conservation and Recreation (DCR).2020a "Community Information System: Repetitive Loss for the Town of Winchendon," Data as of September 2019.

Massachusetts Department of Conservation and Recreation (DCR). "Inventory of Dams." 2020. https://docs.digital.mass.gov/dataset/massgis-data-dams

Massachusetts Department of Conservation and Recreation (DCR). "302 CMR 10.00: Dam Safety," February 10, 2017. mass.gov/files/documents/2017/10/30/302cmr10.pdf.

Massachusetts Department of Conservation and Recreation (DCR). 2017b. Recent Drought History. https://www.mass.gov/files/documents/2017/09/08/drought-status-history.pdf

Massachusetts Department of Environmental Protection. 310 CMR 10.00: Wetlands Protection Act Regulations. 2017. https://www.mass.gov/regulations/310-CMR-1000-wetlands-protection-act-regulations

Massachusetts Department of Public Health (DPH), 2019. Populations Potentially Vulnerable to Heat-Related Impacts. Bureau of Environmental Health. Retrievable from https://nescaum-dataservices-assets.s3.amazonaws.com/MA-statewide-vuln-pop-map.JPG

Massachusetts Division of Fisheries and Wildlife. 2012. BioMap2 Conserving the Biodiversity of Massachusetts in a Changing World. http://maps.massgis.state.ma.us/dfg/biomap/pdf/town_core/Winchendon.pdf

Massachusetts Executive Office of Energy & Environmental Affairs (EEA), and Adaptation Advisory Committee. "Massachusetts Climate Change Adaptation Report," September 2011.

Massachusetts Emergency Management Agency (MEMA), and the Massachusetts Department of Conservation and Recreation (DCR). 2013. "Commonwealth of Massachusetts State Hazard Mitigation Plan,"

Massachusetts Executive Office of Energy and Environmental Affairs (MA EOEEA) and Executive Office of Public Safety and Security (EOPSS). 2018. Massachusetts State Hazard Mitigation and Climate Adaptation Plan.

Massachusetts Executive Office of Energy and Environmental Affairs (EEA) and the Massachusetts Emergency Management Agency (MEMA). 2019. Massachusetts Drought Management Plan. https://www.mass.gov/doc/massachusetts-drought-management-plan/download.

Massachusetts Fire and EMS Mobilization Plan. 2018. https://www.mass.gov/doc/statewide-fire-mobilization-plan/download

Massachusetts Executive Office of Energy and Environmental Affairs (EEA) and the Massachusetts Emergency Management Agency (MEMA). 2019. Massachusetts Drought Management Plan. https://www.mass.gov/doc/massachusetts-drought-management-plan/download

Mass GIS. 2020. Standardized Assessor's Parcel Data. https://docs.digital.mass.gov/dataset/massgis-data-standardized-assessors-parcels.

MA State Building Code. Ninth Edition: 780. 2018. https://www.mass.gov/handbook/ninth-edition-of-the-ma-state-building-code-780.

Montachusett Regional Planning Commission (MRPC); "Montachusett Region Natural Hazard Mitigation Plan 2015 Update."

National Oceanic and Atmospheric Administration (NOAA).2020a. "Observed Weather Reports: Annual Climate Report." National Weather Service Forecast Office: Boston, MA, January 8, w2.weather.gov/climate/index.php?wfo=box.

National Oceanic Atmospheric Administration (NOAA). 2019a National Oceanic Atmospheric Administration (NOAA).2019a. "Storm Events Database: Worcester County." National Centers for Environmental Information. https://www.ncdc.noaa.gov/stormevents/.

National Oceanic and Atmospheric Administration (NOAA). 2018. National Weather Service Forecast Office: Boston, MA. "Seasonal Climate Report." https://w2.weather.gov/climate/index.php?wfo=box.

National Oceanic and Atmospheric Administration. 2015. Atlas 14: Precipitation-Frequency Atlas of the United Sates. Volume 10 Version 2.0: Northeastern States.

National Oceanic and Atmospheric Administration (NOAA) and National Weather Service. 2019. "Heavy Snow." Glossary. https://w1.weather.gov/glossary/index.php?word=heavy+snow.

National Oceanic and Atmospheric Administration (NOAA).n.d. Heat Index. https://www.weather.gov/bgm/heat.

National Oceanic and Atmospheric Administration (NOAA).n.d. " Wind Chill Safety." https://www.weather.gov/bou/windchill.

Oliver: MassGIS Online Mapping Tool for Environmental justice community. http://maps.massgis.state.ma.us/map_ol/ej.php.

Slope Stability Map of Massachusetts focusing on Winchendon. The Massachusetts Geological Survey. 2013. https://mgs.geo.umass.edu/biblio/slope-stability-map-massachusetts.

Town of Winchendon. Bylaws of The Town of Winchendon. Amended as of November 23, 2015 https://www.townofwinchendon.com/sites/g/files/vyhlif4051/f/uploads/townbylaws2015.pdf.

Town of Winchendon. Complete Streets Policy. 2017. https://www.townofwinchendon.com/home/news/town-winchendon-applies-complete-street-grant.

Town of Winchendon. "Economic Development Draft Inventory Analysis". https://www.townofwinchendon.com/sites/g/files/vyhlif4051/f/uploads/draft_anaylysis.pdf.

Town of Winchendon. "2016 Open Space and Recreation Plan, Town of Winchendon". 2016.

Town of Winchendon Website. "Our History". https://www.townofwinchendon.com/our-history.

Town of Winchendon. Winchendon Stormwater Program. https://www.townofwinchendon.com/public-works/pages/winchendon-stormwater-program.

Town of Winchendon. Snow and Ice Informational Booklet. 2017. https://www.townofwinchendon.com/sites/g/files/vyhlif4051/f/uploads/snowicebook.pdf.

Town of Winchendon. Zoning Bylaw. October 2019 (latest amendments). https://www.townofwinchendon.com/sites/g/files/vyhlif4051/f/pages/fall_2019_accepted_changes.pdf.

US Census Bureau QuickFacts U.S Department of Commerce "QuickFacts: Winchendon Town, Worcester County Massachusetts," https://www.census.gov/quickfacts/fact/table/winchendontownworcestercountymassachusetts,US/PST045219.

USGS Current Conditions for the Nation. USGS 01162000 Millers River Near Winchendon, MA. https://waterdata.usgs.gov/ma/nwis/uv/?site_no=01162000&PARAmeter_cd=00065,00060.

United States Geological Survey (USGS).2020. "Earthquake Hazards Program," 2020. earthquake.usgs.gov/.

United States Geological Survey (USGS). 2019. "Landslides 101." https://www.usgs.gov/natural-hazards/landslide-hazards/science/landslides-101?qt-science_center_objects=0#qt-science_center_objects.

United States Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), and National Weather Service. 2018. "Storm Data Preparation." Operations and Services Performance, NWSPF 10-16. nws.noaa.gov/directives/sym/pd01016005curr.pdf.

United States Weather Bureau. 1961. Technical Paper No. 40 (TP-40): Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years. https://www.nws.noaa.gov/oh/hdsc/PF_documents/TechnicalPaper_No40.pdf.

APPENDIX A
Core Team Materials

TOWN OF WINCHENDON

Municipal Vulnerability Preparedness Planning Grant Project

Core Team Meeting

4th Floor, Winchendon Town Hall
Thursday, March 5, 2020
10:00 am – 11:30 am

AGENDA

Introductions	5 minutes
Project Overview	20 minutes
Core Team Role	5 minutes
Goal Setting and Endorsement	20 minutes
Community Resilience Building Workshop and Review of Materials	40 minutes
Data Sources	5 minutes
Workshop Participants	15 minutes
Wrap Up and Next Steps	10 minutes

Weston & Sampson

TOWN OF WINCHENDON

Core Team Meeting
Thursday, March 5th, 2020

Weston & Sampson Photo: Town of Winchendon Website, 2019. 1

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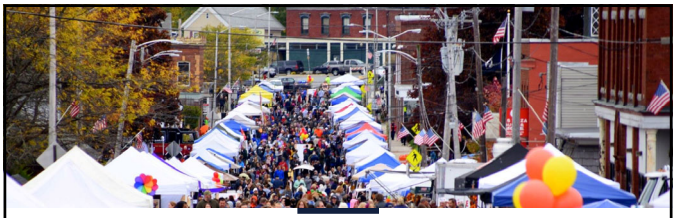


WELCOME CORE TEAM

Tracy Murphy	Alison Manugian	Jim Abare
Al Gallant	Tom Smith	Andrew B. Smith (Regional Coordinator)
David Connor	Dave Walsh	
Keith Hickey	Sheila Bettro	

Weston & Sampson Photo: Winchendon Facebook paige 2

2

Caroline Wells
Adria Boynton

Weston & Sampson 3

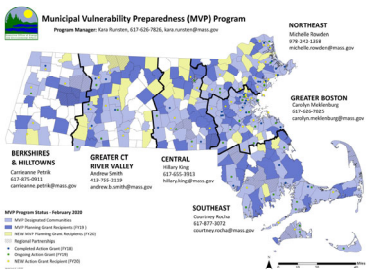
3

Your name
Organization/Relationship to Winchendon
Favorite thing about Winchendon

Weston & Sampson 4

4

MUNICIPAL VULNERABILITY PREPAREDNESS PROGRAM (MVP)



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MVP COMPONENTS

PHASE 1 - PLANNING

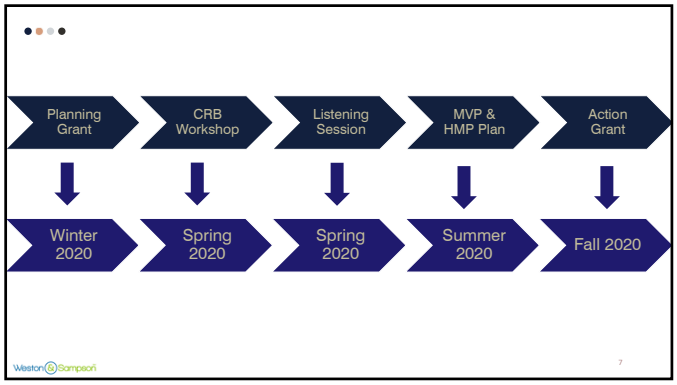
- Receive Planning Grant
- Prioritize Action Items
- Complete MVP Program
- Submit Final Report for Approval
- Become Certified

PHASE 2 - ACTION

- Select an Action Item from Planning Phase
- Apply for Action Grant Funding
- Implement Action Item

Weston & Sampson 6

6



7

MVP PLANNING GRANT COMPONENT

HAZARD MITIGATION PLAN UPDATE

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

8

ELIGIBLE MVP ACTION GRANT PROJECTS

- Detailed Vulnerability and Risk Assessment
- Public Education and Communication
- Local Bylaws, Ordinances, Plans, and Other Management Measures
- Redesigns and Retrofits
- Energy Resilience Strategies
- Chemical Safety
- Nature-Based Storm-Damage Protection, Drought Prevention, 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
- Acquisition of Land to Achieve a Resiliency Objective
- Ecological Restoration and Habitat Management to Increase Resiliency

9

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

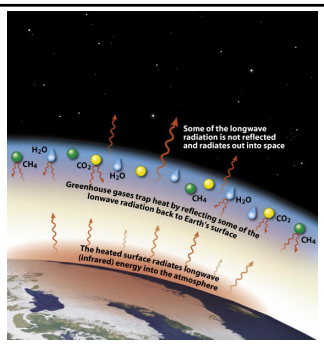
- Review Process
- Set Goals
- Prepare for Stakeholder Meeting

10

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

11

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.

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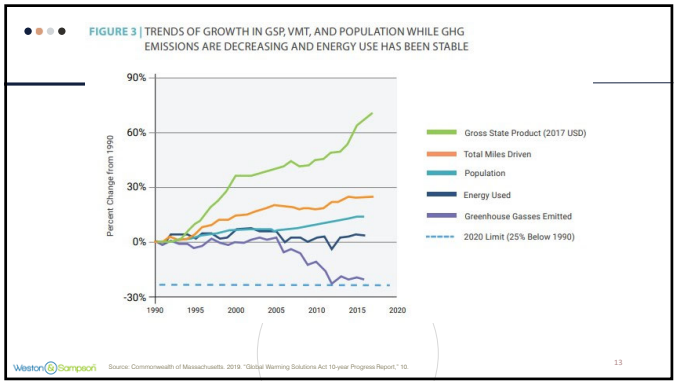

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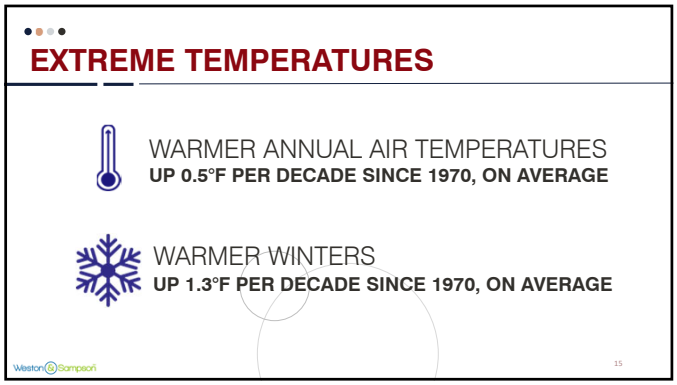

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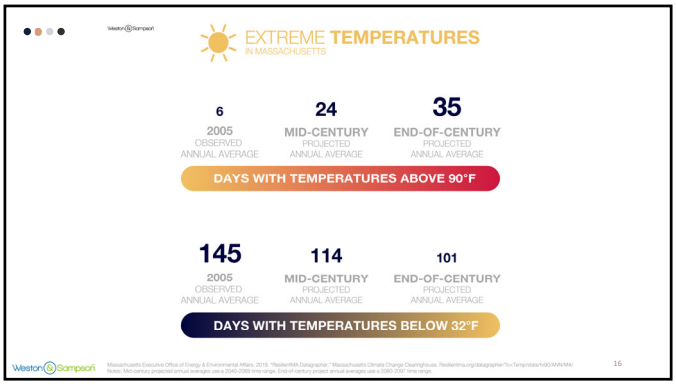

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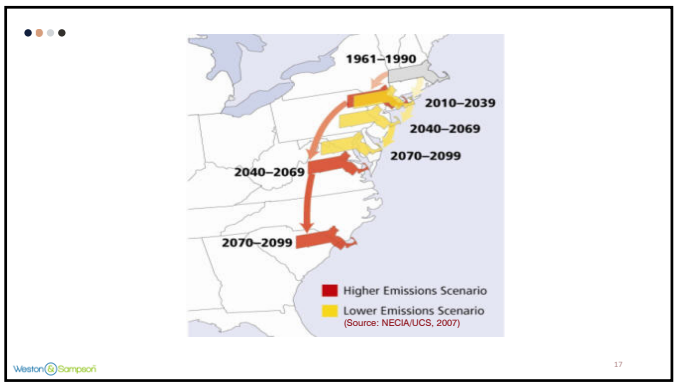

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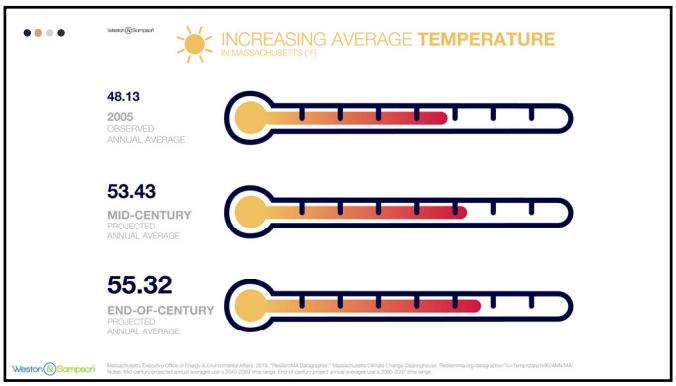

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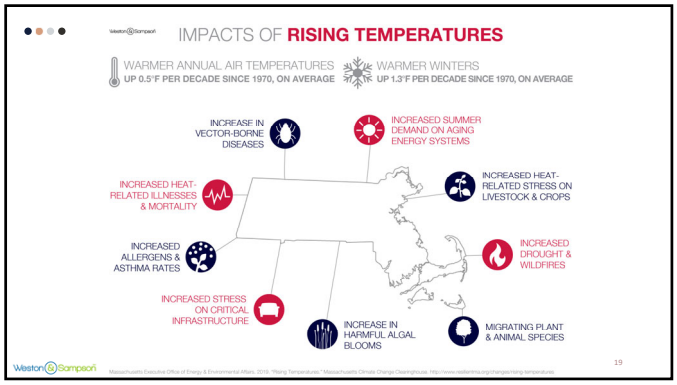

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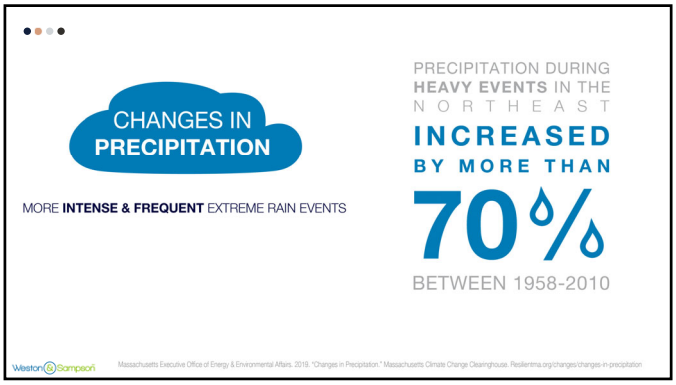

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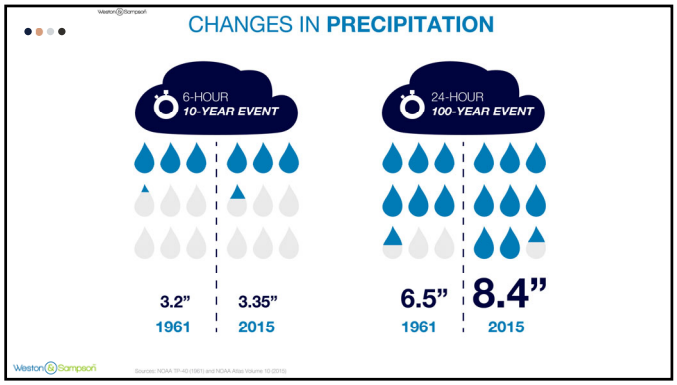

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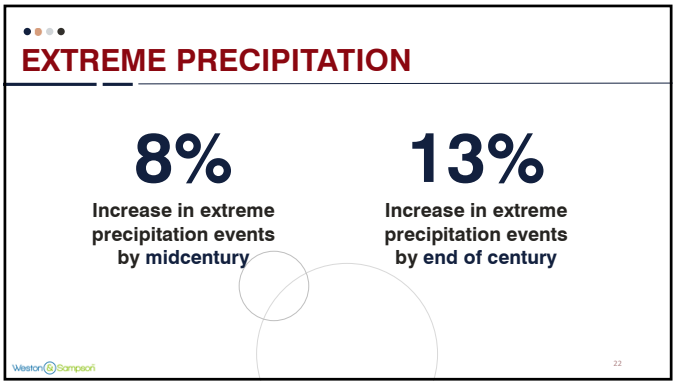

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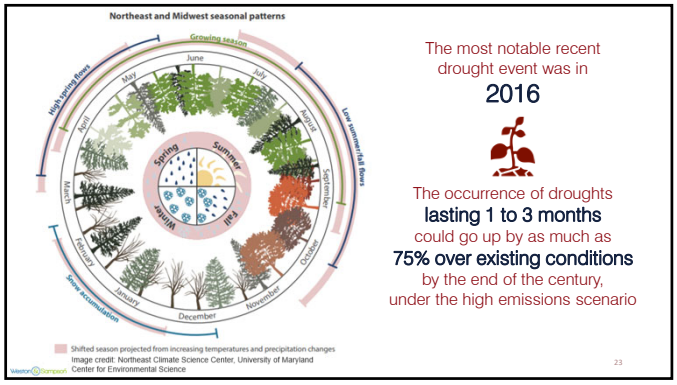

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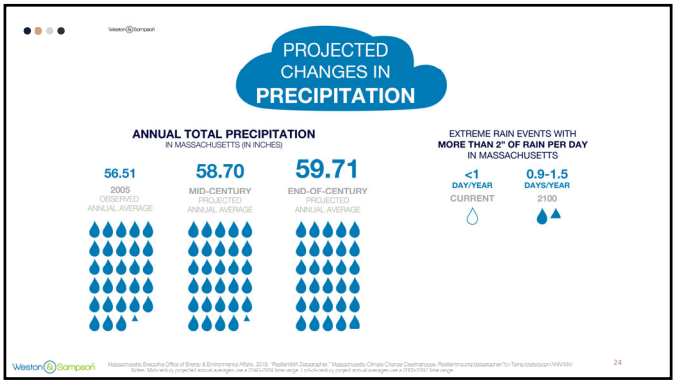

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WINTER STORMS

The blizzard of 2013 left nearly **400,000 Massachusetts residents without power**

"Heavy blizzards are among the **most costly and disruptive** weather events for Massachusetts communities."

25

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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"

26

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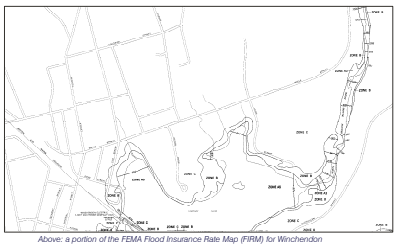
Where are the flood-prone areas in Town?



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

27

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STORMWATER FLOODING

Areas with:

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

Where does stormwater flooding occur in Town?

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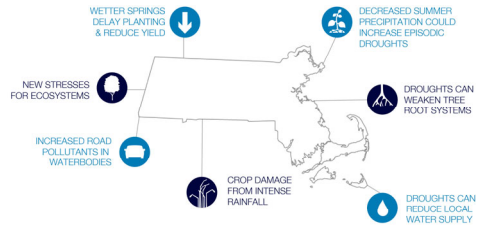
IMPACTS OF CHANGING PRECIPITATION

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



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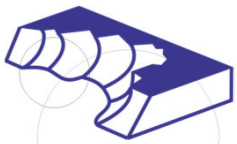
EROSION

Caused by riverine flow & stormwater

Increased precipitation, including winter rains, could increase erosion

Drier soils will reduce resistance to erosion



Source: MA Climate Change Adaptation Report, 2011)

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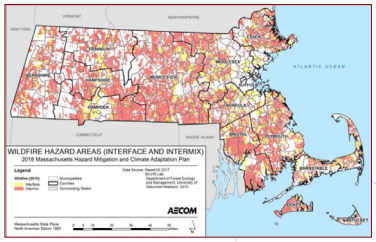
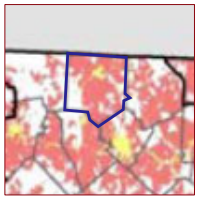
BRUSHFIRE





19 recorded fires between 2017 and 2018

31

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HURRICANES AND EARTHQUAKES

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

EARTHQUAKE

30-40 Earthquakes occur in New England each year, although most are not felt.

Source: Climate Science Special Report, Fourth National Climate Assessment (NCA4), Volume prepared by the U.S. Global Change Research Program (USGCRP)

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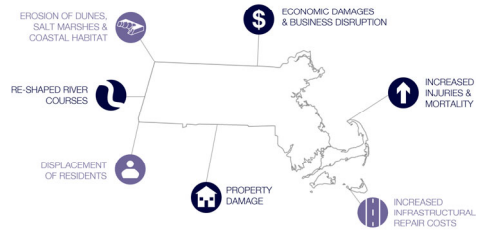
IMPACTS OF EXTREME WEATHER

STORMS ARE BECOMING MORE INTENSE AND DAMAGING



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HAZARD POTENTIAL OF DAMS

Name	Ownership	Hazard Class
Whites Mill Pond Dam	Private	High
Lake Monomonac Dam	Town of Winchendon	High
Whitney Pond Dam	Town of Winchendon	High
Hunts Ponds Dam	Private	Low
Stoddard Pond Dam	Private	Significant
Tannery Pond Dam	Private	Low
Beaman Pond Dam	DCR	Low

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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)

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WORKSHOP OUTLINE

PRESENTATION:
- Overview of Science & Data
- Characterization of Hazards

- BREAK -

INDIVIDUAL TABLES:
- Identify Community Features

- LUNCH -

INDIVIDUAL TABLES:
- Identify and Prioritize Actions

- BREAK -

LARGE GROUP DISCUSSION:
- Determine Overall Priority Actions

Photo: Town website

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RISK MATRIX

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RISK MATRIX

Community Resilience Building Risk Matrix — www.CommunityResilienceBuilding.com

H-M-L priority for action over the Short or Long term (and Ongoing)
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				

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RISK MATRIX: HAZARDS

Community Resilience Building Risk Matrix — www.CommunityResilienceBuilding.com

H-M-L priority for action over the Short or Long term (and Ongoing)
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				

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IDENTIFY HAZARDS

Photo: Police Facebook

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HAZARDS IN WINCHENDON

CHOOSE 4 FOR THE MVP ACTION PLAN

- Flooding
- Brushfires, Urban Fires
- Earthquakes
- Severe Thunderstorms, Wind, Tornado
- Dam Failure
- Drought
- Nor'easters, Ice Storm, Severe Snow Storm
- Hurricanes
- Extreme Temperatures
- Landslide

Weston & Sampson

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RISK MATRIX: HAZARDS

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

				Priority H-M-L	Time Short Long Ongoing

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15 MINUTE BREAK!

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RISK MATRIX: FEATURES

Community Resilience Building Risk Matrix — www.CommunityResilienceBuilding.com

H-M-L priority for action over the Short or Long term (and Ongoing)
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												H-M-L	Short, Long or Ongoing
Infrastructural															
Societal															
Environmental															

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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		

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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	

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FEATURES IN WINCHENDON

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INFRASTRUCTURAL FEATURES

Police Department
Photo by the Winchendon Police Department

Fire Department
Photo by the Winchendon Fire Department

Wastewater Treatment & Collection

Dams
Whites Mill Pond

Transportation
Montachusett Regional Transit

Water Supply

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INFRASTRUCTURAL FEATURES

CRITICAL FACILITY EXAMPLES

- Police and Fire Departments
- Town Facilities
- Communication and Utilities Infrastructure
- Emergency Shelters
- Primary Evacuation Routes
- Critical Bridges, Intersections, and Sites

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INFRASTRUCTURAL FEATURES – DRINKING AND WASTEWATER

- Public Drinking Water Source: Ashburnham Winchendon Joint Water Authority
- The Winchendon Public Works Water and Sewer Departments maintain:
  - 70 miles water transmission and distribution mains
  - Two A22 million-gallon storage tanks
  - Two water booster pump stations for drinking water
  - One water booster pump for firefighting
  - 2,100 water service connections
  - Two sewer pump station
  - 1,200 sewer connections
  - Town-owned fire hydrants

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SOCIETAL FEATURES

Population	Winchendon	Massachusetts
2010	10,300 residents	6,547,790
2018	10,911 residents	6,902,149
Age		
Under 18 years:	24%	19.8%
65+ years:	14.2%	16.5%
Additional Information		
Median household income:	$71,895	$77,378
Persons in poverty:	11.5%	10%
With a disability:	7.8%	7.9%
Language other than English spoken at home:	5%	23.6%

Source: U.S. Census Bureau, 2013-2017 ACS Estimates

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SOCIETAL FEATURES

SCHOOL SYSTEM

- **2,353** students are enrolled in the public school system
- Public school system includes **4** elementary schools and **1** middle school and **1** high school (regional)

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SOCIETAL FEATURES

65 public safety personnel, including:

26 uniformed police officers

39 fire fighters

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ENVIRONMENTAL FEATURES

Water Bodies in Winchendon

- Millers River
- Lake Monomonac
- Lake Denison
- Bailey's Brook
- Whitney Pond
- White's Mill Pond
- Stoddard Pond

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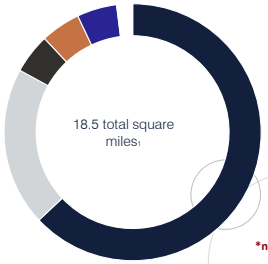
Slide 50

A22 storage tanks located in HIgh Street area, and on Elmwood Road
Author, 2/28/2020

Winchendon's Land Use-NEEDS Updated



- Open Space, Recreation, or Water Use
- Residential Housing
- Agriculture
- Transportation, Mining, or Waste Disposal
- Other

Commercial & Industrial Use

need info from town

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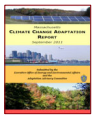
DATA RESOURCES



resilient MA
Climate Change Clearinghouse for the Commonwealth

Massachusetts Climate Change Projections, 2018)

Massachusetts State Hazard and Climate Adaptation Plan, 2018

Massachusetts Climate Change Adaptation Report, 2011

US Census, American Community Survey, 2013-2017

Interviews

Others?

56

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EXISTING HAZARD PROTECTION

Stormwater Bylaw
Wetlands Protection Bylaw
Town Code – Water
Tree Clearing
Emergency Shelter Plan with Fire Department

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MVP GOALS IN WINCHENDON

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LUNCH

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ADAPTATION STRATEGIES

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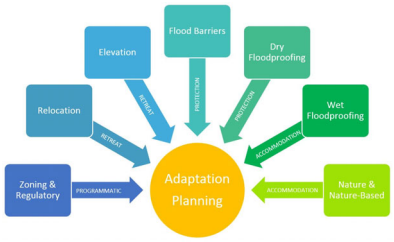
COMMUNITY ACTIONS



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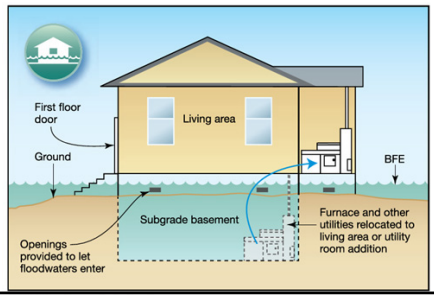
WET FLOODPROOFING



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RAISED BUILDINGS

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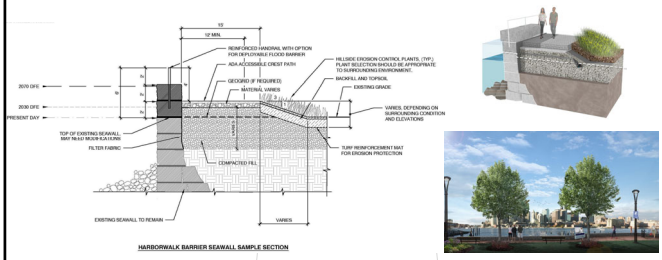
FLOOD WALLS



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DEPLOYABLE FLOOD BARRIER

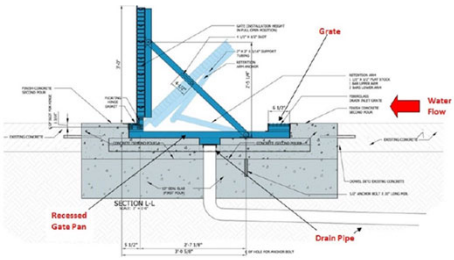

FIGURE 1 | A FloodBreak barrier gate diagram

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PREVENTING SEWER BACKFLOW

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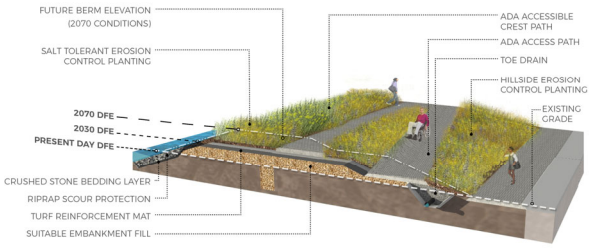
VEGETATED BERM



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MULTI-PURPOSE FLOOD STORAGE

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LOW IMPACT DEVELOPMENT (LID)

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POROUS ASPHALT & PERMEABLE PAVERS

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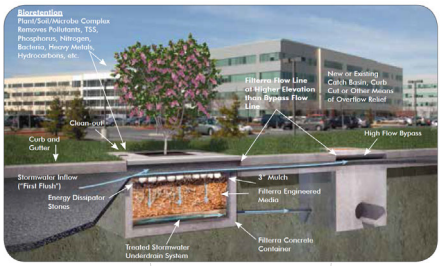
STREET TREES & TREE BOX FILTERS



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STREET TREES & TREE BOX FILTERS

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

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STORMWATER DETENTION & RETENTION

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CULVERT WIDENING TO IMPROVE HABITAT & FLOW

74

74

CLOUDBURST STREETS

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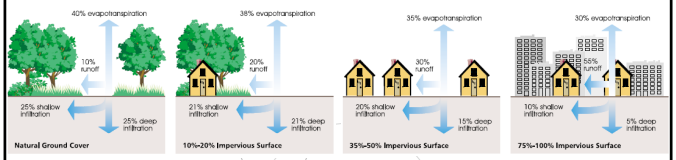
REDUCE IMPERVIOUS AREAS



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GREEN ROOFS

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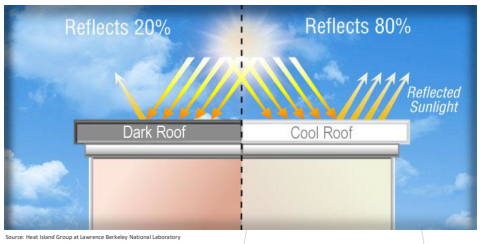
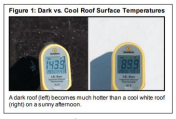
COOL ROOFS



Source: Heat Island Group at Lawrence Berkeley National Laboratory



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COOLING CENTERS

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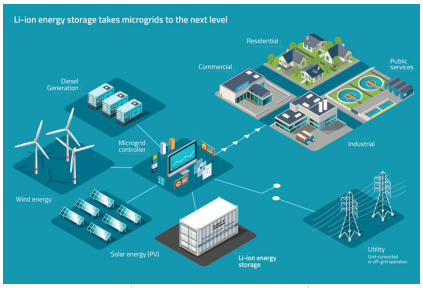
RENEWABLE MICRO-GRIDS



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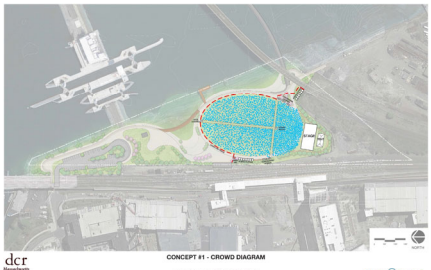
LANDSCAPE DESIGN TO ACCOMMODATE WATER



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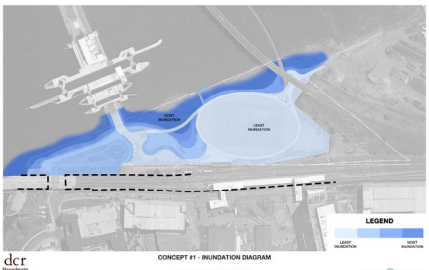
LANDSCAPE DESIGN TO ACCOMMODATE WATER



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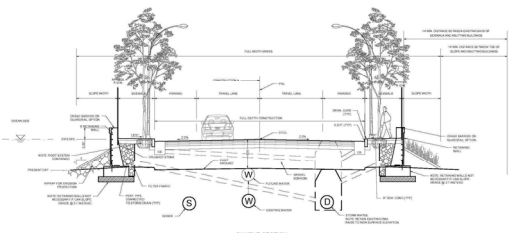
RAISED ROADWAYS



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RETROFITTED FLOODPROOF DOORWAYS

84

84

RE-EVALUATE LOCAL REGULATIONS & POLICIES


BROOKLINE MUNICIPAL VULNERABILITY PREPAREDNESS (MVP) ACTION PROJECT

85

15 MINUTE BREAK!

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DEFINE COMMUNITY ACTIONS

87

IDENTIFY PRIORITY ACTIONS

88

WRAP-UP & CLOSING REMARKS

89

THANK YOU

Weston & Sampson

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APPENDIX B
Listening Sessions

Municipal Vulnerability Planning - MVP

Climate change has the potential to impact how we approach housing,
how we support our community's health,
how we build our infrastructure,
and how we protect the environment.

Your voice represents a unique aspect of the Winchendon community and we'd love to hear your thoughts, experiences, and ideas.

Please take the MVP survey at:

www.townofwinchendon.com

Link located after all COVID-19 related announcements.

If you are unable to access the survey, have questions or comments please contact:
Tracy Murphy, Director of Planning & Development at tmurphy@townofwinchendon.com or 1-978-297-5414

ARE WE PREPARED?

Help us plan for a future with a changing climate

ONLINE PRESENTATION + DISCUSSION

THURSDAY

APRIL 30

2:00 PM

Hazard Mitigation and Municipal Vulnerability Preparedness Plan Listening Session

TOWN OF WINCHENDON
PLANTATION OF IPSWICH CANADA
MASS.
1735
1764

Weston & Sampson℠
transform your environment

Watch the discussion and meeting live on Zoom at **https://tinyurl.com/WinchendonMVP**

Or

Dial in: 1-929-436-2866
Meeting ID: 952 5601 0328
Password: 023990

TOWN OF WINCHENDON

Listening Session Presentation
Thursday, April 30, 2020

Weston & Sampson Photo: Town of Winchendon Website, 2019.

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WATCH THE VIDEO

- What are climate hazards in Winchendon?
- What's at risk?
- What are we doing about it?

TAKE THE SURVEY

to tell us about your experiences, ideas, and questions!

https://tinyurl.com/WinchendonMVPSurvey

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CLIMATE CHANGE

Climate change:
a shift in weather patterns and annual trends. In Winchendon, we can expect hotter temperatures, more severe storms, and more flooding.

Climate hazards:
weather events that can affect human health, livelihoods, homes, businesses, and natural resources

Photo by ellastrails.com

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HAZARDS IN WINCHENDON

Weston & Sampson

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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

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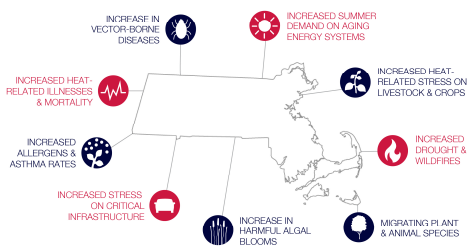
IMPACTS OF RISING TEMPERATURES

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



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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

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EXTREME PRECIPITATION

8%

Increase in extreme precipitation events by midcentury

13%

Increase in extreme precipitation events by end of century

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Where are the flood-prone areas in Town?

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

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STORMWATER FLOODING

Areas with:

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

Where does stormwater flooding occur in Town?

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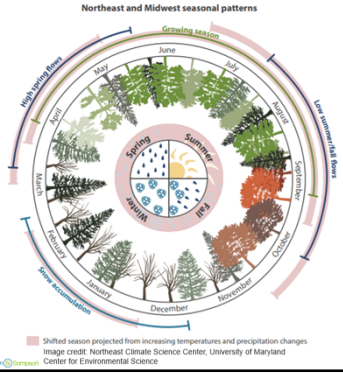

The most notable recent drought event was in

2016

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

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WHAT'S AT RISK?

Increased stress on the challenges we already face and how we operate in our day to day lives

Photo: City Facebook

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WHAT DOES THIS MEAN FOR US?

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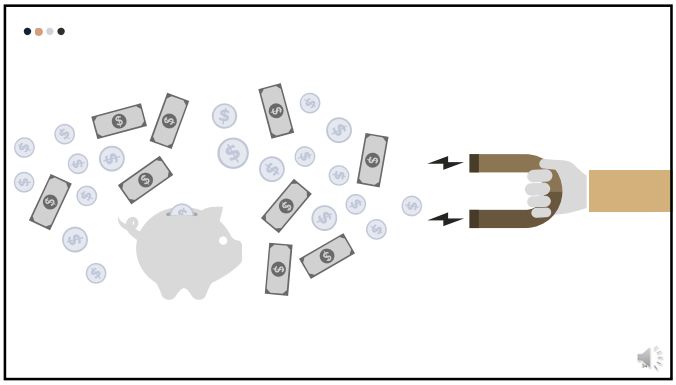

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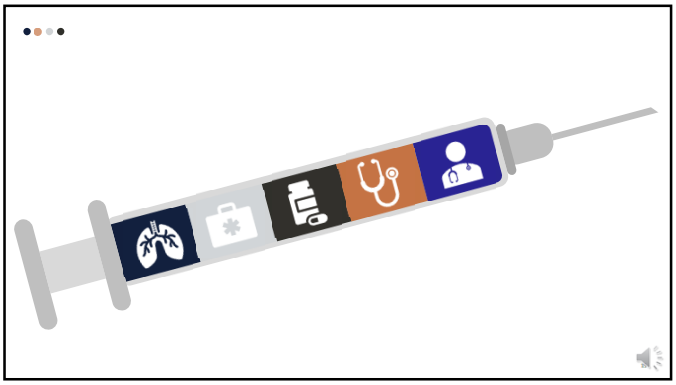

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Infrastructure

Public Transportation

Photo: Montachusett Regional Transit Authority

Roads

Photo by toytownweb.com

Society

Public Services

Photo: Winchendon Police Department

Vulnerable Residents

Photo: Murdoch High School

Environment

Water Bodies

Photo by kids.outdoors.org

Tree Canopy

Photo by Wikipedia Commons

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WHAT ARE WE DOING ABOUT IT?

Make a plan to reduce our vulnerabilities and to build up our strengths

Secure financial support through state and federal programs

Photo: Winchendon Fire Department

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WINCHENDON'S CLIMATE ADAPTATION & HAZARD MITIGATION GOALS

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WILL YOU BE PART OF THE SOLUTION?

- START BY TAKING OUR SURVEY: https://tinyurl.com/WinchendonMVPSurvey
- THEN SHARE ON FACEBOOK

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WHERE CAN I LEARN MORE?

Source	Online
MA Climate Clearinghouse	resilientma.org
National Oceanographic Atmospheric Administration (NOAA)	https://www.noaa.gov/climate
National Aeronautics and Space Administration (NASA)	https://climate.nasa.gov/effects/
Smithsonian Environmental Research Center (greenhouse gases)	https://forces.si.edu/atmosphere/02_04_07.html

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THANK YOU

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APPENDIX C
Community Resilience Building Workshop Matrix

Community Resilience Building Risk Matrix

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	FLOODING	SEVERE WINTER STORMS	HIGH WIND EVENT	EXTREME TEMPERATURES	Priority H - M - L	Time S Short L Long O Ongoing
Infrastructural									
Dams Infrastructure deficiencies (Whitney)	Various	Town/Private	V	Whitney: spillway needs update, complete dam update design, spillway reconstruction (6 mil), West M Road spillway: reconstruction, Great Dam: spillway undersized, Mill Pond: funding needed for removal,	Ice flows from high water levels damage dams and spillways - damage assessment and alternatives, water control necessary to minimize impacts,			H	S
Roads and bridges (Spring, Rt 12, High bridge, Rt 202, River st bridge, Brown St. bridge, Maple st bridge	Townwide	Town/State	V	Identify alternate routes, Central st drainage improvements, small streams (north end) need to be put underground, temporary bridge access, public education on stream flow and preventative measures for stream flooding, public education on evacuation proceedures and emergency situations for vulnerable areas,	drainage projects for roads that ice over regularly (all dirt roads), additional sanders and salters to increase ability to clear roads,	public education on tree maintenance to reduce street closures	assess roads and bridges for prioritization (in process)	H	O
Wastewater treatment system (Millers River)		Town	V/S	See dam issues, communication with ACOE	electrical independence, better local control of infrastructure, treatment facility battery backup			L	O
Water Supply	Various	Public/Private	V/S	private septic systems upgrades needed (older systems)			not currently drought susceptible, analysis of source and surrounding communities, explore mutual aid agreements, upgrades to internet availability and quality	M/H	O
Poor Internet Service	Townwide		V	upgrades to internet availability and quality	upgrades to internet availability and quality	upgrades to internet availability and quality		H	S
Electrical Grid/Interconnectivity	Townwide	NGRID	V		explore mutual aid agreements,	Public education on tree maintenance to reduce outages		H	L

Senior Center upgrades (shelter ability)		Town	V/S	generator needed, structural upgrades needed, additional items for meal service, beds, shower upgrades, capacity analysis, public education on shelter benefits and availability, outreach to vulnerable populations, ability to shelter pets, increase ability to shelter families together,	generator needed, structural upgrades needed, additional items for meal service, beds, shower upgrades, capacity analysis, public education on shelter benefits and availability, outreach to vulnerable populations, ability to shelter pets, increase ability to shelter families together,	generator needed, structural upgrades needed, additional items for meal service, beds, shower upgrades, capacity analysis, public education on shelter benefits and availability, outreach to vulnerable populations, ability to shelter pets, increase ability to shelter families together,	generator needed (H), structural upgrades needed, additional items for meal service, beds, shower upgrades, capacity analysis, public education on shelter benefits and availability, outreach to vulnerable populations, ability to shelter pets, increase ability to shelter families together,	M/H	S
Police Station upgrades (underground stream)		Town	S	drainage system improvements on Central St.				L	L
Fire Station upgrades		Town	V/S		Structural upgrades (flat roof), increase ability to house crew prior to emergencies,		weatherization upgrades	M/H	S
Evacuation Routes/Public Safety Access	Townwide	Town	S	proper signage for evacuation routes		proper signage for evacuation routes		H	O
Societal									
EJ Population (concentrated in particular census tracts)			V	Increase Shelter accessibility, increase mobility options, create evacuation/shelter plans by location, increase public communications	Increase Shelter accessibility, increase mobility options, create evacuation/shelter plans by location, increase public communications	Increase Shelter accessibility, increase mobility options, create evacuation/shelter plans by location, increase public communications	Increase Shelter accessibility, increase mobility options, create evacuation/shelter plans by location, increase public communications, generators for cooling centers	H	O
Senior Population	Townwide		V	Increase Shelter accessibility, increase mobility options, create evacuation/shelter plans by location, increase public communications, increase internal neighborhood communications/support network	Increase Shelter accessibility, increase mobility options, create evacuation/shelter plans by location, increase public communications, increase internal neighborhood communications/support network	Increase Shelter accessibility, increase mobility options, create evacuation/shelter plans by location, increase public communications, increase internal neighborhood communications/support network	Increase Shelter accessibility, increase mobility options, create evacuation/shelter plans by location, increase public communications, increase internal neighborhood communications/support network	H	O
Disabled Population			V	Locate group homes/disabled population, plan for mobility of disabled population	Locate group homes/disabled population, plan for mobility of disabled population	Locate group homes/disabled population, plan for mobility of disabled population	Locate group homes/disabled population, plan for mobility of disabled population	H	O

Municipal Government			S(V)	upgrades to TH emergency generator, Police pickup truck, access to a large capacity vehicle to move people (contract or mou),	upgrades to TH emergency generator, Police pickup truck, access to a large capacity vehicle to move people (contract or mou),	upgrades to TH emergency generator, Police pickup truck, access to a large capacity vehicle to move people (contract or mou),	upgrades to TH emergency generator, Police pickup truck, access to a large capacity vehicle to move people (contract or mou),	H	S
Winchendon School (private grades 9-12)		Private	V/S	analyze/establish shelter capacity, generator upgrades to some buildings,	analyze/establish shelter capacity, generator upgrades to some buildings,	analyze/establish shelter capacity, generator upgrades to some buildings,	analyze/establish shelter capacity, generator upgrades to some buildings,	M	S
The Clark Memorial YMCA		Private	S	analyze/upgrade for shelter capabilities,	analyze/upgrade for shelter capabilities,	analyze/upgrade for shelter capabilities,	analyze/upgrade for shelter capabilities,	M	S
Communication/Disemination of Information (CODE RED/211 System)	Townwide		V/S	building neighborhood networks, provide education in advance of an event, increase ability to distribute radios to those w/out communications,	building neighborhood networks, provide education in advance of an event, increase ability to distribute radios to those w/out communications,	building neighborhood networks, provide education in advance of an event, increase ability to distribute radios to those w/out communications,	building neighborhood networks, provide education in advance of an event, increase ability to distribute radios to those w/out communications,	M/H	O
Vulnerable Neighborhoods	Various		V	Communication plan, neighborhood champions/network, evacuation/response plans based on location and situation, area assessments to mitigate flood issues,	Communication plan, neighborhood champions/network, evacuation/response plans based on location and situation,	Communication plan, neighborhood champions/network, evacuation/response plans based on location and situation,	Communication plan, neighborhood champions/network, evacuation/response plans based on location and situation,	H	O
Environmental									
Bike Path			V/S	alternate route through town,				L	S
Lake Denison recreation area		State	S	provides flood storage				L	
Town Monuments/cultural resources			V	inventory resources and assess vulnerability,				M	S
Agriculture/food economy			V	inventory agricultural land, food economy resources, food processors, distributers,			inventory agricultural land, food economy resources, food processors, distributers, develop drought management plan, irrigation plan,	H	O

Water Quality	Various	Various	V	communications with downstream communities and agencies, chemical release plan,				H	O