Great Barrington Hazard Mitigation & Climate Adaptation Plan

November [pending FEMA review and Town Adoption]

Table of Contents

CHAPTER 1: INTRODUCTION

Purpose

The purpose of hazard mitigation planning is to reduce or eliminate the need to respond to hazardous conditions that threaten human life and property. Hazard mitigation can be an action, activity, process, or physical project designed to reduce or eliminate the long-term risks from hazards.

The Town of Great Barrington Hazard Mitigation and Climate Adaptation Plan (HMCAP) was prepared to meet the goals laid out in this plan as well as in order to meet the requirements of 44 CFR § 201.6 pertaining to local hazard mitigation plans. 44 CFR § 201.6(a)(1) states that a local government must have a mitigation plan approved pursuant to this section in order to receive HMGP project grants. A local government must have a mitigation plan approved pursuant to this section in order to apply for and receive mitigation project grants under all other mitigation grant programs. In accordance with 44 CFR § 201.6 the local mitigation plan is the representation of Great Barrington's commitment to reduce risks from natural hazards, serving as a guide for decision makers as they commit resources to reducing the effects of natural hazards. Additionally, the HMCAP is meant to serve as the basis for the Commonwealth of Massachusetts to provide technical assistance and to prioritize project funding. The HMCAP was also prepared to meet requirements of the Municipal Vulnerability Preparedness (MVP) Planning Grant, which enabled Great Barrington to integrate local effects of climate change into their hazard mitigation action plan. By completing the Community Resilience Building (CRB) process, Great Barrington will be an MVP community eligible for MVP Action Grants to adapt to the impacts of climate change on the community.

The Town of Great Barrington has laid out the following mission statement for their hazard mitigation planning process: To identify observed and projected risks and sustainable cost-effective actions to mitigate the impact of hazards in order to protect life, property and the environment.

Background

Mitigation Planning

The Town of Great Barrington was included in a regional hazard mitigation plan with 18 other Berkshire County municipalities approved by FEMA Region I in 2012. This Hazard Mitigation and Climate Adaptation Plan is an update of the Berkshire County Hazard Mitigation Plan, dated November 5, 2012. This HMP is a single jurisdictional plan.

Location

The Town of Great Barrington is in southern Berkshire County, in the Commonwealth of Massachusetts. The Town's northern border abuts West Stockbridge, Stockbridge, and Lee. The eastern border abuts Tyringham and Monterey. New Marlborough shares a small border with Great Barrington to the southeast, while most of the southern border is with Sheffield. Egremont and Alford share the western border of Great Barrington.

CHAPTER 2: PLANNING PROCESS

44 CFR § 201.6(b) & 44 CFR § 201.6(c)(1)

Introduction

This chapter outlines the development of the Town of Great Barrington Hazard Mitigation and Climate Change Adaptation Plan. It identifies who was involved in the process, how they were involved, and the methods of public participation that were employed. An open public involvement process during the drafting stage was essential to the development of the HMCAP. A discussion of how the community will continue public participation in the plan maintenance process (44 CFR § 201.6(c)(4)(iii)) will be discussed in Chapter 4.

The Town retained the Berkshire Regional Planning Commission, a MVP Provider, to aid them in developing the Hazard Mitigation and Climate Change Adaptation Plan. The essential deliverable was to develop a set of Actions for addressing Priority Hazards, using the CRB Workshop process and methodology as a key stakeholder tool. The Plan is a compilation of data collected by BRPC, information gathered from the planning committee during meetings, and interviews conducted with key stakeholders outside of working meetings. The Great Barrington HMCAP reflects comments provided by participants and the public through the MVP planning process, the Hazard Mitigation Planning Committee, local officials and citizens, neighboring towns, and ultimately MEMA and FEMA. Making the document available to the public for review meets requirements of 44 CFR § 201.6(b)(1).

Planning Meetings and Participation

44 CFR § 201.6(c)(1)

The Building Inspectors Office is the primary agency responsible for regulating development in town and ensuring compliance with all Town bylaws, and integral to the hazard mitigation planning process. The Building Inspector forwards applications to the planning department and other reviewing staff or boards as needed. A biweekly meeting of development review staff ensures regular and ongoing communication between departments. The development review staff coordinates with state agencies as needed.

During the HMCAP planning process there was opportunity for public comment and opportunity for neighboring communities, local and regional agencies or partners involved in hazard mitigation activities, agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process.

The Town of Great Barrington was in the process of completing their hazard mitigation plan for FEMA approval when the Town decided to combine the process with the MVP planning grant. In doing this, they could better plan for future conditions and hazards in a changing climate. The Town was then able to use grants from Federal Emergency Management Agency (FEMA) through the Massachusetts Emergency Management Agency (MEMA) and from the Massachusetts Executive Office of Energy and Environmental Affairs. The combination of these grants made this comprehensive mitigation and climate change planning process feasible.

The Town formed a Hazard Mitigation / MVP planning team with core groups focusing on hazard mitigation plan updates and the MVP/CRB workshop and public listening session. Great Barrington tapped into their newly formed Strategic Sustainability and Livability Committee to lead the MVP/CRB workshop and public listening session planning. Names and roles of those involved in planning are listed in table 2.1.

Table 2.1: Planning Team Members for Hazard Mitigation and Municipal Vulnerability Preparedness

Name	Affiliation	Role
Chris Rembold	Assistant Town Manager	Project Coordinator/ MVP Workshop Presenter
Natalie Narotzky	Strategic Sustainability & Livability Committee	Core Team Member/MVP Workshop Presenter
Jovanina Pagano	Strategic Sustainability & Livability Committee	Core Team Member
Mark Phillips	Strategic Sustainability & Livability Committee	Core Team Member/ MVP Workshop Presenter
Edwin May	Building Commissioner	Hazard Mitigation Planning Group
Chief William Walsh	Police Chief	Hazard Mitigation Planning Group
Rebecca Jurczyk	Health Agent	Hazard Mitigation Planning Group
Sean Van Deusen	DPW Director	Hazard Mitigation Planning Group
Charles Burger	Fire Chief	Hazard Mitigation Planning Group
Pete Soules	Highway Superintendent	Hazard Mitigation Planning Group
Shep Evans	Conservation Commission	Hazard Mitigation Planning Group
Joseph Grochmal	Town Staff	MVP Workshop Presenter
Caroline Massa	BRPC	Lead Facilitator/ MVP Workshop Presenter
Justin Gilmore	BRPC	Facilitator/ MVP Workshop Presenter
Mark Maloy	BRPC	Facilitator/ MVP Workshop Presenter
Peg McDonough	BRPC	Facilitator/ MVP Workshop Presenter

Meetings involved discussing related projects in town including bridge work, open spaces planning, and development goals, as well as how to get key stakeholders and underrepresented groups at the planning table. Great Barrington would utilize the CRB workshop to collect input from as diverse a group of community residents and stakeholders as possible given time and resources available. Invitations were sent to residents and stakeholders electronically, and planning team members contacted invitees directly to encourage participation and ensure receipt of an invitation. A selection of maps and an overview of workshop discussion topics and goals were sent with invitations. Workshop participants are listed in Appendix A.

The central objective of the workshop was to first review regional weather events from the past and climate change data and projections, then collect local data from attendees to help:

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

The CRB Workshop was held at the Great Barrington Fire Station on November 14th, 2019. The planning team aimed to have public participation as engaging as possible and decided to integrate the Data Walk[1] method of community engagement with the CRB methods and materials. A Data Walk presents collected information to stakeholders in a digestible format and encourages engagement and question-asking. Great Barrington set up several stations to present data and contextual information in the following themes: Economy, Environment, Food and Farming, Housing, People, Public Health, Transportation, and Utilities. These posters can be seen in Appendix A and are available for the public on the BRPC website[2]. Posters were created by both Hazard Mitigation and MVP Planning Team members and by BRPC staff depending on area of expertise. On the day of the workshop the 27 attendees were broken in four groups that revolved throughout the space to hear short presentations on each theme and participate in group discussion on the presented information. After reviewing posters groups then were seated at tables to complete the CRB Risk Matrices seen in Appendix C. The matrices included top hazards for Great Barrington, significant assets and vulnerabilities, and proposed adaptations or solutions.

Categories of Concerns and Challenges

Major themes that came out of the initial public participation in Great Barrington highlighted the common vision residents and stakeholders have for the resilience of the entire region. These themes were about more than specific concerns or challenges, but about how they wanted to address vulnerabilities and build upon existing strengths. The following summarizes categories that will be discussed in further detail throughout the plan with specific steps to accomplishing the vision in the Action Plan detailed in the Mitigation Strategy.

Economic Viability

Acknowledging the fact that the population in Great Barrington and the region is declining and aging, a major priority is to find ways to sustain the economy through this period. This means providing all of the necessary resources to empower and employ not only those who grew up in and around Great Barrington, but also attracting new talent and diversity to maintain the attractiveness of living and working in the region. The Town wishes to increase networking and collaboration, internet-dependability, and quality facilities and programming at the regional schools.

[1] Data Walk was created by the Urban Institute. More information can be found here: https://www.urban.org/research/publication/data-walks-innovative-way-share-data-communities

[2] http://berkshireplanning.org/projects/gt.-barrington-municipal-vulnerability-plan

Water Infrastructure

While sometimes they go unnoticed, water resources and systems are an integral part of every built environment. Stakeholders highlighted the need to protect waterways, better manage stormwater, build road-stream crossings to safely convey water from heavy precipitation events, and think innovatively about a climate hazard ready wastewater treatment plant.

Ecosystem Health

Great Barrington is no stranger to environmental stewardship and knowing that our built environment is constructed within the greater natural environment, tied to its ecosystems and ecological health. Stakeholders would like to see wildlife corridors that protect the natural functions of wetlands and floodplains, forest management to deal with invasive species, inventory and quantification of ecosystem services, and sustainable agricultural practices that protect soil health, prevent erosion into waterways, and enable local self-sufficiency.

Energy

A proactive approach to addressing hazards and climate change is through projects that achieve goals of mitigation (reducing climate forcers) and adaptation (building in accordance to a changing climate). Instead of depending on conventional energy and back up power that require access to fossil fuels, Great Barrington wants to pursue alternative energies for backup power. Additionally, the town can reduce energy vulnerabilities by establishing microgrids, burying powerlines, and providing additional redundancy in systems.

Outreach for Marginalized Populations

The need to be inclusive in the planning process is of paramount importance to Great Barrington residents and stakeholders. This value took many forms, including ensuring that emergency communications and services are properly translated, figuring out how to meaningfully involve marginalized populations in Great Barrington, planning for climate refugees, improving shelters and free meal programs, and ensuring that isolated residents are receiving needed information and are taken care of by the community.

Great Barrington as the Regional Resiliency Hub

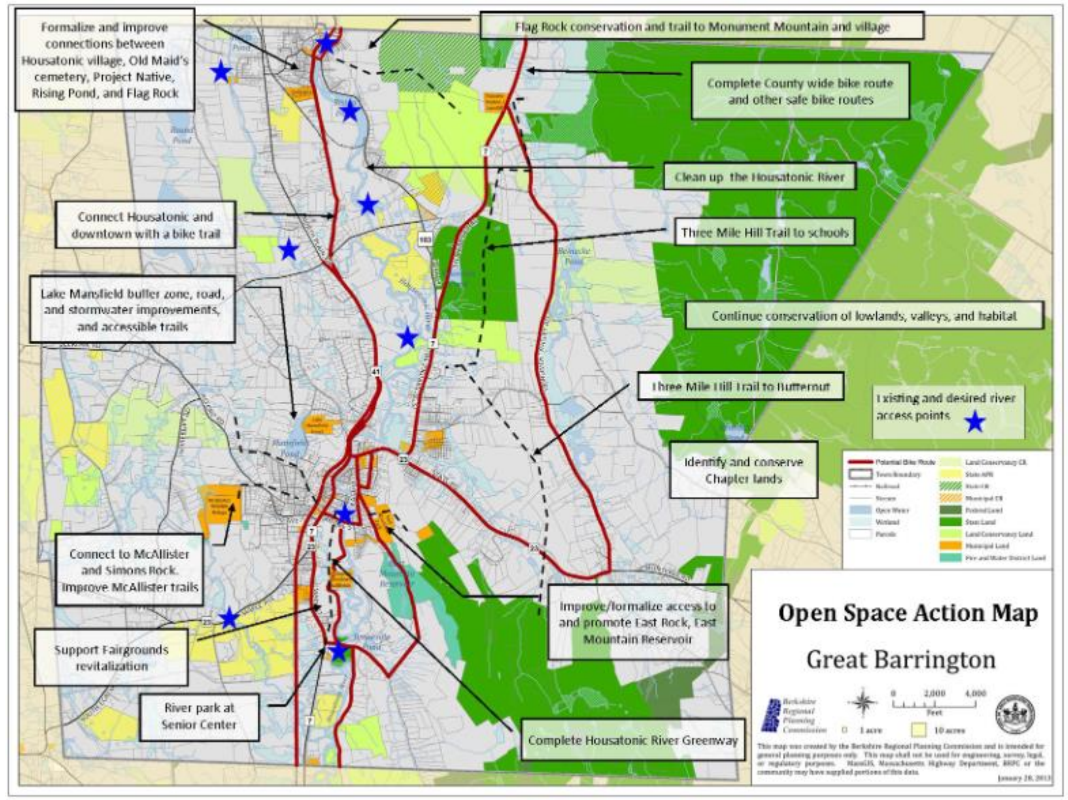
Great Barrington is the most densely developed area in Berkshire County south of I-90. It is the location of the region's schools, and where many people from surrounding towns go for shopping, healthcare, and social activities. Building upon the services Great Barrington already provides and its central location, the Town envisions being the regional resiliency hub. Accomplishing this by establishing additional shelters and emergency services accessible by multiple cultures and those with limited English proficiency, enabling multiple transportation modes, tapping into existing resources such as second homeowner intellectual capital and philanthropy, looking out for the senior population, ensuring adequate and affordable housing stock, and being a model of sustainability.

The Categories of Concerns and Challenges described above were presented to the public at a Public Listening Session on March 9th, 2020. The Public Listening Session included 30 minutes of poster review prior to the meeting and the option to vote on priorities as displayed on the posters at Town Hall. A presentation on the planning process and proposed actions was given by the Assistant Town Manager and televised during the Select Board meeting. The HMCAP was made available for public review and comment in July of 2020 on Town and BRPC websites.

Incorporation of Existing Information

44 CFR § 201.6(b)(3)

No plan should be created in a silo, particularly a hazard mitigation plan because of its applicability to land use, town services, and vulnerable people. The Town of Great Barrington reviewed and incorporated existing plans, studies, reports and technical information into their hazard mitigation and climate adaptation plan with the assistance of BRPC. This plan should be used in conjunction with other local and regional plans. Great Barrington is fortunate in have a Town Planner and several other fulltime staff that assist in the long-term vision of the Town. The Town has a Master Plan from 2013 that involved extensive community outreach to lay out that common long-term vision with areas of focused development and preservation. The Town is currently creating a Open Space and Recreation Plan that will integrate with hazard mitigation with protecting wetlands, rivers, streams, lakes and ponds, and providing places to play outdoors.



During the planning process existing studies, plans and guidance were solicited from the Massachusetts Department of Conservation & Recreation. Plans referenced included the Southern Berkshire District Forest Resource Management Plan. These documents provided important insight into the value of natural resources in Great Barrington and a path forward for protecting the community's assets. Additionally, other hazard mitigation plans in the region were consulted during the development of this plan, many of which are currently in formulation.

The next chapter of this plan will dive into the risk assessment, profiling each hazard with potential to affect the Town of Great Barrington. Table 2.1 illustrates part of the process of prioritizing hazard mitigation actions in addition to the profiling of local impacts during the risk assessment. The method of prioritization meets requirements of 44 CFR § 201.6(c)(3)(iii).

Table 2.1: Hazard Prioritization for the Town of Great Barrington

Hazard	Area of Impact Rate	Frequency of Occurrence Rate	Magnitude / Severity Rate	Hazard Ranking
	1=small 2=medium 3=large	0 = Very low frequency 1 = Low 2 = Medium 3 = High Frequency	1=limited 2=significant 3=critical 4=catastrophic	
Change in Average/Extreme Temperature	3	3	3	**9**
Cyber Security	3	2	4	**9**
Invasive Species	3	3	2	**8**
Hurricane & Tropical Storms	3	2	3	**8**
Pests/Vector-borne Disease	3	3	2	**8**
Tornado	2	2	4	**8**
Severe Storms (High Wind, Thunderstorm)	3	3	1	**7**
Severe Winter Event (Ice Storm, Blizzard, Nor'easter)	3	3	1	**7**
Drought	3	1	3	**7**
Flooding (include Ice Jam, Beaver Activity)	2	3	1	**6**
Earthquake	3	0	3	**6**
Urban & Wildfire	2	1	2	**5**
Dam Failure	2	0	3	**5**
Landslide/Erosion	1	2	1	**4**

Area of Impact	
1=small	isolated to a specific area of town during one event
2=medium	occurring in multiple areas across town during one event
3=large	affecting a significant portion of town during one event
Frequency of Occurrence	
0=Very low frequency	events that have not occurred in recorded history of the town, or that occur less than once in 1,000 years (< 0.1% per year
1=Low frequency	events that occur from once in 100 years to once in 1,000 years (0.1% to 1% per year)
2=Medium frequency	events that occur from once in 10 years to once in 100 years (1% to 10% per year)
3=High frequency	events that occur more frequently than once in 10 years (greater than 10% per year)
Magnitude/Severity	
1=limited	injuries and/or illnesses are treatable with first aid; minor" quality or life" loss; shutdown of critical facilities and services for 24 hours or less; property severely damaged < 10%
2=significant	injuries and/or illnesses do not result in permanent disability; shutdown of several critical facilities and services for more than one week; property severely damaged < 25% to > 10%

3=critical	injuries and/or illnesses result in permanent disability; complete shutdown of critical facilities for at least two weeks; property severely damaged < 50% to > 25%
4=catastrophic	multiple deaths; complete shutdown of facilities for 30 days or more; property severely damaged> 50%

Plan Structure

The next chapter of this plan is the Risk Assessment for the Town of Great Barrington. After a general profile of the Town, each hazard analyzed includes a hazard profile and vulnerability assessment. Hazard profiles consist of likely severity, probability, geographic areas likely impacted, and historic data. The vulnerability Assessment includes hazard effects on people including vulnerable groups, the built environment including infrastructure, the natural environment, the economy, and future conditions to the extent reasonably foreseen in consideration of climate change.

Hazard Mitigation Goals

In developing this plan, the Town of Great Barrington is taking action to reduce or avoid long-term vulnerabilities to the hazard identified in the following chapter. The following are the Town's goals for this hazard mitigation plan:

1. Identify the present and future risks that threaten life, property and environment in Great Barrington.
2. Develop and implement sustainable, cost-effective, and environmentally sound mitigation projects.
3. Protect lives, health, safety, and property of fulltime residents, seasonal visitors, and future generations from the impacts of hazards.
4. Protect critical facilities and essential public services from disruption during or after hazardous conditions.
5. Promote the hazard mitigation and climate adaptation plan and involve all stakeholders to enhance the local capacity to mitigate, prepare for, and respond to the impacts of natural hazards.
6. Integrate the risks and mitigation actions identified through this planning process into all plans for the town and region and ensure its consideration in all land use decisions.

CHAPTER 3: RISK ASSESSMENT

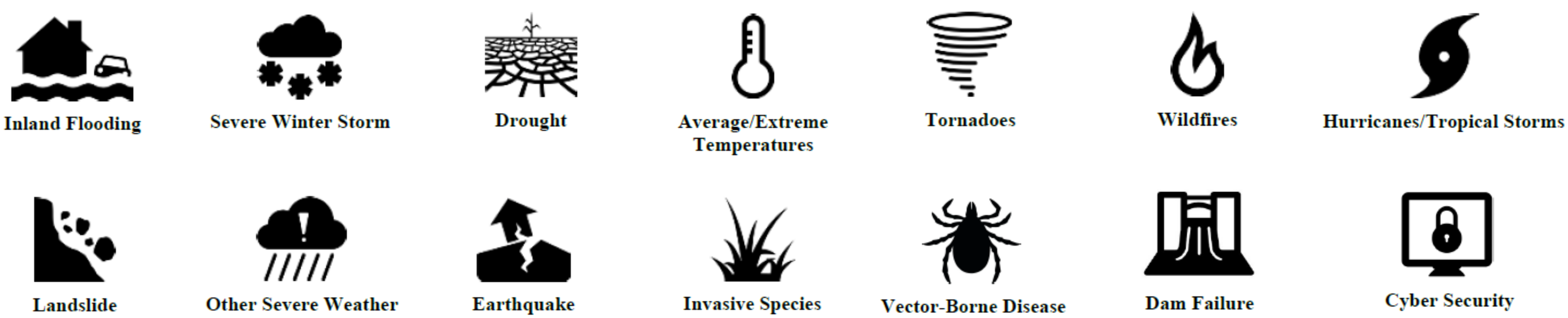
44 CFR § 201.6(c)(2)

FEMA Requirements

In accordance with 44 CFR § 201.6 (c)(2), this risk assessment provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. The risk assessment is an analysis of the hazards and risks facing the Town of Great Barrington and contains detailed hazard profiles and loss estimates to serve as the scientific and technical basis for mitigation actions. This chapter also describes the decision-making and prioritization processes to demonstrate that the information analyzed in the risk assessment enabled the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards. This section also provides information on previous occurrences of hazard events and on the probability of future hazard events with consideration of climate change (44 CFR § 201.6(c)(2)(i).

Hazard Identification and Risk Assessment Processes

In order to identify potential hazards that can affect the Town of Great Barrington several resources were utilized. The 2012 Berkshire County Hazard Mitigation Plan served as a foundation to build from. The hazards identified in the 2012 plan were Flooding, Structurally Deficient Bridges over Waterways, Dam Failure, Wildfire, Snow, High Wind, and Other Natural hazards (i.e. severe storms and tornadoes). In order to build upon this list, the 2018 State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) for the Commonwealth of Massachusetts[3] was consulted. The natural hazards of coastal flooding, coastal erosion and tsunamis are not applicable due to the location of the community within the Commonwealth. Accounting for the location, natural and built environments, history, and scientific studies of the area, it was determined that Great Barrington must plan for the following hazards:



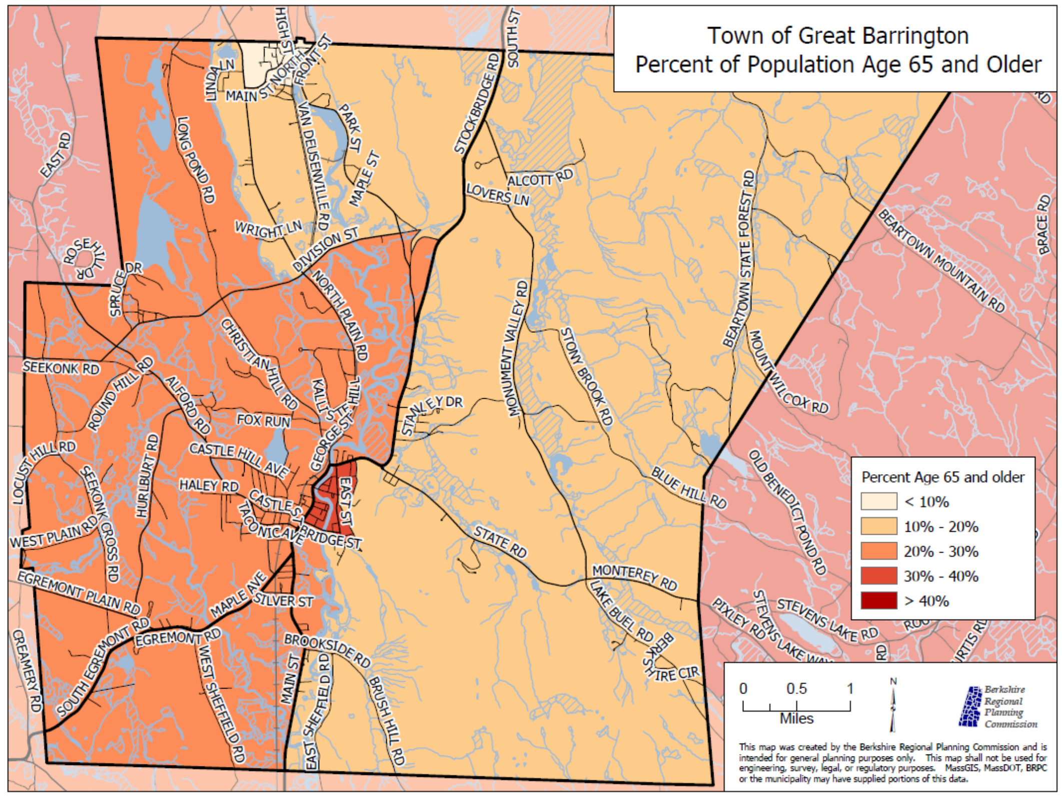
[3] Massachusetts Emergency Management Agency & the Executive Office of Energy and Environmental Affairs developed the MA State Hazard Mitigation and Climate Adaptation Plan, 2018 https://www.mass.gov/service-details/massachusetts-integrated-state-hazard-mitigation-and-climate-adaptation-plan

People

The population of Great Barrington from the 2010 decennial census was 7,106, in 2018 is was estimated at 6,852 in line with the declining population of the Berkshires. Given this estimated population range, Great Barrington has about 150 to 155 people per square mile. The town lost about 410 people since 2000 and about 740 since 1990 when it was at its highest population of 7,841 (US Census Bureau).

Between 1980 and 2010, the median age of Great Barrington's population increased by over 10 years, from 34.8 to 45.5[4] Berkshire County's population is increasing in age overall, and Great Barrington at an even faster rate. Older residents are more vulnerable in hazardous conditions due to a number of factors including limited access to popular communication platforms, mobility handicaps, and fixed incomes that limit the capacity to recover. Figure 3.1 shows a rough distribution of population over 65 in the town.

Figure 3.1: Population Over 65



Great Barrington is proud to be somewhat more diverse than other towns in the county. Due to common undercounts of immigrated families, writers of the Master Plan went to the organization Multicultural BRIDGE for estimates. They estimate that the local Hispanic or Latino population was at about 12 percent in 2013. This significant population requires directed outreach in the planning process and when hazards impact the community. Great Barrington's diversity is in the Town's history as well. Writer and founder of the NAACP, W.E.B. Du Bois was raised in Great Barrington, and the places he influenced and influenced him are celebrated locally[5].

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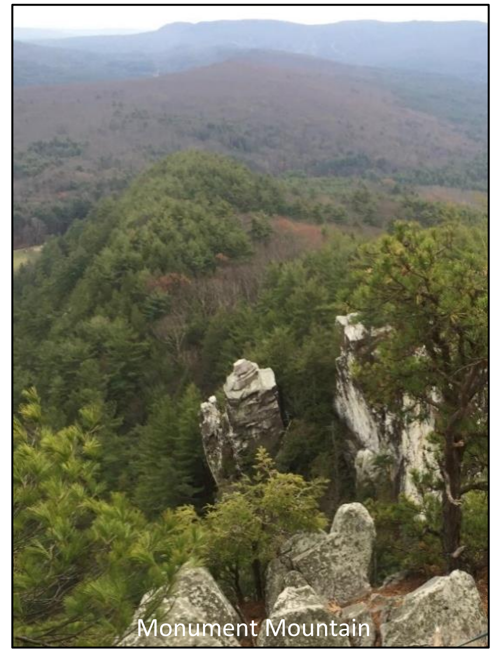
[4] Town of Great Barrington, MA Community Master Plan (2013).

[5] W.E.B. Du Bois National Historic Site. http://www.duboisnhs.org/index.html

Natural Environment

The natural environment provides benefits to a community that are not always quantifiable, many of which directly improve the resilience. Ecosystem benefits such as clean air, carbon sequestration, clean water, wildlife habitat, water retention, wind and heat mitigation, increased real estate value and mental health. The natural environment stands to be damaged by a disaster. Disruptions that allow for a forest to restart the succession process can be very beneficial to the ecosystem. However, the environment can be severely damaged by pollutant contamination or other impacts of human development. On the same note a community may want to replace or restore trees and other assets of the natural environment that are part of the built environment for their ecosystem benefits. Figure 3.2 shows areas of great environmental sensitivity and concern within Great Barrington.


Monument Mountain

Great Barrington is part of the Housatonic Watershed. The Housatonic transects the town and gives Great Barrington its character and historically fueled the economy. Due to multiple dams along the Housatonic in Great Barrington, the floodplain forests that once grew along the river have been altered by the drier conditions[6]. The predominant land uses in Great Barrington are forests (70.2%), agriculture (8.1%), residential (1.1 %) and commercial/industrial (0.5 %) 9.2% of the land is water or wetlands. (MassGIS, 2016). Figure 3.3 shows land use for Great Barrington.


Housatonic Flats

There are several smaller streams that feed into the Housatonic, including the Williams River, Green River, Long Pond Brook, Alford Brook, Seekonk Brook which are all on the west side of the Housatonic. On the east side, Konkapot Brook flows north into Stockbridge before it enters the Housatonic and includes the tributaries Stony Brook and Muddy Brook. The Thomas and Palmer Brook goes underground shortly before entering the Housatonic and the Roaring Brook enters Sheffield before it enters the Housatonic. The town also has several lakes and ponds, including Round Pond, Long Pond, Lake Mansfield, Fountain Pond, Benedict Pond, Barbieri Pond and Root Pond.

There are popular outdoor destinations in Great Barrington including Monument Mountain, managed by the Trustees, Fountain Pond State Park, and the Housatonic Flats managed by the Berkshire Natural Resources Council. These assets bring in tourists and bolster the economy for the region.

[6] https://www.mass.gov/files/documents/2016/08/qz/sbd-resourcemanagement.pdf

Figure 3.2: Environmental Concerns

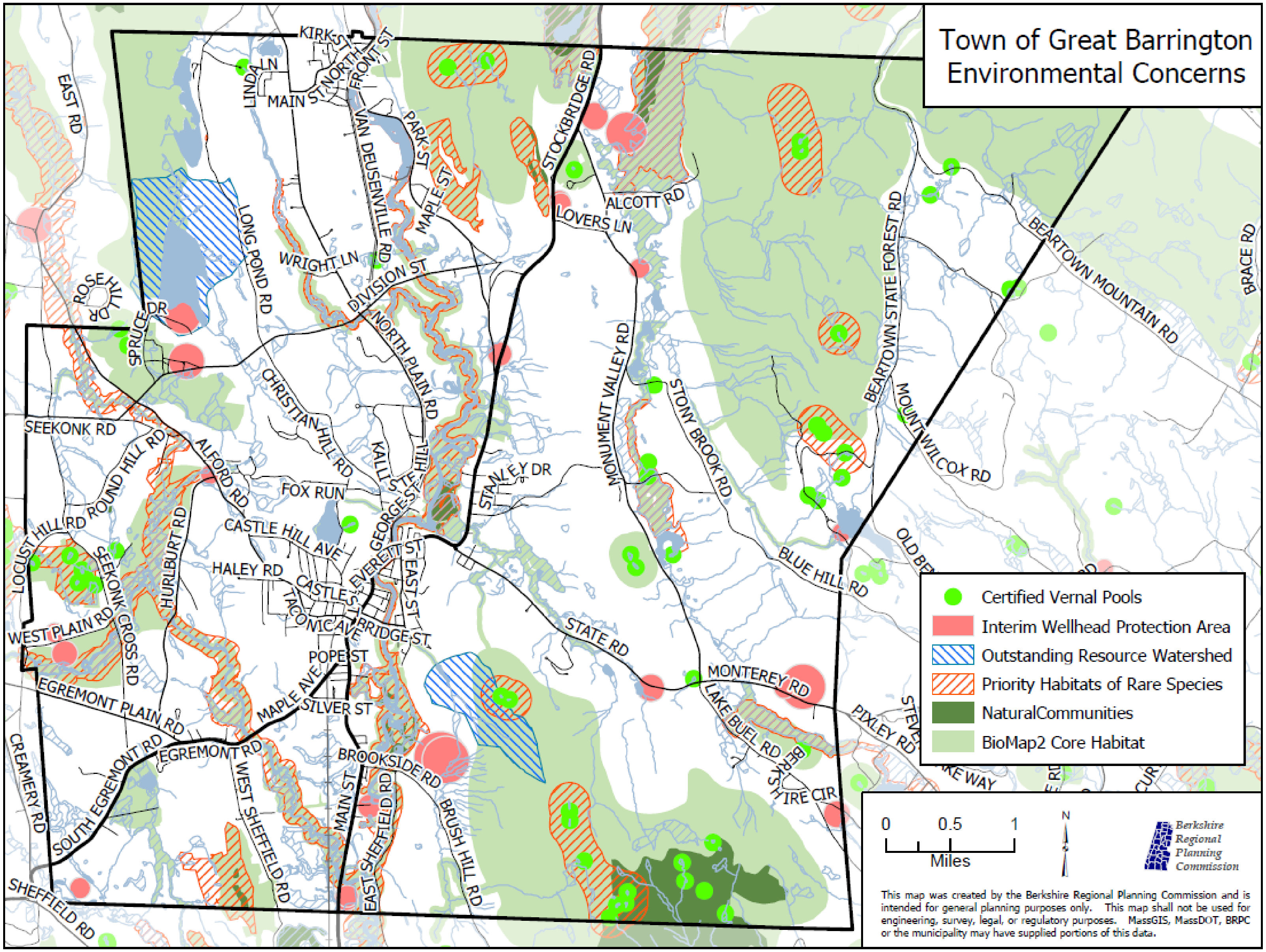
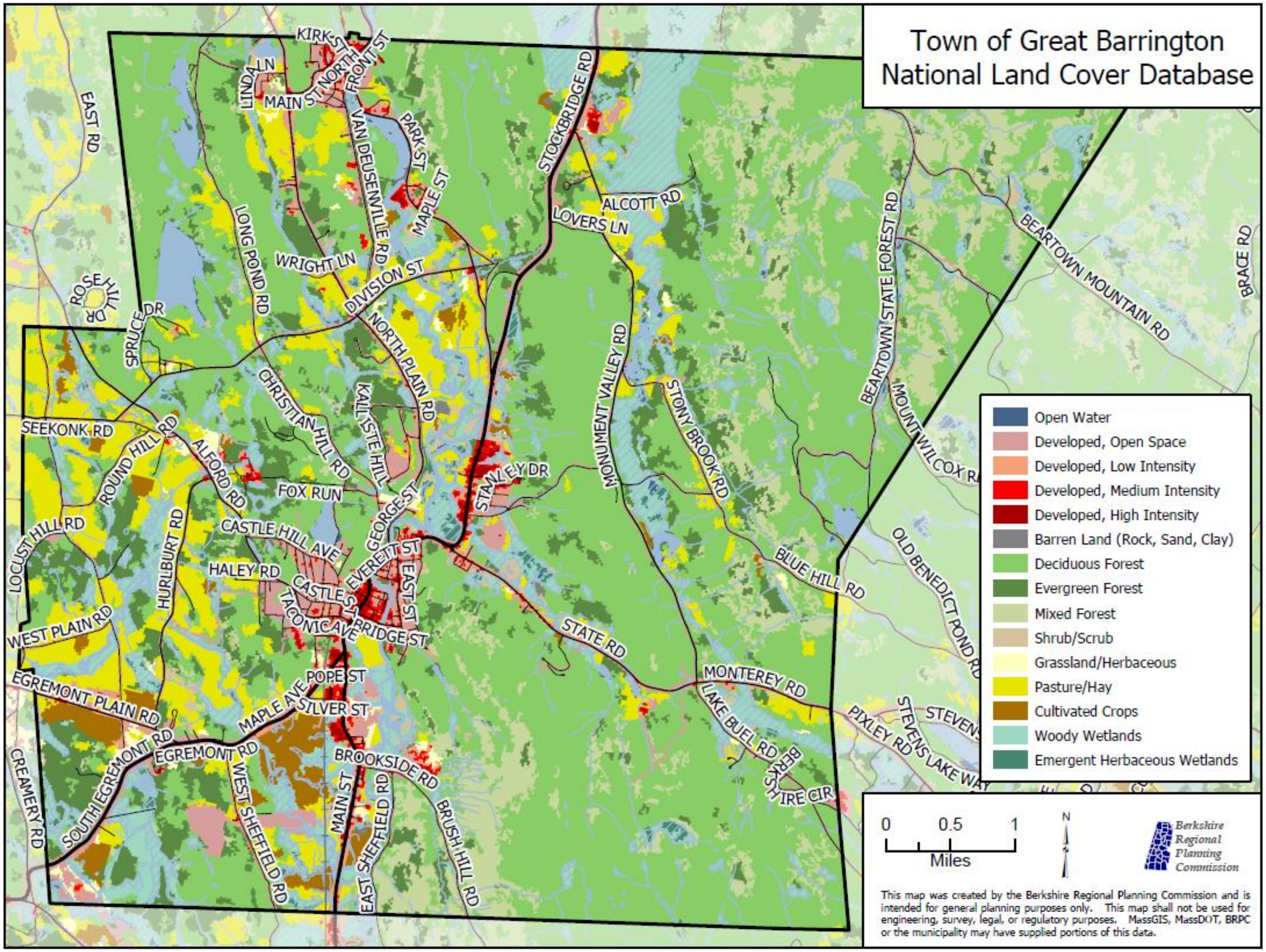


Figure 3.3: National Land Use Cover Data



Built Environment

The town belongs to the Berkshire Hills Regional School District. The elementary school (Muddy Brook), Middle (Monument Valley) and High (Monument Mountain) schools are all in Great Barrington.

Most housing units in Great Barrington are owner-occupied single-family homes, although more rental housing is now being built near downtown. There are still a significant number of multifamily homes and people living in group quarters, like nursing homes. According to the 2010 decennial census data there were 2,879 occupied housing units with a household size of 2.5 people per household (US Census Bureau). The 2018 estimated households in Great Barrington is 2,666 with a median value of $311,700, though homes are often far more expensive given demand from second home buyers.

Great Barrington has a thriving downtown that benefits from occupied storefronts and an economy bolstered by tourism. Development is concentrated along the Housatonic River as is the case for many old towns. Particularly old mill buildings have walls directly at the edge of the armored river.

The Land Use Vision Map (Figure 3.4) from Great Barrington's 2013 Community Master Plan shows areas already developed and proposed for development. 44 CFR § 201.6 (c)(2)(ii)(C) asks that vulnerability in the risk assessment be addressed in terms of land uses and development trends within the community so that mitigation options can be considered in future land use decisions. While population is decreasing in Great Barrington, development pressure still exists as new business ventures are pursued, and land is purchased to construct second homes. Areas such as the Barrington fairgrounds are poised for revitalization efforts, but community stakeholders are aware that this area is within the floodplain of the Housatonic River. A balance between economic development and preserving the benefits and services of the open floodplain must be struck.

Figure 3.4: Land Use Vision Map, 2013

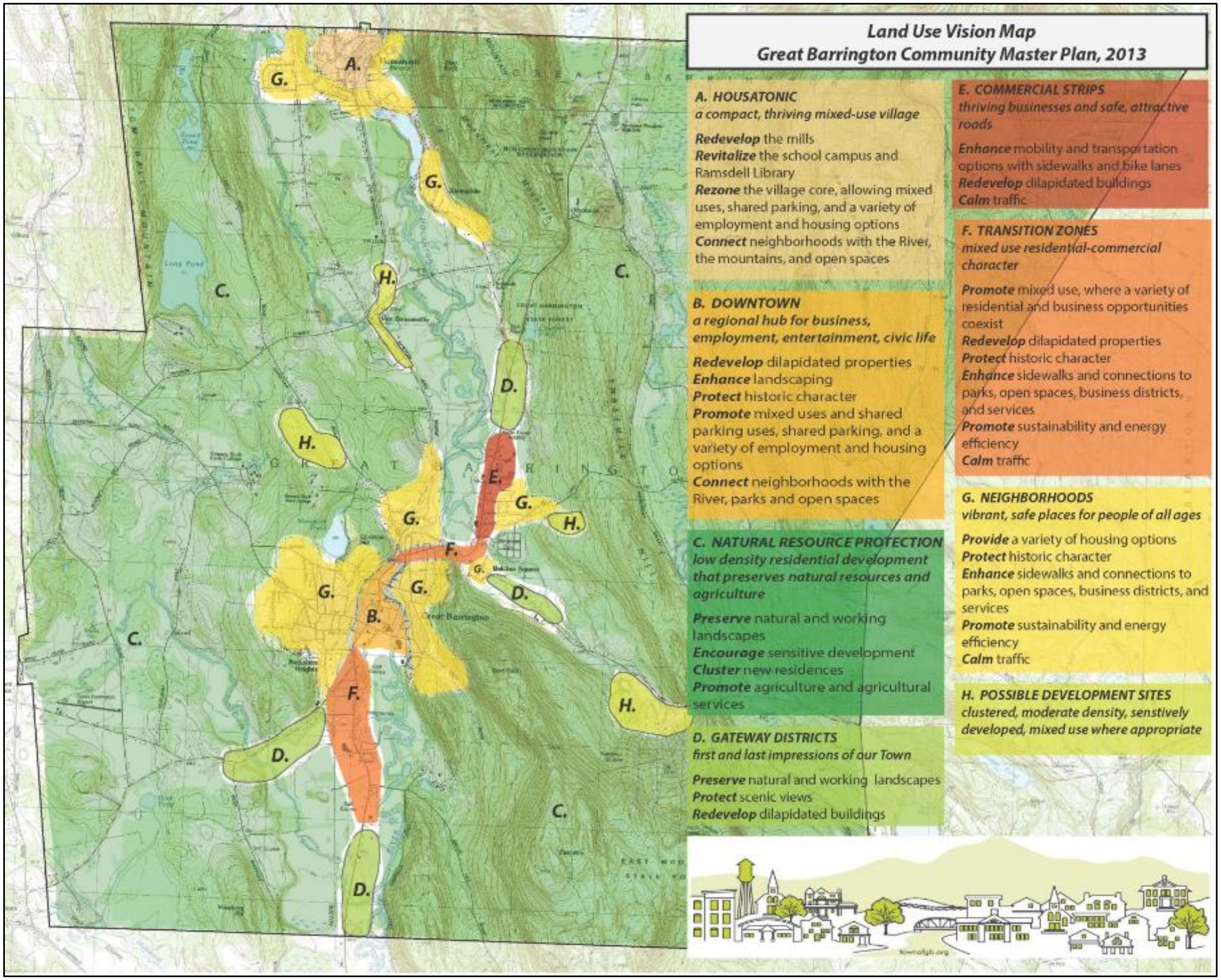
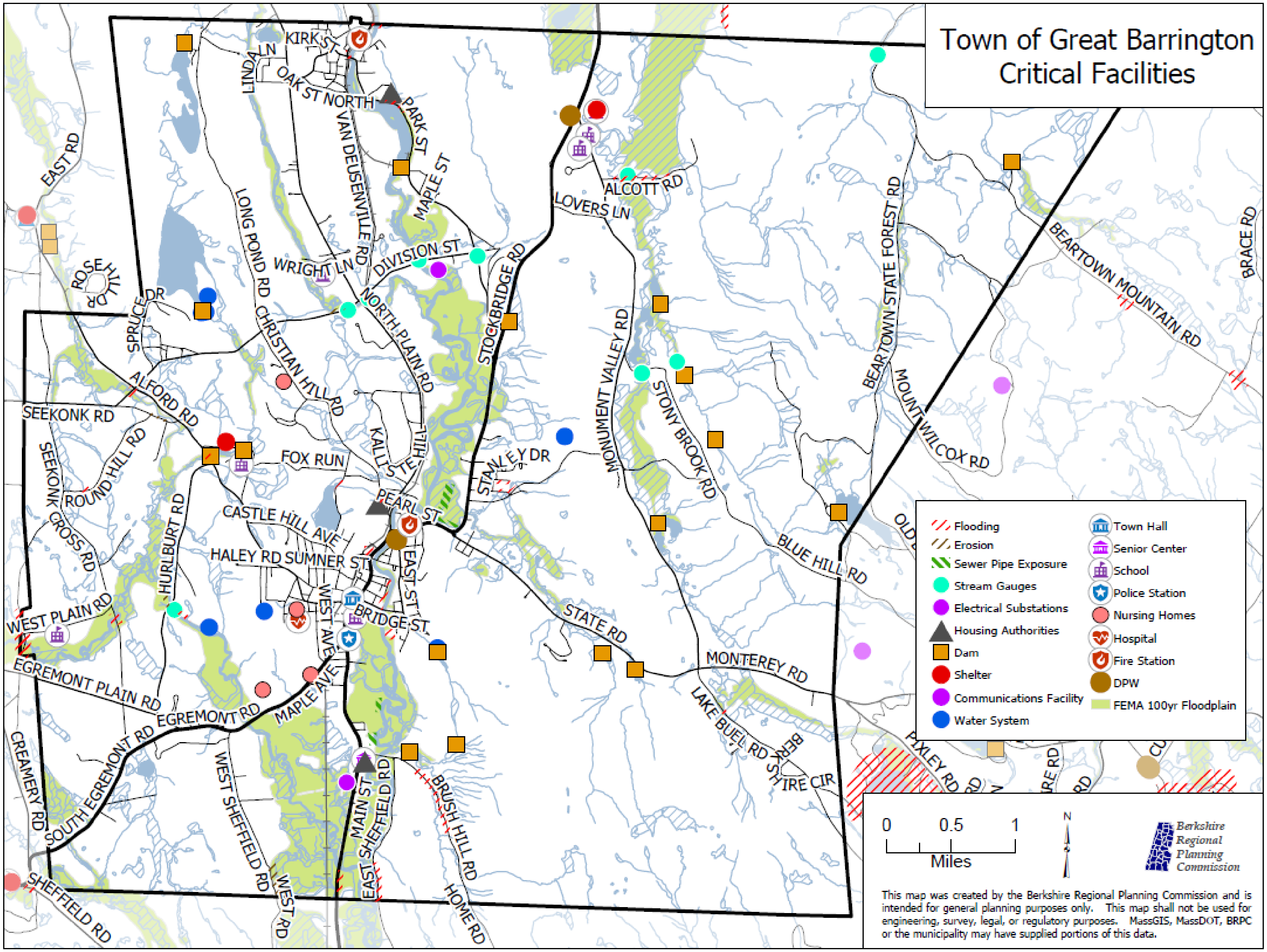


Figure 3.5: Critical Facilities and Areas of Concern



Critical facilities are the buildings and infrastructure hubs that are necessary for continued operation during a hazardous event. Table 3.1 shows Great Barrington's Critical Facilities and figure 3.5 provides a map of the critical facilities and areas of concern.

Table 3.1: Great Barrington Critical Facilities

Type	Name	Address
Police/EOC*	Great Barrington Police Department	465 Main Street
Fire/Alternate EOC*	Great Barrington Fire Department	37 State Road
	Housatonic Fire Department	172 Front Street
Health Services	Southern Berkshire Ambulance	31 Lewis Avenue
	Fairview Commons	151 Christian Hill Road
	Great Barrington Rehabilitation & Nursing Center	148 Maple Avenue
	Timberlyn Heights Nursing Home	320 Maple Avenue
	East Mountain Medical Association	780 Main Street Rte 7
	Fairview Hospital	29 Lewis Avenue
Municipal Facilities	Town Hall	334 Main Street
	DPW Highway Garage	14 East Street
Utilities	Wastewater Treatment Plant	100 Bentley Avenue
	Housatonic Water Works Treatment Plant	162 Division Street
	GB Fire District Water Plant and Pumping Station	95 Hurlburt Road
	Verizon Telephone Station	9 School Street
	Verizon Telephone Station	1058 Main Street, Housatonic
	National Grid Electrical Substation	39 Division Street
	National Grid Office/Yard	927 Main Street
	GB Water Storage Tank 1	Berkshire Heights Road
	GB Water Storage Tank 2	Blue Hill Road
Schools	Rudolf Steiner School	35 West Plain Road
	John Dewey Academy	389 Main Street
	Monument Valley Middle School	313 Monument Valley Road
	Muddy Brook Elementary School	318 Monument Valley Road
	Simon's Rock College	84 Alford Road
	Berkshire Community College	343 Main Street
Shelters	Monument Mountain Regional High School	600 Stockbridge Road
	Housatonic Community Center	1064 Main Street
	URJ Eisner Camp	53 Brookside Road

	Monument Mountain Regional High School	600 Stockbridge Road
Special Needs Facilities	Berkshire Meadows	249 North Plain Road
	Great Barrington Rehabilitation & Nursing Center	148 Maple Avenue
	Timberlyn Heights Nursing & Alzheimer Center	320 Maple Avenue
	Brookside Manor	909 Main Street
	Great Barrington Senior Center	917 South Main Street
	Fairview Commons	151 Christian Hill Road
	Fairview Hospital	29 Lewis Avenue
	Life Needs Co-op Inc.	202 North Plain Road
	Bostwick Gardens	899 Main Street
	Oakdale Foundation	14 Oak Street
	BCARC	395 South Street
	Hillcrest Educational Center	5 Ramsdell Road
	Simon's Rock College	84 Alford Road
	Berkshire Community College	343 Main Street
	Rudolf Steiner School	35 West Plain Road
	John Dewey Academy	389 Main Street
	URJ Eisner Camp	53 Brookside Road
	Beech Tree Commons	24 Silver Street
	Flag Rock Village	27 Bernard Gibbons Drive
	Berkshire South Regional Community Center	15 Crissey Road
	Monument Valley Middle School	313 Monument Valley Road
	Muddy Brook Elementary School	318 Monument Valley Road

*Emergency Operations Center

Economy

The vision of the Great Barrington Economic Development committee is to:

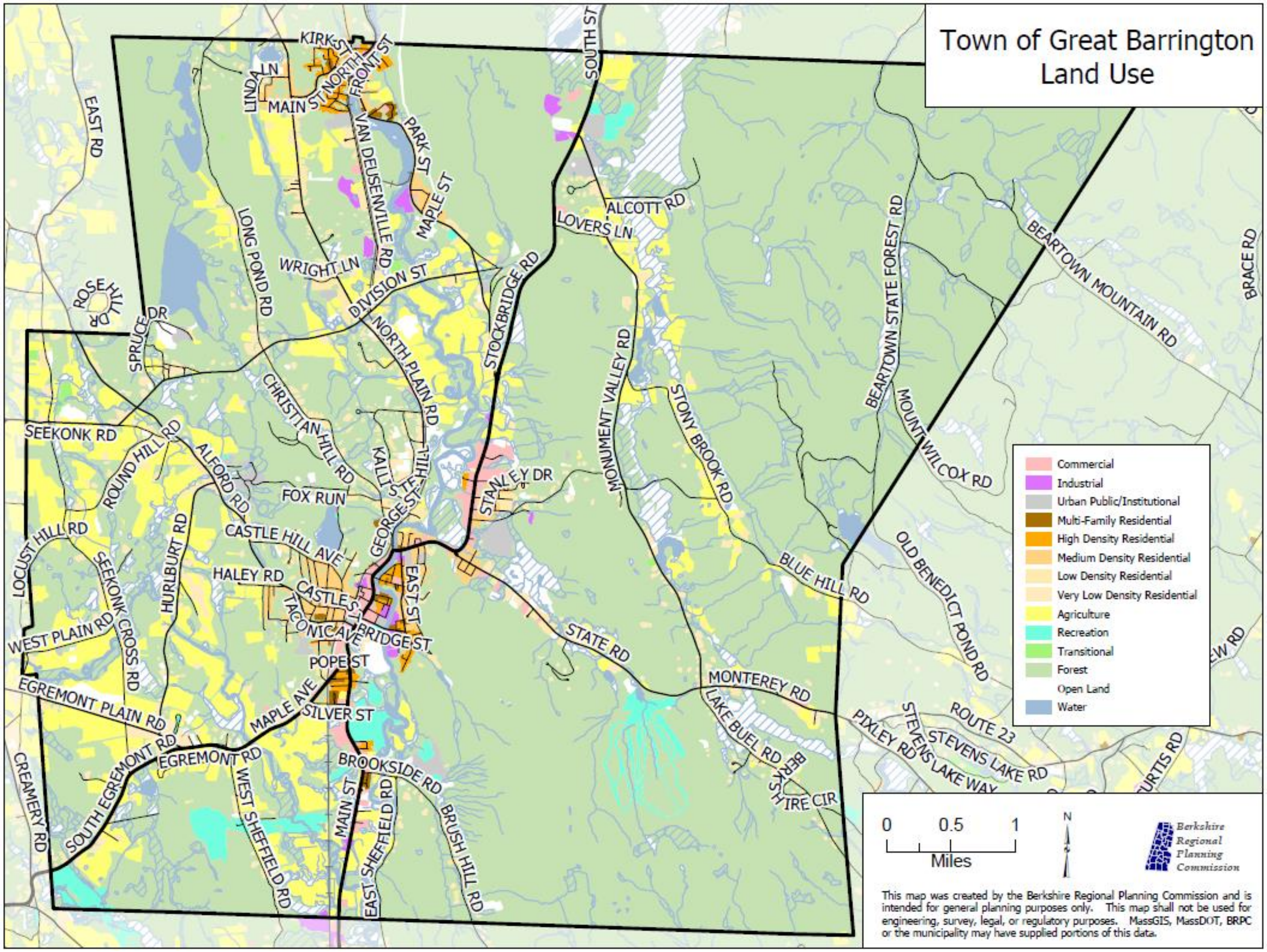
To nurture and enhance the economic well-being of the community through the promotion of a sustainable economy. To develop a resilient strategy for economic development that promotes economic health and vitality for all stakeholders in Great Barrington, one that is recognized for its quality of life, diverse entrepreneurial energy, and pride of place.

According to the U.S. Census Bureau, 2012 Economic Census: Survey of Business Owners, there were 1,703 firms in Great Barrington. Speaking to the diverity of the local economy, 220 of these were minority-owned firms, and 632 were women-owned firms.

The quality of life in Great Brrington is enhanced by the economic vitality of the town. Great Barrington serves the region with shopping, dining, and other needed or desired services people residents and visitors depend on. Great Barrington's attractiveness for tourists noteably boosts the local economy.

The centralized nature of Southern Berkshire's retail, restaurants, and service industry in Great Barrington warrants the need for action to ensure these assets are not vulnerable to the impacts of hazards. Great Barrington provides food, social cohesion, jobs and numerous other resources for the entire region.

Figure 3.6: Land Use



Inland Flooding

Hazard Profile

Flooding, particularly due to extreme precipitation, was identified as a top hazard by participants in the CRB workshop held as part of the MVP planning process. Inland flooding is the result of moderate precipitation over several days, intense precipitation over a short period, or melting snowpack (U.S. Climate Resilience Toolkit, 2017). Developed, impervious areas can contribute to inland flooding (U.S. Climate Resilience Toolkit, 2017). Common types of local or regional flooding are categorized as inland flooding including riverine, ground failures, ice jams, dam overtopping, beaver activity (tree removal, dam construction, and dam failure), levee failure, and drainage from impervious areas such as downtown.

Overbank flooding occurs when water in rivers and streams flows into the surrounding floodplain or into "any area of land susceptible to being inundated by floodwaters from any source." Flash floods are characterized by "rapid and extreme flow of high water into a normally dry area, or a rapid rise in a stream or creek above a predetermined flood level" (EOEEA & MEMA, 2018) The hazards that produce these flooding events in the region include hurricanes, tropical storms, heavy rain events, winter rain-on-snow, thunderstorms, and a recovering beaver population.

Likely severity

In general, the severity level of flood damage is affected by flood depth and flood velocity. The deeper and faster flood flows become, the more power they have and the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment[7]. However, flood damage to homes and buildings can occur even during shallow, low velocity flows that inundate the structure, its mechanical system and furnishings.

The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. The 100-year flood elevation or discharge of a stream or river has a 1% chance of occurring or being exceeded in any given year. In this case the statistical recurrence interval would be 100 years between the storm events that meet the 100-year discharge/flow. Such a storm, with a 1% chance of occurrence, is commonly called the 100-year storm. Similarly, the 50-year storm has

[7] https://www.mass.gov/files/documents/2017/01/mp/massachusetts-state-hazard-mitigation-plan.pdf

a statistical recurrence interval of 50 years and an “annual flood” is the greatest flood event expected to occur in a typical year. It should be understood, however, that these measurements reflect statistical averages only; it is possible for two or more floods with a 100-year flood discharge to occur in a short time period.

Severity is compounded by secondary impacts of flooding. Landslides on steep slopes can occur when soils are saturated and give way to sloughing, often dislodging trees and boulders that were bound by the soil. The damage from Hurricane Irene in 2011 to Route 2 in the Florida/ Charlemont area was a combination of fluvial erosion from the Cold and Deerfield Rivers and a landslide on the upland slope of the road.

Flood waters can increase the risk of the creation of and dislodging of ice dams during the winter months. Blocks of ice can develop in streams and rivers to create a physical barrier or dam that restricts flow, causing water to back up and overflow its banks. Large ice jam blocks that break away and flow downstream can damage culverts, bridges and roadways whose openings are too small to allow passage (MEMA, 2013).

Electrical power outages can occur during flood storm events, particularly when storm events are accompanied by high winds, such as during hurricanes, tropical storms, thunderstorms and micro-bursts. Fortunately, most flooding in the Berkshire region is localized and have resulted in few widespread outages in recent years, and where it occurs service has typically been restored within a few hours.

Probability

The extent of the area of flooding associated with a 1% annual probability of occurrence (the base flood or 100-year flood), most commonly termed the 100-year floodplain area, is a tool for assessing vulnerability and risk in flood-prone communities. The 100-year flood boundary is used as the regulatory boundary by many agencies, including FEMA and MEMA. It is also the boundary used for most municipalities when regulating development within flood-prone areas. The FEMA Flood Insurance Rate Maps (FIRM) developed in the early 1980s for Berkshire County, typically serve as the regulatory boundaries for the National Flood Insurance Program (NFIP) and municipal floodplain zoning. A structure located within a the 100-year floodplain on the NFIP maps has on average a 26% percent chance of suffering flood damage during the term of a 30-year mortgage (MEMA, 2013). Increases in precipitation and extreme storm events will result in increased inland flooding.

Table 3.2: Recurrence Intervals and Probabilities of Occurances

Recurrence interval	Probability of	Percent chance
500	1 in 500	0.2
100	1 in 100	1
50	1 in 50	2
25	1 in 25	4
10	1 in 10	10
5	1 in 5	20
2	1 in 2	50

Due to high slopes and minimal soil cover, Western Massachusetts is particularly susceptible to flash flooding caused by rapid runoff that occurs during heavy precipitation in combination with spring snowmelt. These conditions contribute to riverine flooding. Frozen ground conditions can also contribute to low rainfall infiltration and high runoff events that may result in riverine flooding (MEMA, 2018). Berkshire County has frozen ground conditions for more of the year than most of Massachusetts. There is a 90% likelihood that the temperature will reach 28° by October 22nd, with the potential ground freezing conditions lasting until May 20th of the following year (NOAA, 1988 as cited by UMASS Extension accessed on March 12th, 2019).

Geographic areas likely impacted

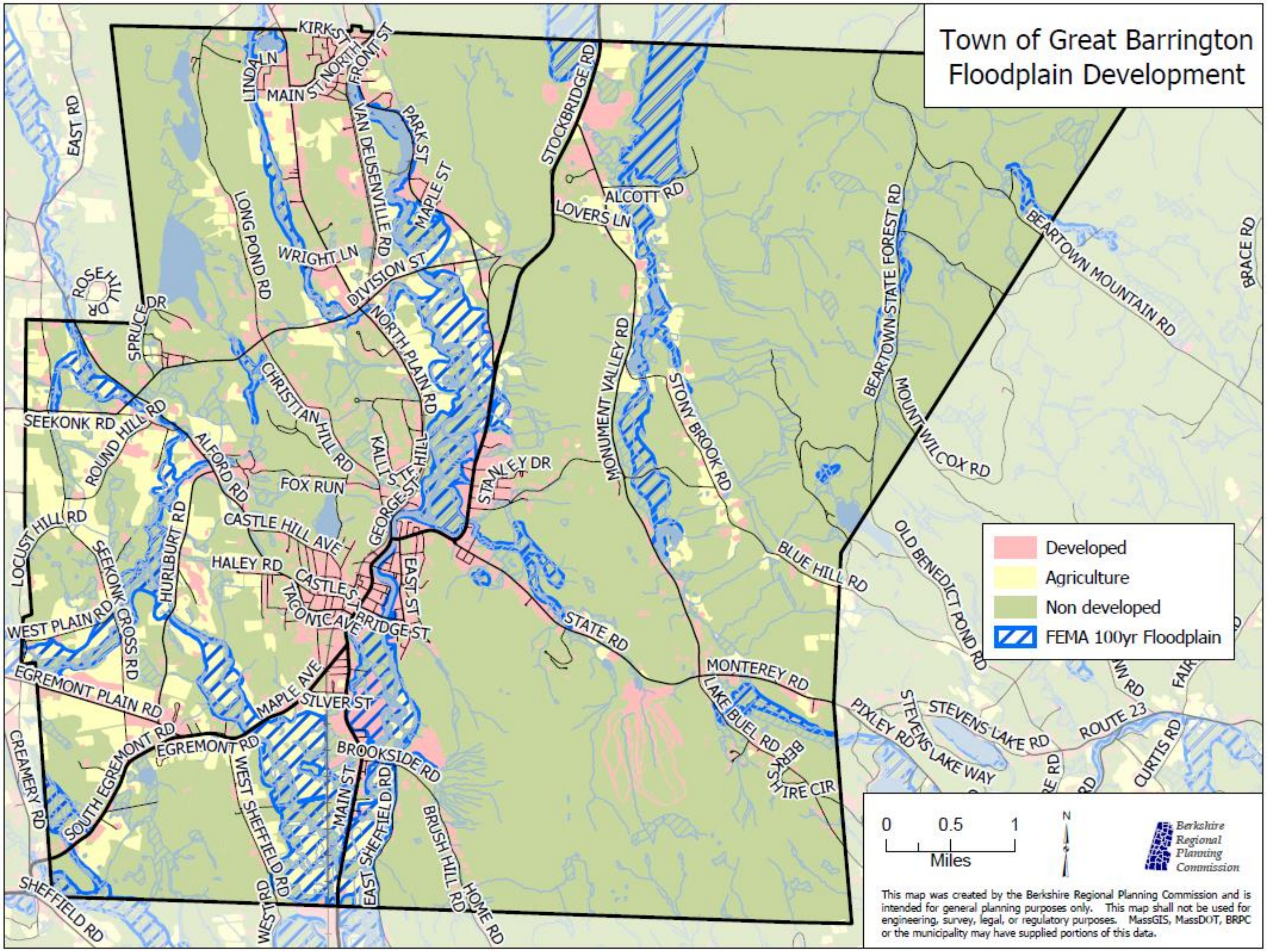
In the Berkshire region rivers and streams tend to be dynamic systems, with stream channel and bank erosion common in both headwater streams and in the level, meandering floodplains of the Housatonic and Hoosic Rivers. Fluvial Erosion is the process where the river undercuts a bank, usually on the outside bend of a meander, causing sloughing and collapse of the riverbank. Fluvial erosion of stream and riverbanks can creep towards the built environment and threaten to undercut and wash away buildings, roads, and bridges. Many roads throughout the region follow streams and rivers, having been laid in the floodplain or carved along the slopes above the bank. Older homes, barns and other structures were also built in floodplain or just upgradient of stream channels in both rural and urban areas. Fluvial erosion can also scour and down cut stream and river channels, threatening bridge pilings and abutments. This type of erosion often occurs in areas that are not part of a designated floodplain (MEMA, 2013).

In Great Barrington, there is regular flooding of Seekonk Cross Road along the Green River. Regular flooding alos occurs on Route 7 south of downtown Great Barrington near the Housatonic River. The Seekonk Brook has caused problematic erosion on Seekonk Road between Round Hill Road and Alford Road. A retaining wall was recently rebuilt, but there is some concern it could fail again. Erosion is also an issue identified for Division Street along the Willliams River, however this erosion has not yet been addressed.

Great Barrington has 3,095.44 acres in the 100-year floodplain. Approximately 38.7 acres are developed in the floodplain, with another 145.6 acres developed open space, likely lawns, in the floodplain as well.

Figure 3.7 shows the areas developed along with the floodplain in Great Barrington. The FIRMs for Great Barrington have not been updated since the 1982 maps were adopted. The Town should assume that these nearly 40-year-old maps are outdated and in a likelihood the floodplain is more substantial than as shown. The floodplain is indicated throughout the Town, though concentrated along with development and the Housatonic, Williams, and Green Rivers, and brooks Hubbard and Konkapot. Great Barrington enforces a floodplain bylaw, protecting zones A and A1-30 as shown on the FIRM, which reduces the level of damage that would occur in a flood event by managing development in the floodplain.

Figure 3.7: Town of Great Barrington Floodplain (FEMA 100 year floodplain FIRM data)



Historic Data

Between 1936 and 2019, four flood events equaling or exceeding the 1% annual chance flood have been documented the Berkshire County region: 1938, 1949, 1955 and 2011. Refer to Table 3.3. for a list of flood events impacting the region

Table 3.3. Previous Flooding Occurrences in the Berkshire County Region

Year	Description of Event
1936	Widespread flooding occurs along the northern Atlantic in March 1936. Widespread loss of life and infrastructure. Many flood stages are discharges highest of record at many USGS stream gages, including Coltsville in Pittsfield.[8]
1938	Large rainstorm hit the area. This storm was considered a 1% annual chance flood event in several communities and a .2% annual chance flood event in Cheshire. The Hoosic River flooded downtown areas of densely developed Adams and North Adams, with loss of life and extensive damage to buildings. Other communities were not as severely impacted by it.
December 31, 1948 - January 1, 1949	The New Year's Flood hit our region with many of our areas registering the flood as a 1% annual chance flood event.
1955	Hurricanes Connie and Diane combined to flood many of the communities in the region and registering in 1% -0.2% annual chance flood event (100-500-year flood event) (FEMA 1977-1991).
May 1984	A multi-day storm left up to 9" of rain throughout the region and 20" of rain in localized areas. This was reported as an 80-year flood for most of the area and higher where the rainfall was greater (USGS, 1989).
September 1999	The remnants from Hurricane Floyd brought over between 2.5-5" of rain throughout the region and produced significant flooding throughout the region. Due to the significant amount of rain and the accompanying wind, there were numerous reports of trees down.
December 2000	A complex storm system brought 2-4" of rain with some areas receiving an inch an hour. The region had numerous reports of flooding.
March 2003	An area of low pressure brought 1-2" of rain, however this and the unseasonable temperatures caused a rapid melting of the snow pack.
August 2003	Isolated thunderstorms developed that were slow moving and prolific rainmakers. These brought flooding to the area and caused the evacuation of the residents of the trailer park along Wahconah Falls Road in neighboring Dalton.
September 2004	The remnants from Hurricane Ivan brought 3-6" of rain. This, combined with saturated soils from previous storms, caused flooding throughout the region.
October 2005	A stationary cold front brought over 6" of rain and caused widespread flooding throughout the region.

[8] Grover, Nathan C., 1937. *The Floods of March 1936, Part 1. New England Rivers*. USGS, Wash. DC.

November 2005	Widespread rainfall across the region of 1-1.5”, which was preceded by 1-2 feet of snow, resulted in widespread minor flooding.
September 2007	Moderate to heavy rainfall occurred, which lead to localized flooding.
March 2008	Heavy rainfall ranging from 1-3” impact the area. Combined with frozen ground and snowmelt, this led to flooding across the region.
August 2008	A storm brought very heavy rainfall and resulted in flash flooding across parts of the region.
December 2008	A storm brought 1-4” of rain to the region, with some areas reporting ¼ to 1/3 of an inch an hour of freezing rain., before changing to snow. Moderate flooding and ponding occurred throughout the region.
June 2009	Numerous slow-moving thunderstorms developed across the region, bringing very intense rainfalls and upwards of 6” of hail. This led to flash flooding in the region.
July 2009	Thunderstorms across the region caused heavy rainfall and flash flooding.
August 2009	An upper level disturbance moved across the region during the afternoon hours and triggered isolated thunderstorms which resulted in roads flooding.
October 2009	A low-pressure system moved across region bringing a widespread heavy rainfall to the area; 2-3” of rain was reported across the region.
March 2010	A storm brought heavy rainfall of 1.5-3” across the region, with roads closed due to flooding.
October 2010	The remnants from Tropical Storm Nicole brought 50-60 mph winds and 4-6” of rain resulting in urban flooding.
March 2011	Heavy rainfall, combined with runoff from snowmelt due to mild temperatures, resulted in flooding of rivers, streams, creeks, roads, and basements.
July 2011	Scattered strong to severe thunderstorms spread across the region resulting in small stream and urban flooding.
August 2011	Two distinct rounds of thunderstorms occurred producing heavy rainfall and localized flooding of roads.
August 2011	Tropical Storm Irene tracked over the region bringing widespread flooding and damaging winds. Riverine and flash flooding resulted from an average of 3-6 inches of rain and upwards of 9”, within a 12-hour period. Widespread road closures occurred throughout the region. In Williamstown this event was a 1% annual chance flood event.
September 2011	Remnants of Tropical Storm Lee brought 4-9” of heavy rainfall to the region. Due to the saturated soils from Tropical Storm Irene, this rainfall lead to widespread minor to moderate flooding on rivers as well as small streams and creeks.
August 2012	Remnants from Hurricane Sandy brought thunderstorms developed repeatedly bringing heavy rains over areas of the region. Upwards of 4-5” of rain occurred and flash flooding caused the closure of numerous roads.
May 2013	Thunderstorms brought wind and heavy rainfall caused flash flooding and road closures in areas.
August 2013	Heavy rainfall repeatedly moved across the region causing more than 3 inches of rain in just a few hours resulting in streams and creeks to overflow their banks and resulting in flash flooding. Roads were closed because of the flooding and water rushed into some basements.
September 2013	Showers and thunderstorms tracked over the same locations and resulted in persistent heavy rain, flash flooding and road closures.

June 2014	Slow moving showers and thunderstorms developed producing very heavy rain over a short period of time. This led to some flash flooding and road closers, especially in urban and poor drainage areas.
June 2014	Showers and thunderstorms repeatedly passed over the same locations, leading to heavy rainfall and significant runoff, which caused flash flooding in some areas. Many roads were closed due to the flooding and some homes were affected by water as well.
July 2014	A cluster of strong to severe thunderstorms broke out causing heavy rainfall and flash flooding with 3-6" of rainfall occurring.
May 2016	Bands of slow-moving showers and thunderstorms broke out over the region. Due to the slow movement of these thunderstorms, heavy rainfall repeatedly fell over the area resulting in flash flooding and some roads were temporarily closed.
August 2017	Widespread rain moved through the area resulting in isolated flash flooding.
August 2017	Severe thunderstorms developed resulting in flash flooding.

Source: BRPC 2018 (unless otherwise noted)
***Bolded** events are in the top 15 events that caused the Housatonic River to flow above flood stage at the Coltsville USGS gage (5')*

Vulnerability Assessment

People

The impact of flooding on life, health, and safety is dependent upon several factors, including the severity of the event and whether adequate warning time is provided to residents. Populations living in or near floodplain areas may be impacted during a flood event. People may also be impacted when transportation infrastructure is compromised from flooding.

Of the population exposed, the most vulnerable include people with low socioeconomic status, people over the age of 65, young children, people with medical needs, and those with low English language fluency. For example, people with low socioeconomic status are more vulnerable because they are likely to consider the economic impacts of evacuation when deciding whether to evacuate. The population over the age of 65 is also more vulnerable because some of these individuals are more likely to seek or need medical attention because they may have more difficulty evacuating or the medical facility may be flooded. Those who have low English language fluency may not receive or understand the warnings to evacuate. Vulnerable populations may also be less likely to have adequate resources to recover from the loss of their homes and jobs.

In Great Barrington, the Claire Teague Senior Center and senior housing adjacent to Claire Teague is not in the floodplain identified by the effective FIRMs, however, it is very close to the floodplain and historical images of the river suggest the river is currently shifting its position –

something that may continue to become more pronounced in the years ahead. The Town will continue to monitor river movement to ensure the safety of residents.

The total number of injuries and casualties resulting from typical riverine flooding is generally limited due to advance weather forecasting, blockades, and warnings. The historical record from 1993 to 2017 indicates that there have been two fatalities associated with flooding (occurring in May 2006) and five injuries associated with two flood events (occurring within 2weeks of each other in March 2010). However, flooding can result in direct mortality to individuals in the flood zone. This hazard is particularly dangerous because even a relatively low-level flood can be more hazardous than many residents realize. For example, while 6 inches of moving water can cause adults to fall, 1 foot to 2 feet of water can sweep cars away. Downed powerlines, sharp objects in the water, or fast-moving debris that may be moving in or near the water all present an immediate danger to individuals in the flood zone. Events that cause loss of electricity and flooding in basements, which are where heating systems are typically located in Massachusetts homes, increase the risk of carbon monoxide poisoning. Carbon monoxide results from improper location and operation of cooking and heating devices (grills, stoves), damaged chimneys, or generators.

According to the U.S. Environmental Protection Agency (EPA), floodwater often contains a wide range of infectious organisms from raw sewage. These organisms include intestinal bacteria, MRSA (methicillin-resistant staphylococcus aureus), strains of hepatitis, and agents of typhoid, paratyphoid, and tetanus (OSHA, 2005). Floodwaters may also contain agricultural or industrial chemicals and hazardous materials swept away from containment areas. Individuals who evacuate and move to crowded shelters to escape the storm may face the additional risk of contagious disease; however, seeking shelter from storm events when advised is considered far safer than remaining in threatened areas. Individuals with pre-existing health conditions are also at risk if flood events (or related evacuations) render them unable to access medical support. Flooded streets and roadblocks can also make it difficult for emergency vehicles to respond to calls for service, particularly in rural areas. Flood events can also have significant impacts after the initial event has passed. For example, flooded areas that do not drain properly can become breeding grounds for mosquitos, which can transmit vector-borne diseases. Exposure to mosquitos may also increase if individuals are outside of their homes for longer than usual as a result of power outages or other flood-related conditions.

Finally, the growth of mold inside buildings is often widespread after a flood. Investigations following Hurricane Katrina and Superstorm Sandy found mold in the walls of many water-damaged homes and buildings. Mold can result in allergic reactions and can exacerbate existing respiratory diseases, including asthma (CDC, 2004). Property damage and displacement of homes and businesses can lead to loss of livelihood and long-term mental stress for those facing relocation. Individuals may develop post-traumatic stress, anxiety, and depression following major flooding events (Neria et al., 2008 as cited in MEMA & EOEEA, 2018)

Built Environment

Dam failures, which are defined as uncontrolled releases of impounded water due to structural deficiencies in the dam, can occur due to heavy rain events and/or unusually high runoff events (MEMA, 2013). Severe flooding can threaten the functionality or structural integrity of dams.

Lake Mansfield Road acts as a dam for Lake Mansfield. If the road fails, Lake Mansfield could partially drain and cause flooding downstream. Great Barrington currently has a plan in place to address this vulnerability in place, however funding is needed for implementation.

The Green River crosses under Seekonk Cross Road and periodically experiences problems. The road will occasionally wash out and cause some localized flooding. This area also periodically floods due to ice jams, as was the case during the December 2008 ice storm.

Another area where flooding was pointed out is off Main Street around the Cumberland Farms store where there is a small drainage pond. This pond periodically floods in the winter and impacts the local businesses as the water often reaches Main Street. The Great Barrington DPW regularly responds to water running down from the railroad and backing up at the parking lot culvert. Water backing up in Egremont is also a concern at the bridge on Pumpkin Hollow Road where crossed by the Green River. This bridge was elevated prior to the 2012 Hazard Mitigation Plan, but the concern for a high intensity storm remained. Some work has also been done to address the stormwater outlets under Great Barrington's mill buildings. The Town found that there are several stormwater outlets that cross under mill buildings. These buildings periodically have basement flooding. The town has conducted a stormwater master plan for the Housatonic Village area and the Castle Hill drainage area which has identified the problem areas.

The Housatonic Railroad cuts through Great Barrington carrying freight and connecting CSX owned lines. Historically also carrying passengers, work is underway to revive the passenger use of this line in the near future. Of note, the railroad track traverse areas deep within the mapped floodplain, particularly between West Sheffield Road and Main Street just south of downtown Great Barrington.

Flood event often cause damage to wastewater treatment plants because of their position along waterways. Great Barrington's plant rests on the edge of the Housatonic River, though outside of the 100-year floodplain according to the effective FIRMs. Inundation of the treatment tanks or shutdown of the treatment system can pose health hazards that should be planned for. Septic systems can also flood, contaminating the surrounding areas, posing health risks, and damaging the environment. A common effect of septic overflows due to flooding is nutrient overloads in nearby bodies of water that can kill native wildlife and vegetation.

Flooding of homes and businesses can impact human safety health if the area of inundation is not properly dried and restored. Wood framing can rot if not properly dried, compromising building structure and strength. Undetected populations of mold can establish and proliferate in carpets, duct work, wall board and almost any surface that is not properly dried and cleaned. Repeated inundation brings increased risks of both structural damage and mold. Vulnerable populations, such as those whose immune systems are compromised by chronic illness or asthma, are at higher risk of illness due to mold.

The effective FIRMs for Great Barrington are from 1982 and out of date. Determining the number of buildings in the floodplain by overlaying the FIRM data and building footprints for Great Barrington with GIS applications will produce a conservative estimate. According to the analysis performed, there are an approximate 44 residential buildings in floodplain in Great Barrington, along with 4 mixed use buildings, 26 commercial buildings, and 8 industrial buildings. Table 3.4 summaries the number and types of buildings in the floodplain according to Effective FIRMs, as well as the potential value of the building and building contents lost in a flood event. Value of contents for residential buildings is 50% of property value, mixed use is 75% of property value, commercial is 100% of property value, and industrial is 125% of property value.

Table 3.4: Value of Buildings in the Floodplain as Indicated by the Effective FIRMs

Type	Total Buildings	Buildings in the Floodplain	Value of Building & Contents in the Floodplain
Residential	2715	44	$16,050,150
Mixed Use	83	4	$2,763,075
Commercial	450	26	$140,037,600
Industrial	19	8	$9,618,975
Total	**3267**	**82**	**$168,469,800**

The Town of Great Barrington is a National Flood Insurance Program (NFIP) community. 44 CFR § 201.6(c)(2)(ii) requires all plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods. Community Information System (CIS) from 2020 show that there are four properties in Great Barrington with repetitive flood loss claims. Total payments for buildings equaled $120,938.00 and building contents were worth $51,552.00 in payments.

The Town of Great Barrington requested data on repetitive loss data in 2020. There were three reported repetitive flood loss properties, all of which were commercial. According to the 2009 data utilized for the 2012 hazard mitigation plan, there was a total of 33 policies in force in Great Barrington with a total of 46 claims paid equaling $244,354.00.

Natural Environment

Flooding has the potential to affect the natural environment in several ways. Flooding can spread contamination potentially harmful to people, the environment, and wildlife. Flooding can remove trees, other vegetation, rocks and soil causing erosion, high turbidity and the loss of community assets. Additionally, flooding can spread invasive species that damages forest health so both native species and logging viability. Invasive Species will be discussed further in the Risk Assessment and Invasive Species Hazard Profile.

Economy

In addition to the value of buildings potentially lost during a flood event, there may be economic loss due to an inability to commute to work or communicate. There will potentially be a loss of Farms crops and livestock or forest products that provide revenue for local businesses. There are several businesses in the floodplain according effective FIRMS. These businesses may or may not be able to come back after flood loss. Their resilience depends on insurance coverage, maintaining customer loyalty during recovery, level of loss, and many other factors.

Future Conditions

Based on data gathered from the Northeast Climate Science Center (NECSC), the yearly precipitation total for Berkshire County has been experiencing a gradual rise over the last 70 years, rising from 40.1 inches in the 1960's to 48.6 inches in the 2000's. According to projections from the NECSC, the county is projected to experience an additional 3.55 inches by the 2050's and 4.72 inches by the 2090's. (Northeast Climate Science Center, 2018)

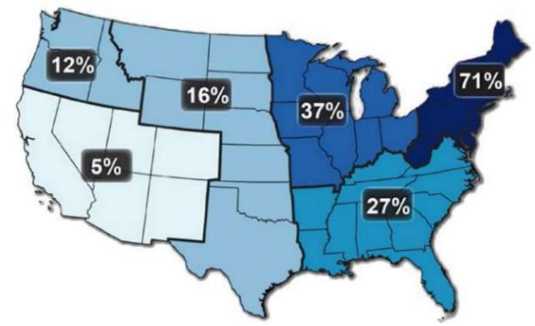
The scientific community agrees that climate change is altering the weather and precipitation patterns of the northeastern region of the U.S. The Intergovernmental Panel on Climate Change report of 2007 predicts temperature increases ranging from 2.5-5.0° C (36-41° F) over the next 100 years across the U.S., with the greatest increase in the northern states and during the winter months. More mid-winter cold/thaw weather patterns events could increase the risk of ice jams. Many studies agree that warmer late winter temperatures will result in more rain-on-snow storm events, leading to higher spring melt flows, which typically are already the highest flows of the year.

Studies have also reported increases in precipitation in both developed and undeveloped watersheds across the northeast, with the increases being observed over a range of precipitation intensities, particularly in categories characterized as heavy and extreme storm events. These events are expected to increase both in number and in magnitude. Some scientists predict that the recurrence interval for extreme storm and flood events will be significantly reduced. One study concluded that the 10-year storm may more realistically have a recurrence interval of 6 years, a 25-year storm may have a recurrence interval of 14 years and the 100-year storm may have a recurrence interval of 49-years. The same study predicts that if historic trends continue that flood magnitudes will increase, on average, by almost 17%. (Walter & Vogel, 2010)

Data from at USGS streamflow gages across the northeast show a clear increase in flow since 1940, with an indication that a sharp "stepped" increase occurred in the 1970s. This is despite the fact that much of the land within many New England watershed has been reforested, and this type of land cover change would tend to reduce, rather than increase, flood peaks (Collins, 2008).

Climate change will likely alter how the region receives its precipitation, with an increase of it falling in the form of severe or heavy events. The observed amount of precipitation falling in very heavy events, defined as the heaviest one percent of all daily events, has increased 71% in the Northeast between 1958-2012.[9]

Figure 3.8 Increase in Precipitation Falling in Top 1% Extreme Precipitation Events 1958-2012

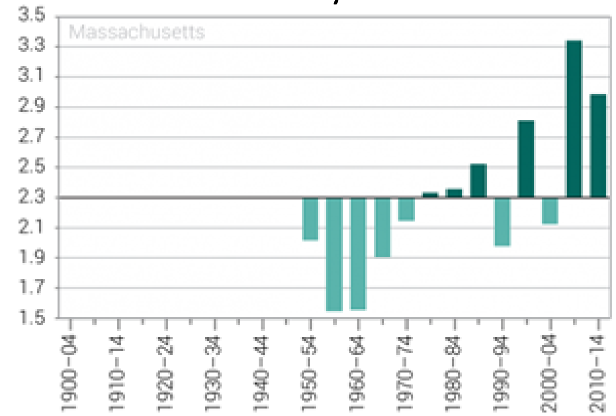


Source: NOAA, adapted from Karl, et al, 2009

[9] *NOAA - https://toolkit.climate.gov/image/762, adapted from Karl et al.*

The NECSC also predicts that the Northeast will see an increase in the number of days with at least 1 inch of precipitation from 4.5 days in the 1960s, to 5.1 days in the 2000s to 6.6 days in 2050s and 7.1 days in 2090s. (Northeast Climate Science Center, 2018) Days with precipitation of more than 1 inch in the Hoosic River Watershed, as predicted in the Massachusetts Climate Change Projections report, is predicted to increase from the baseline of 5.9 days per year to 6.4 to 8.3 days by the 2050s, and to 6.5 to 9.4 days by the 2090s. The baseline reflects precipitation data 1971-2000. The upper scenario represents a 41% increase in these storms from the baseline by mid-century and a 60% increase by end of century. Summer is currently season when there is the greatest chance for extreme precipitation events to occur, and summer is projected to continue to be the season of greatest chance and the season with the greatest increases in the number of days with extreme precipitation.

Figure 3.9: Number of Extreme Precipitation Events of 2" or more in 1 Day



Source: https://statesummaries.ncics.org/ma

Already observed in Massachusetts, the number of extreme precipitation events, those defined as more than two inches in one day, has increased since the the 1980s, with the greastest increase in the past decade (see Fig. 3.9)[10].

This trend has direct implications on the design of municipal infrastructure that can withstand extreme storm and flood events, indicating that all future designs must be based on them most updated precipitation and stream gauge information available.

It may be prudent, therefore, to slightly overdesign the size of new stormwater management and flood control systems so that they have the capacity to accept the increase in flow or volume without failing. For many piped systems, such as culverts, drainage ditches and swales, the slight increase in size may provide a large increase in capacity, and for very little increase in cost. If space is available, an increase in the capacity of retention/detention ponds may also be cost effective. Bioretention cells can be engineered so that they can increase their holding capacity for extreme storm events with little incremental cost. The size of the engineered soil media, which is a costly component of the system, may remain the same size as current designs call for, but a surface ponding area surrounding the central soil media is increased to serve as a holding pond.

[10] *https://statesummaries.ncics.org/ma*

Severe Winter Storms

Hazard Profile

Severe winter storms in Great Barrington typically include heavy snow, blizzards, nor'easters, and ice storms. A blizzard is a winter snowstorm with sustained or frequent wind gusts to 35 mph or more, accompanied by falling or blowing snow reducing visibility to or below a quarter-mile. These conditions must be the predominant condition over a three-hour period. Extremely cold temperatures are often associated with blizzard conditions, but are not a formal part of this definition. However, the hazard created by the combination of snow, wind, and low visibility increases significantly with temperatures below 20ºF. 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 (MEMA, 2013).

A Nor'easter is typically a large counterclockwise wind circulation around a low-pressure center often resulting in heavy snow, high winds, and rain. Strong areas of low pressure often form off the southern east coast of the U.S, moving northward with heavy moisture and colliding with cooler winter inland temperatures. Sustained wind speeds of 20-40 mph are common during a nor'easter, with short-term wind speeds gusting up to 50-60 mph or even to hurricane force winds (MEMA, 2013).

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 criteria 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 pulling down of power lines and trees (MEMA, 2013).

Likely Severity

Periodically, a storm will occur which is a true disaster, and necessitates intense, large-scale emergency response. The main impacts of severe winter storms in the Berkshires is deep snow depths, high winds and reduced visibility, potentially resulting in the closing of schools, businesses, some governmental operations and public gatherings. Loss of electric power and possible closure of roads can occur during the more severe storms events.

The magnitude or severity of a severe winter storm depends on several factors including a region's climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, time of occurrence during the day (e.g., weekday versus weekend), and time of season (MEMA, 2013)

NOAA's National Climatic Data Center (NCDC) is currently producing the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the U.S. The RSI ranks snowstorm impacts on a scale from one to five. RSI is based on the spatial extent of the storm, the amount of snowfall, and the combination of the extent and snowfall totals with population. Data beginning in 1900 is used to give a historic perspective (MEMA 2013, NOAA 2018).

Table 3.5 Regional Snowfall Index Ranking Categories

Category	Description	RSI-Value	Approximate Percent of Storms
1	Notable	1-3	1%
2	Significant	3-6	2%
3	Major	6-10	5%
4	Crippling	10-18	25%
5	Extreme	18+	54%

Source: MEMA 2013.

Of the 12 recent winter storm disaster declarations that included Berkshire County, only two events were ranked as Extreme (EM-3103 in 1993 and DR-1090 in 1996), one was ranked Crippling (IM-3175 in 2003) and two were ranked as Major (EM-3191 in 2003 and DR-4110 in 2013). It should be noted that because population is used as a criteria, the storms that rank higher will be those that impact densely populated areas and regions such as Boston and other large cities and, as such, might not necessarily reflect the storms that impact lightly populated areas like the Berkshires. For example, one of the most famous storms in the Commonwealth in modern history was the Blizzard of '78, which dropped over two feet of snow in the Boston area during 65 mph winds that created enormous drifts and stranded hundreds of people on local highways. The storm hit the snow-weary city that was still digging out of a similar two-foot snowstorm 17 days earlier. Although the Berkshires received snow from this storm, the county was not listed in the declaration.

One of the most serious storms to impact communities in the Berkshires was the Ice Storm of December 11, 2008. The storm created widespread downed trees and power outages all across New York State, Massachusetts and New Hampshire. Over one million customers were without electricity, with 800,000 without power three days later and some without power weeks later. Living conditions were acerbated by extremely cold temperatures in the days following the event.

While severe winter weather declarations have become more prominent in the 1990s, we do not believe that this reflects more severe weather conditions than the Berkshires experienced in the years 40+ years prior to the 1990s. Respected elders across Berkshire County comment that snow depths prior to the 1990s were consistently deeper that what currently occurs in the 2010s.

Probability

The majority of blizzards and ice storms are viewed by people in the region as part of life in the Berkshires, an inconvenience and drain on municipal budgets. Residents and town staff expect to deal with several snow storms and a few Nor'easters each winter. According to the NOAA-NCDC storm database, over 200 winter storm events occurred in the Commonwealth between 2000 and 2012. Therefore, the subset of severe winter storms are likely to continue to occur annually (MEMA, 2013). The Town of Great Barrington's location in Western New England places it at a high-risk for winter storms. While the town may not get the heavy snowfall associated with coastal storms, the severe storms that the county gets are added to the higher annual snowfall the county normally gets due to its slightly higher elevation then its neighboring counties in the Pioneer and Hudson River Valleys.

Using history as a guide for future severe winter storms, it can be assumed that the town will be at risk for approximately six severe winter storms per winter. The highest risk of these storms occurs in January with significant risk also occurring in December through March. The region is getting less snowfall then previous years and can expect less snowfall in future years, however this does not mean the county will not experience years with high snowfall amounts (2010-11 had over 100 inches), but the trend indicates that the yearly snowfall total will continue to go down. It should be noted that although total snow depths may be reduced in the future, warmer winter temperatures will likely increase the number and severity of storms with heavy, wet snow, which can bring concerns for road travel, human injuries linked to shoveling and risk of roof failures.

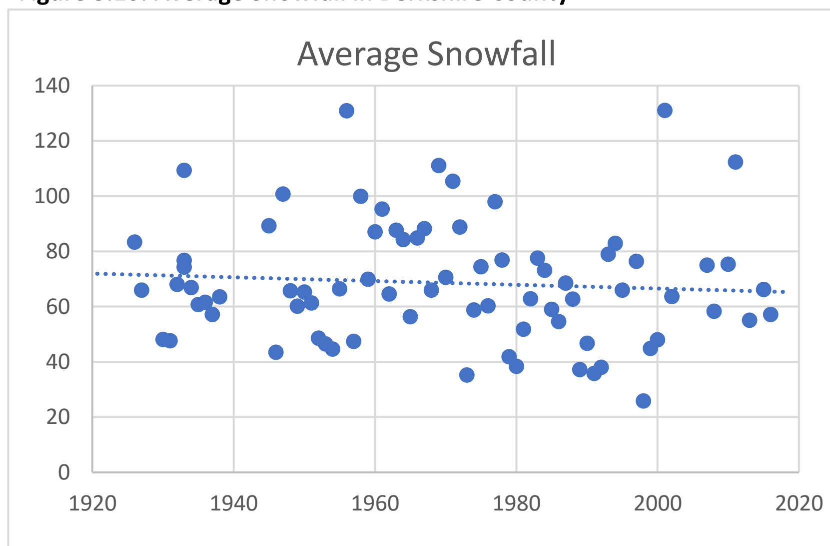
Geographic Areas Likely Impacted

Winter storms are the most common and most familiar of Massachusetts hazards which affect large geographical areas. Severe winter storm events generally occur across Great Barrington, although higher elevations have slightly higher snow depths.

Historic Data

Figure 3.10 illustrates historic snowfall totals the region has received. Although the entire community is at risk, the higher terrains tend to receive higher snowfall amounts, and these same areas may receive snow when the lower elevations received mixed snow/rain or just rain (National Climatic Data Center, 2017). The National Climatic Data Center, a division of NOAA, reports statistics on severe winter storms from 1993 through 2017. During this 24-year span, Berkshire County experienced 151 severe winter storms, an average of six per winter. This number

Figure 3.10: Average Snowfall in Berkshire County



varies each winter, ranging from one during 2006 to 18 during 2008. Snow and other winter precipitation occur very frequently across the entire region. Snowfall in the region can vary between 26 and 131 inches a year, however it averages around 65 inches a year, down from around 75 inches a year in 1920. Another tracking system is the one- and three-day record snowfall totals. According to data from the Northeast States Consortium, 99% of the one-day record snowfall events in the region typically yield snow depths in the range of 12”-24”, while the majority of three-day record snowfall events yield snow depths of 24”-36” (Table 3.6).

Table 3.6: Record Snowfall Events and Snow Depths for Berkshire County

Record Snowfall Event	Snowfall 12” – 24”	Snowfall 24” – 36”
1-Day Record	99%	1%
3-Day Record	36%	64%

Source: (Northeast States Emergency Consortium, 2010).

Since 2000, two severe ice storm events have occurred in the region. The storms within that period occurred in December and January, but ice storms of lesser magnitudes may impact the region from October to April, and on at least an annual basis.

Based on all sources researched, known winter weather events that have affected Massachusetts and were declared a FEMA disaster are identified in the following sections. Of the 18 federally declared winter storm-related disaster declarations in Massachusetts between 1954 to 2018, Berkshire County has been included in 12 of those disasters. The number of disaster declarations for severe winter events in which Berkshire County was included is more than double that of declarations for non-winter, non-flood-related severe storm events.

Table 3.7: Severe Winter Weather – Declared Disasters that included Berkshire County 1992-2017

Incident Period	Description	Declaration Number
12/11/92-12/13/92	Nor’easter with snow 4’+ in higher elevations of Berkshires, with 48” reported in Becket, Peru and Becket; snow drifts of 12’+; 135,000 without power across the state	DR-975
03/13/93-03/17/93	High winds & heavy snow; generally 20-30” in Berkshires; blizzard conditions lasting 3-6 hrs afternoon of March 13.	EM-3103
01/07/96-01/08/96	Blizzard of 30+” in Berkshires, with strong to gale-force northeast winds; MEMA reported claims of approx. $32 million from 350 communities for snow removal	DR-1090
03/05/01-03/06/01	Heavy snow across eastern Berkshires to Worcester County; several roof collapses reported; $21 million from FEMA	EM-3165
02/17/03-02/18/03	Winter storm with snow of 12-24”, with higher totals in eastern Berkshires to northern Worcester County; $28+ million from FEMA	EM-3175
12/06/03-12/07/03	Winter Storm with 1’-2’ across state, with 36” in Peabody; $35 million from FEMA	EM-3191
01/22/05-01/23/05	Blizzard with heavy snow, winds and coastal flooding; highest snow falls in eastern Mass.; $49 million from FEMA	EM-3201
04/15/07-04/16/07	Severe Storm and Flooding; wet snow, sleet and rain added to snowmelt to cause flooding; higher elevations received heavy snow and ice; $8 million from FEMA	DR-1701

12/11/08-12/12/08	Major ice storm across eastern Berkshires & Worcester hills; at least ½" of ice accreted on exposed surfaces, downing trees, branches and power lines; 300,000+ customers without power in state, some for up to 3 wks.; $51+ million from FEMA	DR-1813
01/11/11-01/12/11	Nor'easter with up to 2' within 24 hrs.; $25+ million received from FEMA	DR-1959
10/29/11-10/30/11	Severe storm and Nor'easter with 1'-2' common; at peak 665,000 residents state-wide without power; 2,000 people in shelters statewide	DR-4051
02/08/13-02/09/13	Severe Winter Snowstorm and Flooding; $56+ million from FEMA	RE-4110

Source: FEMA 2017.

Vulnerability Assessment

People

In rural areas such as parts of Great Barrington, homes and farms may be isolated for days, and unprotected livestock may be lost. In the mountains, heavy snow can lead to avalanches. Residents may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss of life.

According to the NOAA National Severe Storms Laboratory, every year, winter weather indirectly and deceptively kills hundreds of people in the U.S., primarily from automobile accidents, overexertion, and exposure. Winter storms are often accompanied by strong winds creating blizzard conditions with blinding wind-driven snow, drifting snow, and extreme cold temperatures with dangerous wind chill. They are considered deceptive killers because most deaths and other impacts or losses are indirectly related to the storm. Injuries and deaths may occur due to traffic accidents on icy roads, heart attacks while shoveling snow, or hypothermia from prolonged exposure to cold (MEMA & EOEEA, 2018).

Vulnerable populations include the elderly living alone, who are susceptible to winter hazards due to their increased risk of injury and death from falls, overexertion, and/or hypothermia from attempts to clear snow and ice, or injury and death related to power failures. In addition, severe winter weather events can reduce the ability of these populations to access emergency services. People with low socioeconomic status are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on the net economic impact on their families. Residents with low incomes may not have access to housing or their housing may be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply). The population over the age of 65, individuals with disabilities, and people with mobility limitations or who lack transportation are also more vulnerable because they are more likely to seek or need medical attention, which may not be available due to isolation during a flood event. These individuals are also more vulnerable because they may have more difficulty if evacuation becomes necessary. People with limited mobility risk becoming isolated or "snowbound" if they are unable to remove snow from their homes. Rural populations may become isolated by downed trees, blocked roadways, and power outages. The ability of emergency responders to respond to calls may be impaired by heavy snowfall, icy roads, and downed trees (MEMA & EOEEA, 2018).

Built Environment

Severe winter storms can damage the built environment by collapsing roofs under the weight of snow, making roads impassable due to snow or ice, damaging roads by freezing or unintended damage due to snowplows, freezing and bursting pipes, downing trees and power lines, and the flooding damages that result from melting snow.

Natural environment

Although winter storms are a natural part of the Massachusetts climate, and native ecosystems and species are well adapted to these events. However, changes in the frequency or severity of winter storms could increase their environmental impacts. Environmental impacts of severe winter storms can include direct mortality of individuals and felling of trees, which can damage the physical structure of the ecosystem. Similarly, if large numbers of plants or animals die as the result of a storm, their lack of availability can impact the food supply for animals in the same food web. If many trees fall within a small area, they can release large amounts of carbon as they decay. This unexpected release can cause further imbalance in the local ecosystem. The flooding that results when snow and ice melt can also cause extensive environmental impacts. Nor'easters can cause impacts that are similar to those of hurricanes and tropical storms, coastal flooding, and inland flooding. These impacts can include direct damage to species and ecosystems, habitat destruction, and the distribution of contaminants and hazardous materials throughout the environment (MEMA & EOEEA, 2018).

Economy

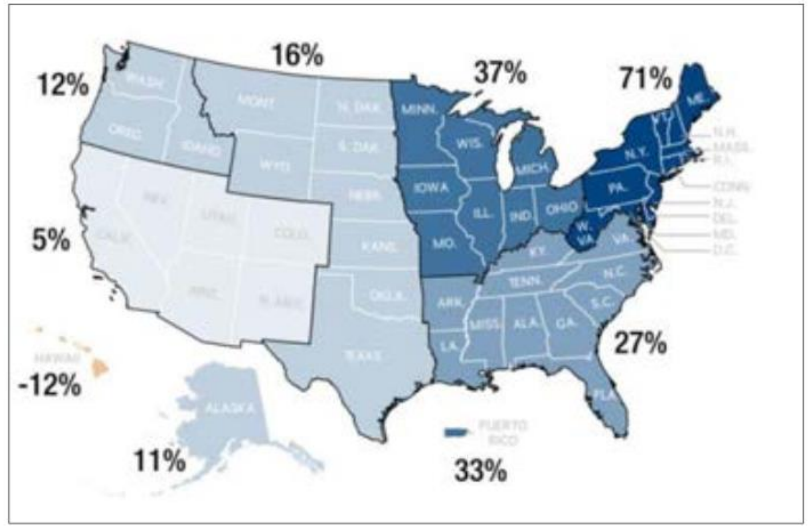
The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain municipal and state financial resources due to the cost of staff overtime, snow removal and wear on equipment. Rescheduling of schools and other municipal programs and meetings can also be costly. The potential secondary impacts from winter storms also impact the local economy including loss of utilities, interruption of transportation corridors, and loss of business operations and functions, as well as loss of wages for employees.

Severe winter weather can lead to flooding in low-lying agricultural areas. Ice that accumulates on branches in orchards and forests can cause branches to break, while the combination of ice and wind can fell trees. Storms that occur in spring can delay planting schedules. Frost that occurs after warmer periods in spring can cause cold weather dieback and damage new growth (MEMA & EOEEA, 2018).

Future Conditions

Increased sea surface temperature in the Atlantic Ocean will cause air moving north over this ocean to hold more moisture. As a result, when these fronts meet cold air systems moving from the north, an even greater amount of snow than normal can be anticipated to fall on Massachusetts. Although no one storm can be linked directly to climate change, the severity of rain and snow events has increased dramatically in recent years. As shown in Figure 3.11, the amount of precipitation released by storms in the Northeast has increased by 71 percent from the baseline level (recorded from 1901 to 1960) and present-day levels (measured from 2001 to 2012) (USGCRP, 2014 as cited in MEMA & EOEEA, 2018).Winter precipitation is predicted to more often be in the form of rain rather than snow.

Figure 3.11: Observed Changes in Heavy Precipitation



Source: NCA, 2014 as cited in MEMA & EOEEA

Droughts

Hazard Profile

Drought is a period characterized by long durations of below normal precipitation. Drought occurs in virtually all climatic zones, yet its characteristics vary significantly from one region to another, since it is relative to the normal precipitation in that region. Direct impacts of drought include reduced water supply, crop yield, increased fire hazard, reduced water levels, and damage to wildlife and fish habitat.

The Massachusetts Executive Office of Energy and Environmental Affairs (EEA) and the Massachusetts Emergency Management Agency (MEMA) partnered to develop the *Massachusetts Drought Management Plan*, of which 2013 is the most updated version. The state's Drought Management Task Force, comprised of state and federal agencies, was created to assist in monitoring, coordinating and managing responses to droughts and recommends action to minimize impacts to public health, safety, the environment and agriculture (EEA, MEMA, 2013). The MA Department of Conservation Resources staff compile data from the agencies and develop monthly reports to track and summarize current water resource conditions.

In Massachusetts the determination of drought level is based on seven indices: Standardized Precipitation Index, Crop Moisture Index, Keetch-Byram Drought Index, Precipitation, Groundwater levels, Streamflow levels, and Index Reservoir levels. The Standardized Precipitation Index (SPI) reflects soil moisture and precipitation conditions, calculated monthly using Massachusetts Rainfall Database at the Department of Conservation and Recreation Office of Water Resources. SPI values are calculated for "look-back" periods of 1 month, 3 months, 6 months, and 12 months. (EEA, MEMA 2013)

The Crop Moisture Index (CMI) reflects short-term soil moisture conditions as used for agriculture to assess short-term crop water conditions and needs across major crop-producing regions. It is based on the concept of abnormal evapotranspiration deficit, calculated as the difference between computed actual evapotranspiration (ET) and computed potential evapotranspiration (i.e., expected or appropriate ET). Actual evapotranspiration is based on the temperature and precipitation that occurs during the week and computed soil moisture in both the topsoil and subsoil layers.

The Keetch-Byram Drought Index (KBDI)is designed specifically for fire potential assessment. It is a number representing the net effect of evapotranspiration and precipitation in producing cumulative moisture deficiency in deep duff and upper soil layers. It is a continuous index, relating to the flammability of organic material in the ground. The KBDI attempts to measure the amount of precipitation necessary to return the soil to full field capacity. The inputs for KBDI are weather station latitude, mean annual precipitation, maximum dry bulb temperature, and the last 24 hours of rainfall.

Determinations regarding the end of a drought or reduction of the drought level focus on two key drought indicators: precipitation and groundwater levels. These two factors have the greatest long-term impact on streamflow, water supply, reservoir levels, soil moisture and potential for forest fires. Precipitation is a key factor because it is the overall cause of improving conditions. Groundwater levels respond slowly to improving conditions, so they are good indicators of long-term recovery to normal conditions.

Likely severity

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts. Droughts are not usually associated with immediate impacts on people or property, but they can have significant impacts on agriculture, which can impact the farming community of the region. As noted in the state Hazard Mitigation Plan, agriculture-related drought disasters are quite common, with 1/2 to 2/3 of the counties in the U.S. having been designated as disaster areas in each of the past several years. These designations make it possible for producers suffering losses to receive emergency loans. Such a disaster was declared in December 2010 for Berkshire County (USDA Designation # S3072).

When measuring the severity of droughts, analysts typically look at economic impacts on a planning area. Drought warnings, watches and advisories can be reduced based on: 1) normal levels of precipitation, and 2) groundwater levels within the “normal” range. In order to return to a normal status, groundwater levels must be in the normal range and/or one of two precipitation measures must be met. The precipitation measures are: 1) three months of precipitation that is cumulatively above normal, and 2) long-term cumulative precipitation above normal. The period for long-term cumulative precipitation ranges from 4 to 12 months, depending on the time of year. Precipitation falling during the fall and spring is ideal for groundwater recharge and, therefore, will result in the quickest return to normal conditions. Because the same levels of cumulative precipitation can differ in their abilities to reduce drought conditions, the decision to reduce a drought level will depend on the professional judgment of the Secretary of EEA with input from his agencies and the Drought Management Task Force (MEMA 2013)

MassDEP has the authority to declare water emergencies for communities facing public health or safety threats as a result of the status of their water supply systems, whether caused by drought conditions or for other reasons. The Department of Public Health (DPH) in conjunction with the DEP monitors drinking water quality in communities.

According to the data at hand, the most severe droughts in Massachusetts occurred 1930-31 and 1964-67. Many local water managers and officials remember the drought years of the 1960s, where mandatory water bans were issued. Outside of this time period, most water restrictions in the region have been voluntary.

Probability

As described below, Berkshire County is at lower risk of drought relative to the rest of the Commonwealth. However, that does not eliminate the hazard from potentially impacting the County and the Town of Great Barrington. Patterns show near misses of severe drought conditions, and increases in temperature lead to faster evaporation and drying of kindling.

Geographic Areas Likely Impacted

For the purposes of tracking drought conditions across the Commonwealth, the state has been divided into six regions, with the Western Region being made up of Berkshire County. For the purposes of this plan, the entire Town of Great Barrington is at risk of drought

Historic Data

Massachusetts is relatively water-rich, with few documented drought occurrences. According to the state's Hazard Mitigation Plan of 2013, the state has experienced multi-year droughts periods 1879-83, 1908-12, 1929-32, 1939-44, 1961-69 and 1980-83. There have been 13 documented droughts in the state between 1945 and 2002 (see Table 3.8) (MEMA, 2013), The most severe drought occurred during the 1960s, due to both severity and extended duration.

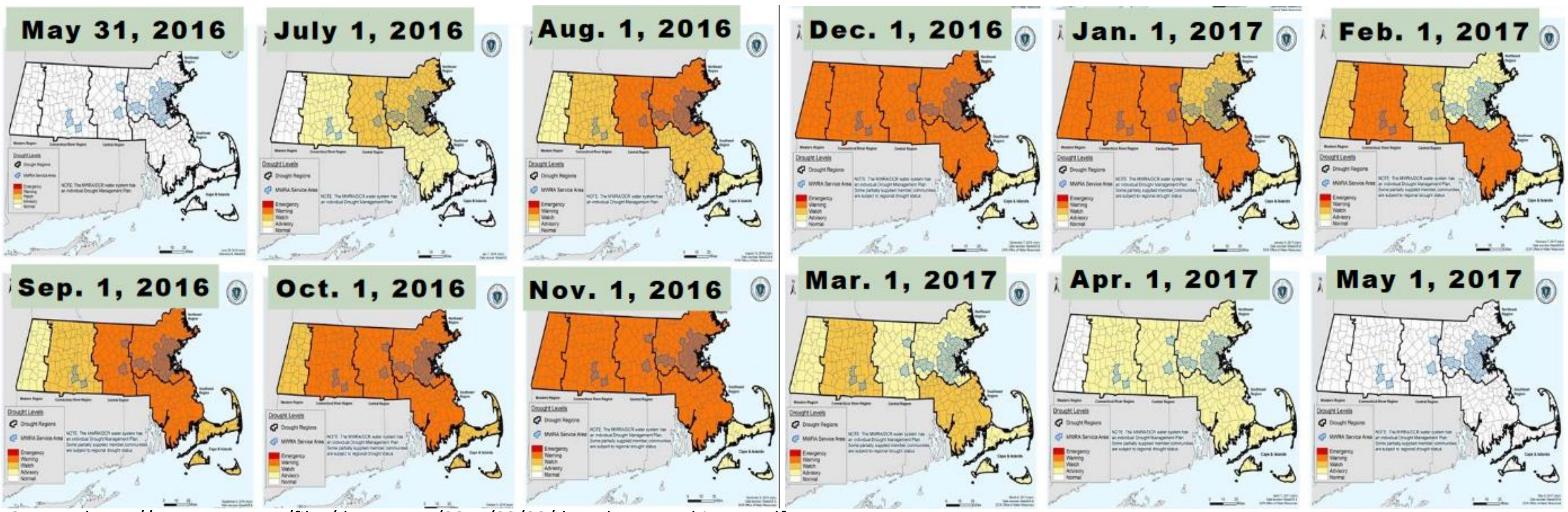
Table 3.8: Estimated Droughts Based on the Mass. Standardized Precipitation Index

Year(s)	Duration (Months)	Estimated Drought Level
1924-1925	13	Warning
1930-1931	12	Emergency
1934-1935	15	Warning
1944	11	Watch
1949-1950	15	Watch
1957-1958	12	Warning
1964-1967	36	Emergency
1971	8	Watch
1980-1981	13	Watch
1985	7	Watch
1988-1989	11	Watch
1990-1991	9	Watch
2001-2002	13	Watch

Source: MEMA, 2013

Additional information indicates that droughts occurred in the state 2007-08 and in 2010, although neither of these involved drought conditions in Berkshire County (Western Drought Region). The most recent drought in Massachusetts occurred during a 10-month span in 2016-17. In July 2016 Advisory and Watch drought levels began to be issued for the eastern and central portions of the state, worsening in severity until the entire state was under a Drought Warning status for the months of November-December 2016. Water levels began to recover in February 2017, with the entire state determined to be back to normal water levels in May 2017. The Massachusetts Water Resources Commission stated that the drought was the worst since the state's Drought Management Plan was first issued in 2001, and the most severe since the 1960s drought of record.[11]

Figure 3.12: Progression of the 2016-17 Drought



Source: https://www.mass.gov/files/documents/2017/09/08/drought-status-history.pdf

In general, the central portion of the state faired the worse and Berkshire County faired the best, with the county entering the drought later and emerging from the drought earlier than most of the rest of the state. Berkshire County was under a Watch status for two months and under a Warning status for three months during the height of the drought.

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[11] *MA Water Resources Commission, 2017. Annual Report, Fiscal Year 2017. Boston, MA.*

Vulnerability Assessment

People

For the purposes of this plan update, the entire population of Great Barrington is exposed and vulnerable to drought. Those with shallow wells may be hardest hit because shallow, quickly constructed wells are the most likely to go dry. Those with access and functional needs are at greatest risk in the case that they are unable to travel to or afford alternative water sources.

The Berkshire region has not suffered a severe, Emergency level drought since the 1960s and it is unclear how well the system could serve the demands of Great Barrington during a prolonged drought given an increased population and changes in precipitation patterns.

Due to the great expanses of state forest and wildlife lands in the region, which attract hikers and campers, and a tourist-based economy that brings additional people to the region in the summer, the risk of wildfire would increase during a severe drought. Drought would reduce the capacity of local firefighting efforts, hampering control of wildfire. A more detailed discussion of wildfire and the Town's vulnerability is found in that section of the report.

Built Environment with Infrastructure and Systems

Drought does not threaten the physical stability of critical facilities in the same manner as other hazards such as wind-based or flood-related events. However, if drought led to wildfire the entire Town, primarily private residential buildings, would be at risk. Additionally, as a result of wildfire, electrical and communication systems would be a significant risk. What water was remaining available would also be at risk of contamination.

Natural Environment

The natural environment is at greatest risk due to drought. Vegetation and wildlife would be challenged to find water to sustain life, and the vegetation and wildlife most sensitive to water availability would die off providing kindling for wildlife and leaving room for invasive species to dominant the landscape.

Drought has a wide-ranging impact on a variety of natural systems. Some of those impacts can include the following (Clark et al., 2016 as cited in MEMA & EOEEA, 2018):

- Reduced water availability, specifically, but not limited to, habitat for aquatic species
- Decreased plant growth and productivity
- Increased wildfires
- Greater insect outbreaks
- Increased local species extinctions

- Lower stream flows and freshwater delivery to downstream estuarine habitats
- Changes in the timing, magnitude, and strength of mixing (stratification) in coastal waters
- Increased potential for hypoxia (low oxygen) events
- Reduced forest productivity
- Direct and indirect effects on goods and services provided by habitats (such as timber, carbon sequestration, recreation, and water quality from forests)
- Limited fish migration or breeding due to dry streambeds or fish mortality caused by dry streambed/

In addition to these direct natural resource impacts, a wildfire exacerbated by drought conditions could cause significant damage to the Commonwealth's environment as well as economic damage related to the loss of valuable natural resources (MEMA & EOEEA, 2018).

Economy

The economic impacts of drought can be substantial, and would primarily affect the agriculture, recreation and tourism, forestry, and energy sectors. For example, drought can result in farmers not being able to plant crops or in the failure of planted crops (MEMA & EOEEA, 2018). Drier summers and intermittent droughts may strain irrigation water supplies, stress crops, and delay harvests (resilient MA, 2018). Droughts affect the ability of farmers to provide fresh produce to neighboring communities. Insufficient irrigation will impact the availability of produce, which may result in higher demand than supply. This can drive up the price of food, leading to economic stress on a broader portion of the economy.

In any season, a drought can also harm recreational companies that rely on water (e.g., ski areas, swimming pools, water parks, and river rafting companies) as well as landscape and nursery businesses because people will not invest in new plants if water is not available to sustain them. Social and environmental impacts are also significant, but data on the extent of damages is more challenging to collect. Although the impacts can be numerous and significant, dollar damage estimates are not tracked or available (MEMA & EOEEA, 2018).

Future Conditions

Changes in winter temperatures will lead to less snowpack and more rain-on-snow events, leading to more surface runoff and less groundwater recharge, leading to less stream and river base flows. Higher temperatures in warmer seasons can more severely impact the reduced base flows due to higher rates of evaporation of moisture from soil and lower groundwater and surface water inputs. According to the state's Climate Change Adaptation Report, a continued high greenhouse-gas-emission scenario could result in a 75% increase in the occurrence of drought conditions lasting 1-3 months.

For drought conditions to occur it is likely that soil moisture is limited or lacking, forest duff is dried out and standing vegetation is dry and possibly dead, providing the fuel needed for a wildfire. Given that the Town of Great Barrington is 80.2% forested, the risk of wildfire during drought conditions is a concern.

Hazard Profile

Extreme temperature, particularly heat, was a top hazard identified by stakeholders through the MVP planning process. Temperature is a fundamental measurement to describe climate, which is the prevailing weather patterns in a given area. Climate determines the types of plant and animal species that are able to survive in a region, and changes in climate will have significant impacts on the landscape because most species will not have the time to evolve and adapt over multiple generations to the new climate[12]. Scientists are still uncovering ways climate change will impact our lives both directly and indirectly.

Likely severity

Relative to the rest of the Commonwealth, the Town of Great Barrington is protected from extreme heat by the higher elevation. At the same time however, the lack of many extreme heat events has left most unprepared. Homes have been built to keep in warmth, and few have air conditioners. The environment and people have adapted to cooler conditions; however, extremes in cold and hot still can and will occur, particularly in the changing climate.

NOAA utilizes data to determine average temperature using land-based weather station measurements and by satellite measurements that cover the lowest level of the Earth's atmosphere. In moderate climate like in the Berkshires, the most severe impacts of the change in average temperature will be on our environmental composition, as well as on our vulnerable populations, particularly in urbanized areas. There is limited evidence that downtown Great Barrington experiences some level of the Urban Heat Island (UHI) effect.

The extent (severity or magnitude) of extreme cold temperatures is generally measured through the Wind Chill Temperature Index. Wind Chill Temperature is the temperature that people and animals feel when they are outside, and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. As the wind increases, the body loses heat at a faster rate, causing the skin's temperature to drop. The NWS issues a Wind Chill Advisory if the Wind Chill Index is forecast to dip to –15°F to –24°F for at least 3 hours, based on sustained winds (not gusts). The NWS issues a Wind Chill Warning if the Wind Chill Index is forecast to fall to –25°F or colder for at least 3 hours. On November 1, 2001, the NWS implemented a Wind Chill Temperature Index designed to more accurately calculate how cold air feels on human skin.

[12] https://www.epa.gov/climate-indicators/climate-change-indicators-us-and-global-temperature

The NWS issues a Heat Advisory when the NWS Heat Index is forecast to reach 100 to 104°F for 2 or more hours. The NWS issues an Excessive Heat Warning if the Heat Index is forecast to reach 105°F or higher for 2 or more hours. The NWS Heat Index is based both on temperature and relative humidity and describes a temperature equivalent to what a person would feel at a baseline humidity level. It is scaled to the ability of a person to lose heat to their environment. It is important to know that the heat index values are devised for shady, light wind conditions. Exposure to full sunshine can increase heat index values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can increase the risk of heat-related impacts.

Extreme heat temperatures are those that are 10°F or more above the average high temperature for the region and last for several hours. A heat wave is defined as 3 or more days of temperatures of 90°F or above. A basic definition of a heat wave implies that it is an extended period of unusually high atmosphere-related heat stress, which causes temporary modifications in lifestyle and which may have adverse health consequences for the affected population (MEMA & EOEEA, 2018).

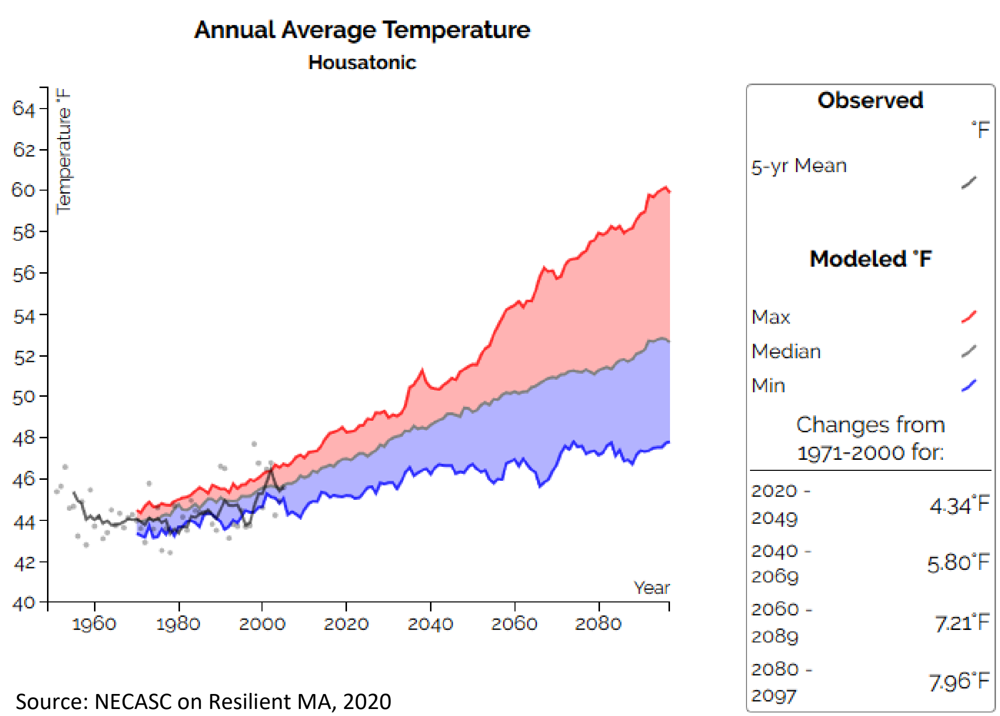
Probability

The change in average temperatures has already affected the Town of Great Barrington. Figure 3.13 shows the observed and projected annual average temperature, increasing through the next century. In the next 30 years, Great Barrington, evaluated within the Hudson basin, will warm by an average of 4.34°F. The global changes in climate will lead to extreme temperatures as global weather patterns are altered. Figure 3.14 shows that Great Barrington has little experience with days over 90°F, but that will soon change as we see more days with dangerous levels of heat.

Geographic Areas Likely Impacted

Great Barrington in its entirety is exposed to the impacts of extreme temperatures and the change in average temperature. Extreme temperature events occur more frequently and vary more in the inland regions where temperatures are not moderated by the Atlantic Ocean. There may be significant UHI effect in Great Barrington, though much more

Figure 3.13: Observed and Projected Annual Average Temperature by Watershed Basin



Source: NECASC on Resilient MA, 2020

moderate than larger urban areas. UHI occurs were there are dark surfaces including pavement and building roofs that absorb heat, anthropogenic heat production such as air conditioners and cars, and a dearth of natural vegetation to provide a cooling effect through evapotranspiration or by providing shade.

Historic Data

The world's five warmest years have all occurred since 2015 with nine of the 10 warmest years occurring since 2005, according to scientists from NOAA's National Centers for Environmental Information (NCEI)[13]. Figure 3.14 shows the increase in the number of observed and projected days over 90°F in the Housatonic watershed and Figure

Figure 3.15: Observed and Projected Days Below 32°F by Watershed Basin

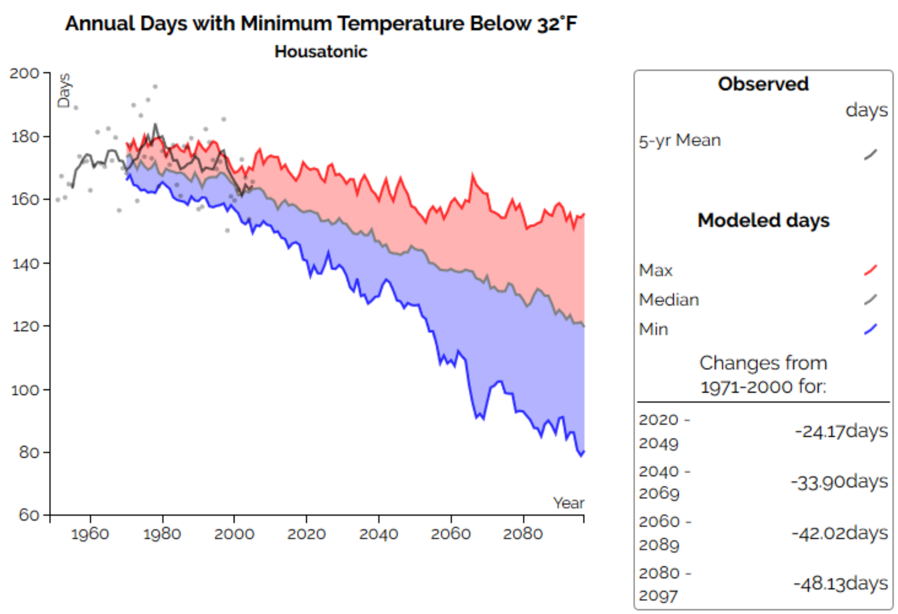
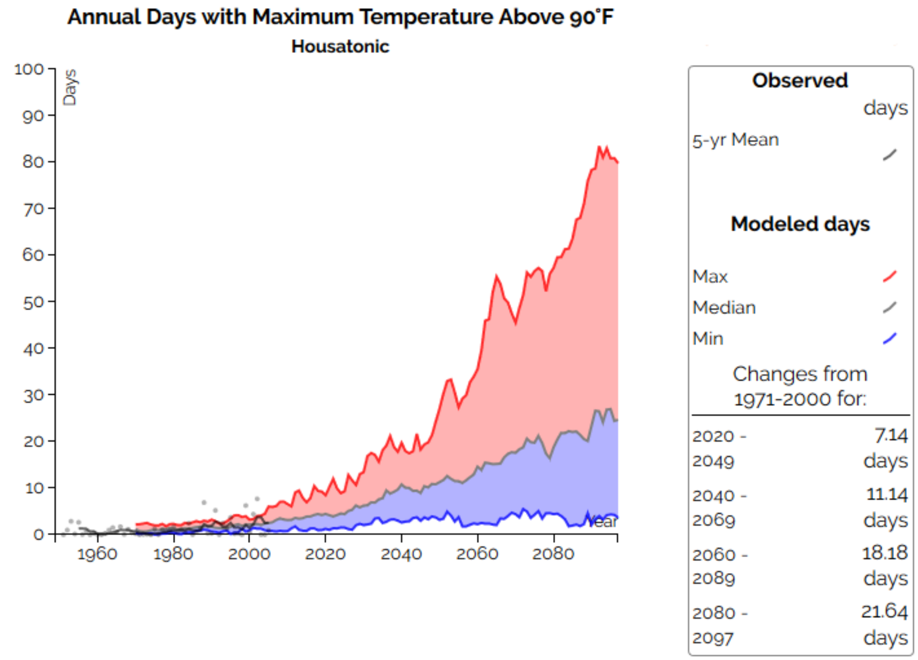


Figure 3.14: Observed and Projected Days Above 90°F by Watershed Basin



3.15 shows the decline in observed and projected days below freezing for the Housatonic watershed, including Great Barrington.

July is on average the hottest month of the year in Great Barrington with an average of high temperature of 81°F. The lowest average temperature in Great Barrington occurs in January. The average low in January is 11°F.

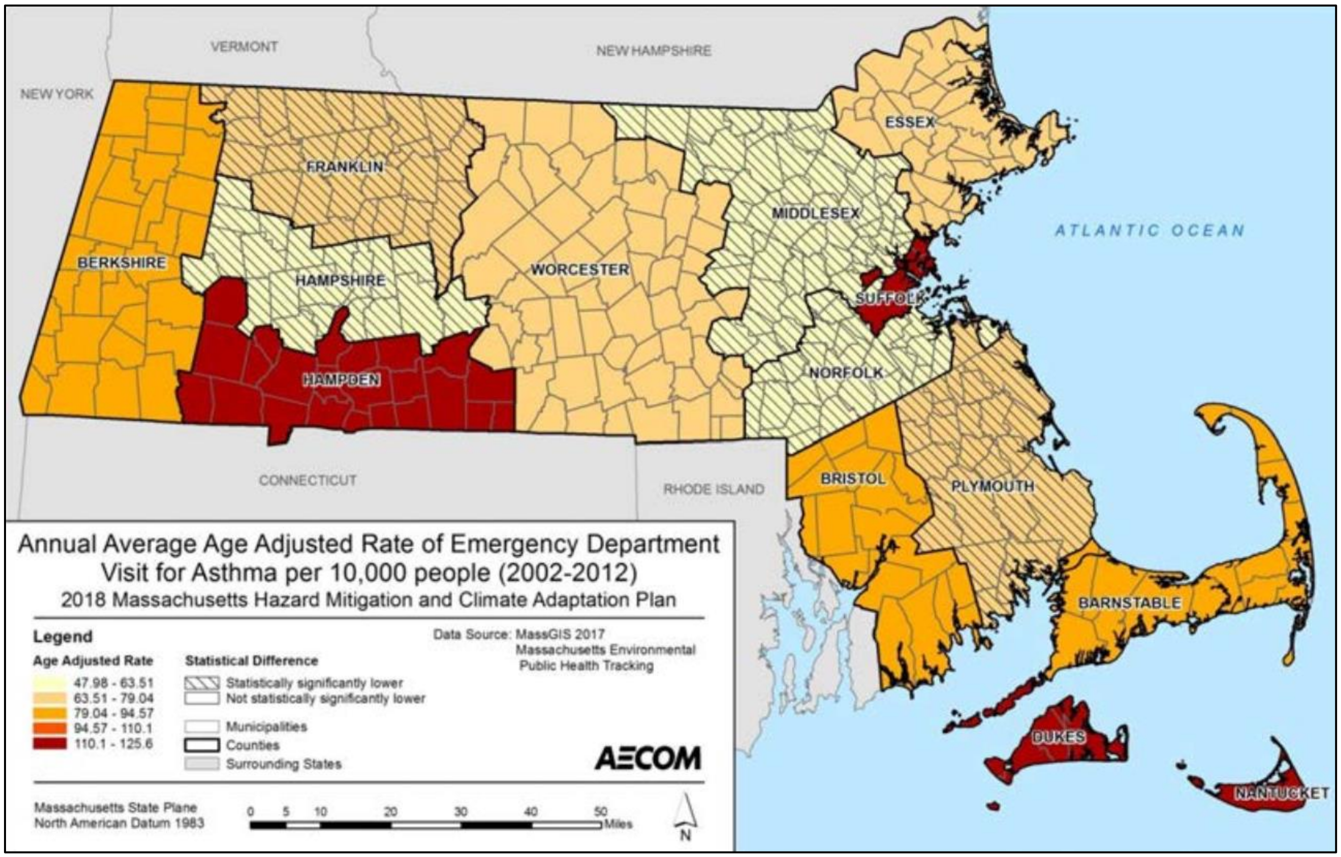
Great Barrington has seen both the lowest and highest temperatures recorded in the Berkshire region from 1895 to present. Seeing -27°F temperatures as well as 99°F temperatures in August 2019 (National Climatic Data Center, 2017).

[13] https://www.noaa.gov/news/2019-was-2nd-hottest-year-on-record-for-earth-say-noaa-nasa

While some might see this as something to celebrate, there will be impacts on everything from natural cycles of snow melt and waterflow to the ability of insects such as ticks to survive and even reproduce at greater rates through the winter. Additional impacts will be discussed in the Vulnerability Assessment.

Vulnerability Assessment

Figure 3.16: Rates of Emergency Department Visits Due to Asthma by County



People

Temperature alone does not define the stress that heat can have on the human body – humidity plays a powerful role in human health impacts, particularly for those with pre-existing pulmonary or cardio-vascular conditions. The NWS issues a Heat Advisory when the Heat Index is forecast to reach 100° to 104°F for two or more hours. The NWS issues an Excessive Heat Warning if the Heat Index is forecast to reach 105°F or more for two or more hours. According to the Centers for Disease Control and Prevention, populations most at risk to extreme cold and heat events include the following: (1) people over the age of 65, who are less able to withstand temperatures extremes due to their age, health conditions, and limited mobility to access shelters; (2) infants and children under 5 years of age; (3) individuals with pre-existing medical conditions that impair heat tolerance (e.g., heart disease or kidney disease); (4) low-income individuals who cannot afford proper heating and cooling; (5) people with respiratory conditions, such as asthma or chronic obstructive pulmonary disease; and (6) the general public who may overexert themselves when working or exercising during extreme heat events or who may experience hypothermia during extreme cold events. Additionally, people who live alone—particularly the elderly and individuals with disabilities—are at higher risk of heat-related illness due to their isolation and reluctance to relocate to cooler environments.

When people are exposed to extreme heat, they can suffer from potentially deadly illnesses, such as heat exhaustion and heat stroke. Heat is the leading weather-related killer in the U.S., even though most heat-related deaths are preventable through outreach and intervention (EPA, 2016). A study of heat-related deaths across Massachusetts estimated that when the temperature rises above the 85th percentile (hot: 85-86°F), 90th percentile (very hot: 87-89°F) and 95th percentile (extremely hot: 89-92°F) there are between five and seven excess deaths per day in Massachusetts.

These estimates were higher for communities with high percentages of African American residents and elderly residents on days exceeding the 85th percentile (Hattis et al., 2011). A 2013 study of heart disease patients in Worcester, MA, found that extreme heat (high temperature greater than the 95th percentile) in the 2 days before a heart attack resulted in an estimated 44 percent increase in mortality. Living in poverty appeared to increase this effect (Madrigano et al., 2013). In 2015, researchers analyzed Medicare records for adults over the age of 65 who were living in New England from 2000 to 2008. They found that a rise in summer mean temperatures of 1°C resulted in a 1 percent rise in the mortality rate due to an increase in the number and intensity of heat events (Shi et al., 2015). Hot temperatures can also contribute to deaths from respiratory conditions (including asthma), heart attacks, strokes, other forms of cardiovascular disease, renal disease, and respiratory diseases such as asthma and chronic obstructive pulmonary disorder. Human bodies cool themselves primarily through sweating and through increasing blood flow to body surfaces. Heat events thus increase stress on cardiovascular, renal, and respiratory systems, and may lead to hospitalization or death in the elderly and those with pre-existing diseases. Massachusetts has a very high prevalence of asthma: approximately 1 out of every 11 people in the state currently has asthma (Mass.gov, n.d.). In Massachusetts, poor air quality often accompanies heat events, as increased heat increases the conversion of ozone precursors in fossil fuel combustion emissions to ozone. Particulate pollution may also accompany hot weather, as the weather patterns that bring heat waves to the region may carry pollution from other areas of the continent. Poor air quality can negatively affect respiratory and cardiovascular systems and can exacerbate asthma and trigger heart attacks.

Built Environment

All elements of the built environment are exposed to the extreme temperature hazard, including state-owned critical facilities. The impacts of extreme heat on buildings include: increased thermal stresses on building materials, which leads to greater wear and tear and reduces a building's useful lifespan; increased air-conditioning demand to maintain a comfortable temperature; overheated heating, ventilation, and air-conditioning systems; and disruptions in service associated with power outages (ResilientMA, 2018). Extreme cold can cause materials such as plastic to become less pliable, increasing the potential for these materials to break down during extreme cold events (resilient MA, 2018). In addition to the facility-specific impacts, extreme temperatures can impact critical infrastructure sectors of the built environment in a number of ways, which are summarized in the subsections that follow.

Extreme cold temperature events can damage buildings through freezing or bursting pipes and freeze and thaw cycles. Additionally, manufactured buildings (trailers and mobile homes) and antiquated or poorly constructed facilities may not be able to withstand extreme temperatures. The heavy snowfall and ice storms associated with extreme cold temperature events can also cause power interruptions. Backup power is recommended for critical facilities and infrastructure.

Extreme heat has potential impacts on the design and operation of the transportation system. Impacts on the design include the instability of materials, particularly pavement, exposed to high temperatures over longer periods of time, which can cause buckling and lead to increased failures (MassDOT, 2017). High heat can cause pavement to soften and expand, creating ruts, potholes, and jarring, and placing additional stress on bridge joints. Extreme heat may cause heat stress in materials such as asphalt and increase the frequency of repairs and replacements (resilient MA, 2018). Similar effects can occur as the result of freezing and thawing cycles that cause what is known as a frost heave in the pavement. Frost heaves are significant hazards to drivers and railways, as they can make roads and tracks uneven.

Railroad tracks can expand in extreme heat, causing the track to “kink” and derail trains. Higher temperatures inside the enclosure-encased equipment, such as traffic control devices and signal control systems for rail service, may result in equipment failure (MEMA & EOEEA, 2018).

Natural Environment

There are numerous ways in which changing temperatures will impact the natural environment. Because the species that exist in a given area have adapted to survive within a specific temperature range, extreme temperature events can place significant stress both on individual species and the ecosystems in which they function. High-elevation spruce-fir forests, forested boreal swamp, and higher-elevation northern hardwoods are likely to be highly vulnerable to climate change (MCCS and DFW, 2010). Higher summer temperatures will disrupt wetland hydrology. Paired with a higher incidence and severity of droughts, high temperatures and evapotranspiration rates could lead to habitat loss and wetlands drying out (MCCS and DFW, 2010). Individual extreme weather events usually have a limited long-term impact on natural systems, although unusual frost events occurring after plants begin to bloom in the spring can cause significant damage. However, the impact on natural resources of changing average temperatures and the changing frequency of extreme climate events is likely to be massive and widespread. Climate change is anticipated to be the second-greatest contributor to this biodiversity crisis, which is predicted to change global land use. One significant impact of increasing temperatures may be the northern migration of plants and animals. Over time, shifting habitat may result in a geographic mismatch between the location of conservation land and the location of critical habitats and species the conserved land was designed to protect. Between 1999 and 2018 (fiscal years), the Commonwealth spent more than $395 million on the acquisition of more than 143,033 acres of land and has managed this land under the assumption of a stable climate. As species respond to climate change, they will likely continue to shift their ranges or change their phenologies to track optimal conditions (MCCS and DFW, 2010). As a result, climate change will have significant impacts on traditional methods of wildlife and habitat management, including land conservation and mitigation of non-climate stressors (MCCS and DFW, 2010). Changing temperatures, particularly increasing temperatures, will also have a major impact on the sustainability of our waterways and the connectivity of aquatic habitats (i.e., entire portions of major rivers will dry up, limiting fish passage down the rivers). Additional impacts of warming temperatures include the increased survival and grazing damage of white-tailed deer, increased invasion rates of invasive plants, and increased survival and productivity of insect pests, which cause damage to forests (MCCS and DFW, 2010). As temperature increases, the length of the growing season will also increase. Since the 1960s, the growing season in Massachusetts increased by approximately 10 days (CAT, n.d. as cited in MEMA & EOEEA, 2018).

Climate change is also likely to result in a shift in the timing and durations of various seasons. This change will likely have repercussions on the life cycles of both flora and fauna within the Commonwealth. While there could be economic benefits from a lengthened growing season, a lengthened season also carries a number of risks. The probability of frost damage will increase, as the earlier arrival of warm temperatures may cause many trees and flowers to blossom prematurely only to experience a subsequent frost. Additionally, pests and diseases may also have a greater impact in a drier world, as they will begin feeding and breeding earlier in the year (Land Trust Alliance, n.d. as cited in MEMA & EOEEA, 2018).

Economy 44 CFR § 201.6(c)(2)(i)(B)

The agricultural industry is most directly at risk in terms of economic impact and damage due to extreme temperature and drought events. Extreme heat can result in drought and dry conditions, which directly impact livestock and crop production. Increasing average temperatures may make crops more susceptible to invasive species (see Section 4.3.3 for additional information). Higher temperatures that result in greater concentrations of ozone negatively impact plants that are sensitive to ozone (USGCRP, 2009). Additionally, as previously described, changing temperatures can impact the phenology.

Above average, below average, and extreme temperatures are likely to impact crops—such as apples, cranberries, and maple syrup—that rely on specific temperature regimes (resilient MA, 2018). Unseasonably warm temperatures in early spring that are followed by freezing temperatures can result in crop loss of fruit-bearing trees. Farmers may have the opportunity to introduce new crops that are viable under warmer conditions and longer growing seasons; however, a transition such as this may be costly (resilient MA, 2018 as cited in MEMA & EOEEA, 2018). Livestock are also impacted, as heat stress can make animals more vulnerable to disease, reduce their fertility, and decrease the rate of milk production. Additionally, scientists believe the use of parasiticides and other animal treatments may increase as the threat of invasive species grows. Increased use of these treatments increases the risk of pesticides entering the food chain and could result in pesticide resistance, which could result in additional economic impacts on the agricultural industry (MEMA & EOEEA, 2018).

Future Conditions

Temperature changes will be gradual over the years. However, for the extremes, meteorologists can accurately forecast event development and the severity of the associated conditions with several days lead time. High, low, and average temperatures in Massachusetts are all likely to increase significantly over the next century as a result of climate change. This gradual change will put long-term stress on a variety of social and natural systems and will exacerbate the influence of discrete events (MEMA & EOEEA, 2018).

Hazard Profile

Tornadoes / high wind was identified by Great Barrington as a top hazard during the MVP planning process.

Likely Severity

Tornadoes are potentially the most dangerous of local storms. If a major tornado were to strike damage could be significant, particularly if there is a home or other facility in its path. Many people could be displaced for an extended period of time; buildings could be damaged or destroyed; businesses could be forced to close for an extended period of time or even permanently; and routine services, such as telephone or power, could be disrupted.

The NWS rates tornadoes using the Enhanced Fujita scale (EF scale), which does not directly measure wind speed but rather the amount of damage created. This scale derives 3-second gusts estimated at the point of damage based on the assignment of 1 out of 8 degrees of damage to a range of different structure types. These estimates vary with height and exposure. This method is considerably more sophisticated than the original Fujita scale, and it allows surveyors to create more precise assessments of tornado severity.

Probability

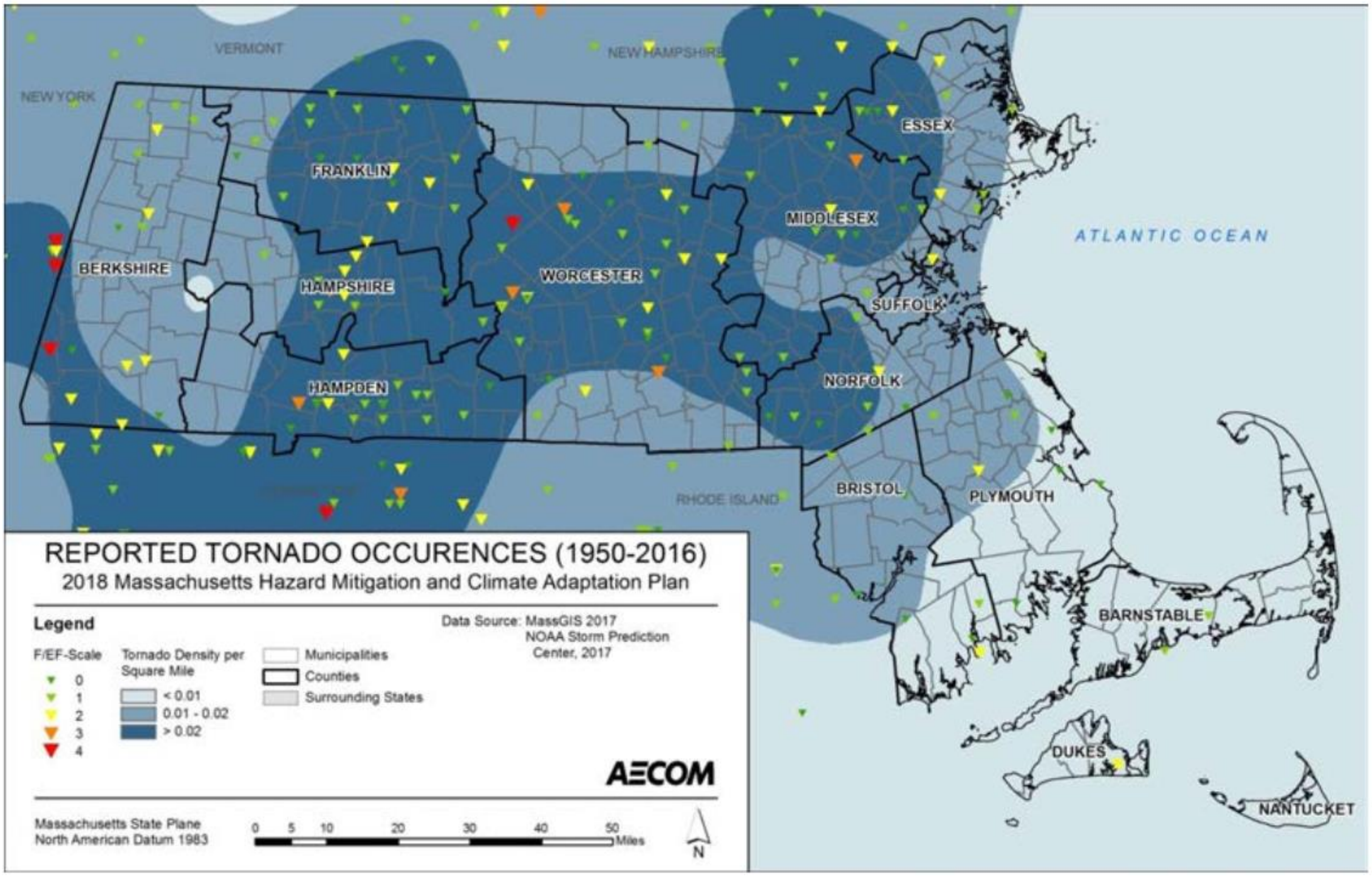
The location of tornado impact is totally unpredictable. Tornadoes are fierce phenomena which generate wind funnels of up to 200 MPH or more, and occur in Massachusetts usually during June, July, and August. Worcester County, and areas just to its west have been dubbed the "tornado alley" of the state, as the majority of significant tornadoes in Massachusetts weather history have occurred in that region (BRPC, 2012).

From 1950 to 2017, the Commonwealth experienced 171 tornadoes, or an average annual occurrence of 2.6 tornado events per year. In the last 20 years, the average frequency of these events has been 1.7 events per year (NOAA, 2018).   Massachusetts experienced an average of 1.4 tornadoes per 10,000 square feet annually between 1991 and 2010, less than half of the national average of 3.5 tornadoes per 10,000 square feet per year (NOAA, n.d. as cited in MEMA & EOEEA, 2018).

Geographic Areas Likely Impacted

While the area impacted by a tornado will be limited at the time of the event, anywhere in Great Barrington is susceptible. There are areas in Great Barrington and neighboring communities that appear to have more tornado activity, the next tornado would not likely follow this path. Figure 3.15 is show tornadoes reported in Massachusetts.

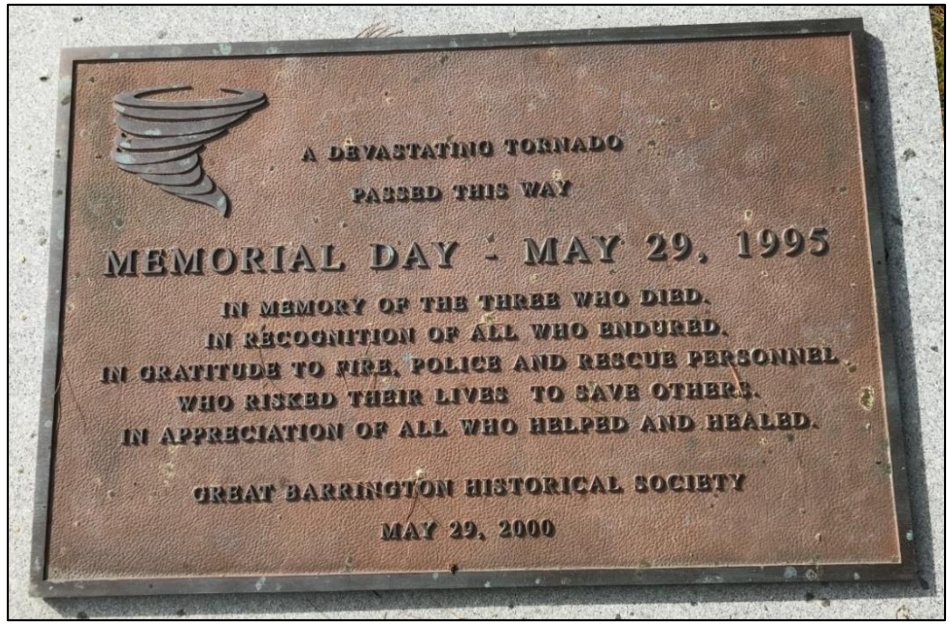
Figure 3.17: Density of Reported Tornadoes per Square Mile



Historic Data

The National Climatic Data Center reports data on tornado events and does so as far back as 1950. Of the 18 tornados that have occurred in Berkshire County between 1950 and 2018, only one has occurred since 2007, an EF1 in July 2014 in Dalton. Four tornados occurred during a single storm on July 3, 1997. These have resulted in over $29 million in damage, seven deaths, and 60+ injuries (NOAA, 2017). The most memorable tornados in recent history occurred in West Stockbridge in August of 1973 (category F4) and in Great Barrington, Egremont, and Monterey in May of 1995 (category F4). In the West Stockbridge tornado four people died and 36 were injured, and in Great Barrington three people died and 24 were injured. The signs of the tornado's destruction are still visible today in Great Barrington from Rt. 7. The hill to the east is scarred where the tornado uprooted and toppled trees (MEMA & EOEEA, 2018).

Figure 3.18: memorial in Great Barrington for Lives Lost in 1995 Due to Tornado



Vulnerability Assessment

People

In general, vulnerable populations include people over the age of 65, people with low socioeconomic status, people with low English language fluency, people with compromised immune systems, and residents living in areas that are isolated from major roads. Power outages can be life-threatening to those who are dependent on electricity for life support and can result in increased risk of carbon monoxide poisoning. Individuals with limited communication capacity, such as those with limited internet or phone access, may not be aware of impending tornado warnings. The isolation of these populations is also a significant concern, as is the potential insufficiency of older or less stable housing to offer adequate shelter from tornadoes (MEMA & EOEEA, 2018).

Built Environment

All critical facilities and infrastructure are exposed to tornado events. High winds could down power lines and poles adjacent to roads (resilient MA, 2018). Damage to aboveground transmission infrastructure can result in extended power outages. Incapacity and loss of roads and bridges are the primary transportation failures resulting from tornadoes, and these failures are primarily associated with secondary hazards, such as landslide events. Tornadoes can cause significant damage to trees and power lines, blocking roads with debris, incapacitating transportation, isolating populations, and disrupting ingress and egress. Of particular concern are bridges and roads providing access to isolated areas and to the elderly. The hail, wind, debris, and flash flooding associated with tornadoes can cause damage to infrastructure, such as storage tanks, hydrants, residential pumping fixtures, and distribution systems. This can result in loss of service or reduced pressure throughout the system. Water and wastewater utilities are also vulnerable to potential contamination due to chemical leaks from ruptured containers. Ruptured service lines in damaged buildings and broken hydrants can lead to loss of water and pressure (EPA, 2015 as cited in MEMA & EOEEA, 2018).

Natural environment

Direct impacts may occur to flora and fauna small enough to be uprooted and transported by the tornado. Even if the winds are not sufficient to transport trees and other large plants, they may still uproot them, causing significant damage to the surrounding habitat. As felled trees decompose, the increased dry matter may increase the threat of wildfire in vegetated areas. Additionally, the loss of root systems increases the potential for soil erosion. Disturbances created by blowdown events may also impact the biodiversity and composition of the forest ecosystem. Invasive plant species are often able to quickly capitalize on the resources (such as sunlight) available in disturbed and damaged ecosystems. This enables them to gain a foothold and establish quickly with less competition from native species. In addition to damaging existing ecosystems, material transported by tornadoes can also cause environmental havoc in surrounding areas. Particular challenges are presented by the possibility of asbestos-contaminated building materials or other hazardous waste being transported to natural areas or bodies of water, which could then become contaminated. Public drinking water reservoirs may also be damaged by widespread winds uprooting watershed forests and creating serious water quality disturbances.

Economy

Forestry species and agricultural crops, equipment, and infrastructure may be directly impacted by tornadoes. Tornado events are typically localized; however, in those areas, economic impacts can be significant. Types of impacts may include loss of business functions, water supply system damage, damage to inventories, relocation costs, wage losses, and rental losses due to the repair or replacement of buildings. Recovery and clean-up costs can also be costly. The damage inflicted by historical tornadoes in Massachusetts varies widely, but the average damage per event is approximately $3.9 million.

Future Conditions

As highlighted in the National Climate Assessment, tornado activity in the U.S. has become more variable, and increasingly so in the last 2 decades. While the number of days per year that tornadoes occur has decreased, the number of tornadoes on these days has increased. Climate models show projections that the frequency and intensity of severe thunderstorms (which include tornadoes, hail, and winds) will increase (USGCRP, 2017 as cited in MEMA & EOEEA, 2018).

Landslides

Hazard Profile

The term landslide includes a wide range of ground movements, such as rock falls, deep failure of slopes, and shallow debris flows. The most common types of landslides in Massachusetts include translational debris slides, rotational slides, and debris flows. Most of these events are caused by a combination of unfavorable geologic conditions (silty clay or clay layers contained in glaciomarine, glaciolacustrine, or thick till deposits), steep slopes, and/or excessive wetness leading to excess pore pressures in the subsurface (MEMA & EOEEA, 2018).

Likely Severity

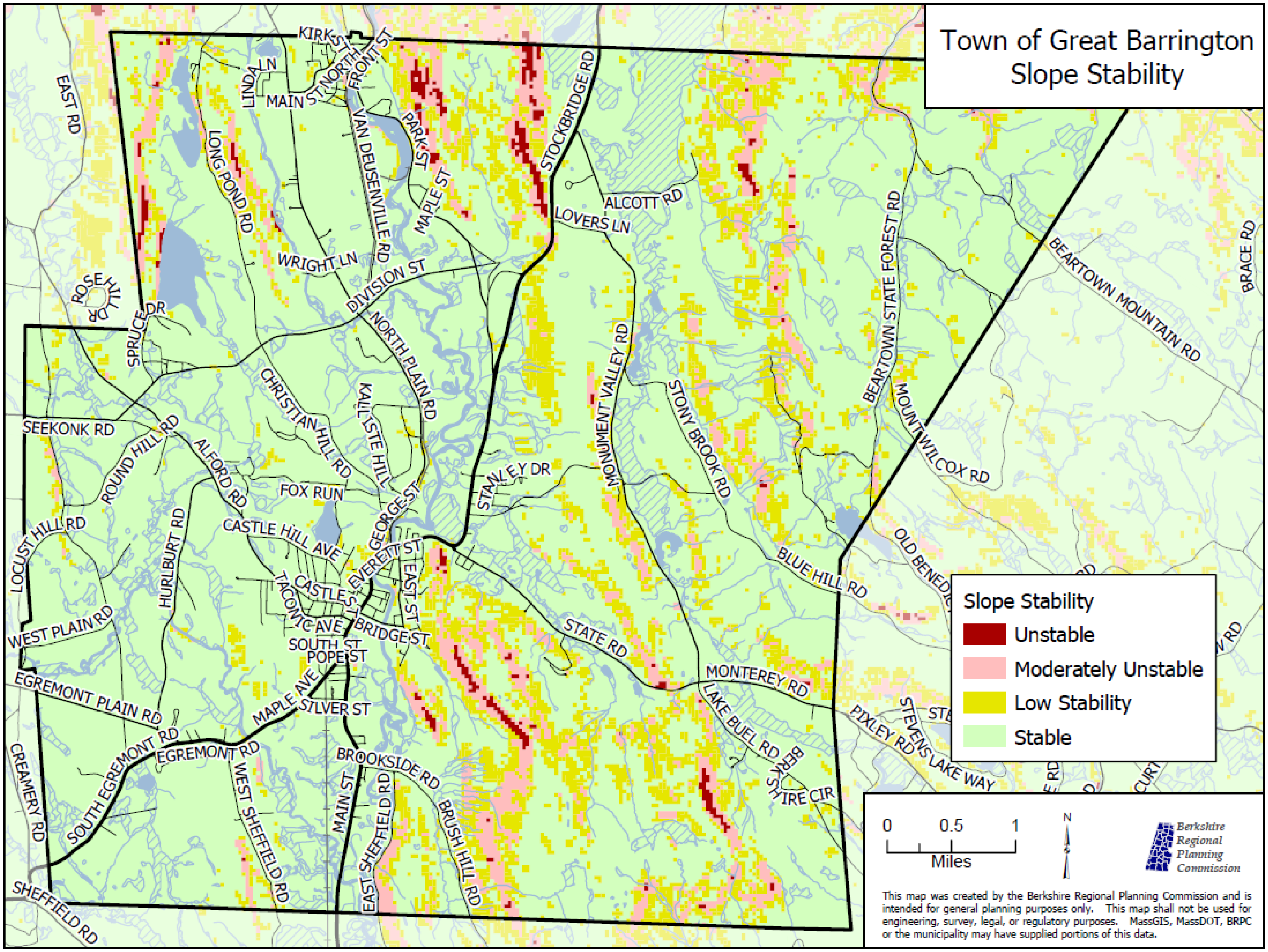
Natural variables that contribute to the overall extent of potential landslide activity in any particular area include soil properties, topographic position and slope, and historical incidence. Predicting a landslide is difficult, even under ideal conditions (MEMA & EOEEA, 2018). The Town of Great Barrington did not rank damages of landslides as severe relative to other hazards because it is likely to impact a very small area that may or more likely will not have structures. estimations of the potential severity of landslides are informed by previous occurrences as well as an examination of landslide susceptibility. Information about previous landslides provide insight as to both where landslides may occur and what types of damage may result. It is important to note, however, that landslide susceptibility only identifies areas potentially affected and does not imply a time frame when a landslide might occur (MEMA & EOEEA, 2018).

Probability

The probability of instability metric indicates how likely each area is to be unstable. In 2013, the Massachusetts Geological Survey prepared an updated map of potential landslide hazards for the Commonwealth (funded by FEMA's Hazard Mitigation Grant Program) to provide the public, local governments, and emergency management agencies with the location of areas where slope movements have occurred or may possibly occur in the future under conditions of prolonged moisture and high-intensity rainfall (MEMA & EOEEA, 2018). Using the data prepared for Massachusetts, a color-coded map of slope stability was prepared for Great Barrington, which can be used to roughly predict areas prone to landslide. This study is discussed further later in the landslide section of this plan.

For the purposes of this HMP, the probability of future occurrences is defined by the number of events over a specified period of time. Looking at the recent record, from 1996 to 2012, there were eight noteworthy events that triggered one or more slides in the Commonwealth. However, because many landslides are minor and occur unobserved in remote areas, the true number of landslide events is probably higher. Based on conversations with the Massachusetts Department of Transportation (MassDOT), it is estimated that about 30 or more landslide events occurred in the period between 1986 and 2006 (Hourani, 2006). This roughly equates to one to three landslide events each year.

Figure 3.19: Great Barrington Slope Stability - Landslide Map



Generally accepted warning signs for landslide activity include the following:

- Springs, seeps, or saturated ground in previously dry areas
- New cracks or unusual bulges in the ground
- Soil moving away from foundations
- Ancillary structures, such as decks and patios, tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken waterlines and other underground utilities
- Leaning telephone poles, trees, retaining walls, or fences
- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content)
- Sudden decrease in creek water levels even though rain is still falling or has just recently stopped
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb
- A faint rumbling that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together (MEMA & EOEEA, 2018

Geographic Areas Likely Impacted

Although specific landslide events cannot be predicted, a slope stability map shows where slope movements are most likely to occur after periods of high-intensity rainfall. Unstable areas are located throughout the Commonwealth. The highest prevalence of unstable slopes is generally found in the western portion of the Commonwealth, including the area around Mount Greylock and the nearby portion of the Deerfield River, the U.S. Highway 20 corridor near Chester, as well as the main branches of the Westfield River (MEMA & EOEEA, 2018). Figure 3.19 shows slope stability in Great Barrington. The color-coded map delineates relative hazard rankings (high, moderate, low and very low) for the initiation of naturally occurring, shallow, translational slope movements (debris flows, debris avalanches, mudslides). These rankings are based on the severity of the slope, various soil parameters and the response of that landscape to rainfall that leads to saturated conditions (relative wetness index). The four relative hazard rankings are generalized from six stability zones[14]. The red areas on the map indicating unstable to the upper threshold of instability for the Predicated Stability Zone. Pink shows the lower threshold of instability. Mustard yellow is nomically stable or moderately stable, which would require minor to moderate destabilizing factors for instability. Green represents the stable areas, which would require significant destabilizing factors to cause instability. Areas with high to moderate hazard rankings are areas where further slope stability analysis and assessment, including field verification, is recommended before any ground disturbance[15].

Landslides associated with slope saturation occur predominantly in areas with steep slopes underlain by glacial till or bedrock. Bedrock is relatively impermeable relative to the unconsolidated material that overlies it. Similarly, glacial till is less permeable than the soil that forms

[14,10] http://www.geo.umass.edu/stategeologist/Products/Landslide_Map/Slope_Stability_Map_MA_Report.pdf?_ga=2.218289625.1917141679.1562177934-548417844.1562177934

above it. Thus, there is a permeability contrast between the overlying soil and the underlying, and less permeable, unweathered till and/or bedrock. Water accumulates on this less permeable layer, increasing the pore pressure at the interface. This interface becomes a plane of weakness. If conditions are favorable, failure will occur (Mabee, 2010 as cited in MEMA & EOEEA, 2018). Occasionally, landslides occur as a result of geologic conditions and/or slope saturation. Adverse geologic conditions exist wherever there are lacustrine or marine clays, as clays have relatively low strength. These clays often formed in the deepest parts of the glacial lakes that existed in Massachusetts following the last glaciation. Landslides can also be caused by external forces, including both undercutting (due to flooding) and construction. Construction-related failures occur predominantly in road cuts excavated into glacial till where topsoil has been placed on top of the till. Examples can be found along the Massachusetts Turnpike. Other construction-related failures occur in utility trenches excavated in materials that have very low cohesive strength and an associated high-water table (usually within a few feet of the surface). This situation occurs in sandy deposits with very few fine sediments and can occur in any part of the Commonwealth (MEMA & EOEEA, 2018).

Historic Data

Historical landslide data for the Commonwealth suggests that most landslides are preceded by 2 or more months of higher than normal precipitation, followed by a single, high-intensity rainfall of several inches or more (Mabee and Duncan, 2013). This precipitation can cause slopes to become saturated. In Massachusetts, landslides tend to be more isolated in size and pose threats to high traffic roads and structures that support tourism, and general transportation. Landslides commonly occur shortly after other major natural disasters, such as earthquakes and floods, which can exacerbate relief and reconstruction efforts. Many landslide events may have occurred in remote areas, causing their existence or impact to go unnoticed. Expanded development and other land uses may contribute to the increased number of landslide incidences and/or the increased number of reported events in the recent record (MEMA & EOEEA, 2018).

The most severe landslide to occur in the Berkshire region occurred along Route 2 in Savoy during T.S. Irene in 2011. The slide was 900 feet long, approximately 1.5 acres, with an average slope angle is 28 to 33°. The elevation difference from the top of the slide to the bottom was 460 feet, with an estimated volume of material moved being 5,000 cubic yards. Only the top 2 to 4 feet of soil material was displaced (BRPC, 2012).

Vulnerability Assessment

People

Populations who rely on potentially impacted roads for vital transportation needs are considered to be particularly vulnerable to this hazard. The number of lives endangered by the landslide hazard is increasing due to the state's growing population and the fact that many homes are built on property atop or below bluffs or on steep slopes subject to mass movement. People in landslide hazard zones are exposed to the risk of dying during a large-scale landslide; however, damage to infrastructure that impedes emergency access and access to health care is the largest health impact associated with this hazard. Mass movement events in the vicinity of major roads could deposit many tons of sediment and debris on top of the road. Restoring vehicular access is often a lengthy and expensive process. Additionally, landslides can result in injury and loss of life. Landslides can impact access to power and clean water and increase exposure to vector-borne diseases.

Built Environment

According to the building maps available, Great Barrington does not have any buildings within areas designated as unstable, or within that red zone on the map. Great Barrington does have 15 buildings, including residential and religious buildings within areas designated at moderately unstable, or the pink areas on the map. In addition, there are 34 buildings, residential and mixed use, that are within the mustard yellow areas designated at low stability. If property is further developed around those 15 buildings within the lower threshold of instability (pink on the map) then analysis should be required to prevent destabilizing the slope in that area.

Landslides can result in direct losses as well as indirect socioeconomic losses related to damaged infrastructure. Infrastructure located within areas shown as unstable on the Slope Stability Map should be considered to be exposed to the landslide hazard. Highly vulnerable areas include mountain roads and transportation infrastructure, both because of their exposure to this hazard and the fact that there may be limited transportation alternatives if this infrastructure becomes unusable. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use. Access to major roads is crucial to life safety after a disaster event and to response and recovery operations. The ability of emergency responders to reach people and property impacted by landslides can be impaired by roads that have been buried or washed out by landslides. The instability of areas where landslides have occurred can also limit the ability of emergency responders to reach survivors.

The energy sector is vulnerable to damaged infrastructure associated with landslides. Transmission lines are generally elevated above steep slopes, but the towers supporting them can be subject to landslides. A landslide may cause a tower to collapse, bringing down the lines and causing a transmission fault. Transmission faults can cause extended and broad area outages (MEMA & EOEEA, 2018).

Surface water bodies may become directly or indirectly contaminated by landslides. Landslides can reduce the flow of streams and rivers, which can result in upstream flooding and reduced downstream flow. This may impact the availability of drinking water (MEMA & EOEEA, 2018).

Natural Environment

Landslides can affect a number of different facets of the environment, including the landscape itself, water quality, and habitat health. Following a landslide, soil and organic materials may enter streams, reducing the potability of the water and the quality of the aquatic habitat. Additionally, mass movements of sediment may result in the stripping of forests, which in turn impacts the habitat quality of the animals that live in those forests (Geertsema and Vaugeouis, 2008 as cited in MEMA & EOEEA, 2018). Flora in the area may struggle to re-establish following a significant landslide because of a lack of topsoil.

Economy

Direct costs of landslide include the actual damage sustained by buildings, property, and infrastructure. Indirect costs, such as clean-up costs, business interruption, loss of tax revenues, reduced property values, and loss of productivity are difficult to measure. Additionally, ground failure threatens transportation corridors, fuel and energy conduits, and communication lines (USGS, 2003 as cited in MEMA & EOEEA, 2018). Landslides that affect farmland can result in significant loss of livelihood and long-term loss of productivity. Forests can also be significantly impacted by landslides.

Future Conditions

Increased precipitation, severe weather events and other effects of climate change affecting Great Barrington and the great region may lead to a higher likelihood for landslides as soil and vegetative cover are impacted. Overall Great Barrington is at low risk of landslide, however further development of unstable slopes could prove to be detrimental.

Hazard Profile

A wildfire can be defined as any non-structure fire that occurs in vegetative wildland that contains grass, shrub, leaf litter, and forested tree fuels. Wildfires in Massachusetts are caused by natural events, human activity, or prescribed fire. Wildfires often begin unnoticed but spread quickly, igniting brush, trees, and potentially homes (MEMA & EOEEA, 2018).

Likely severity

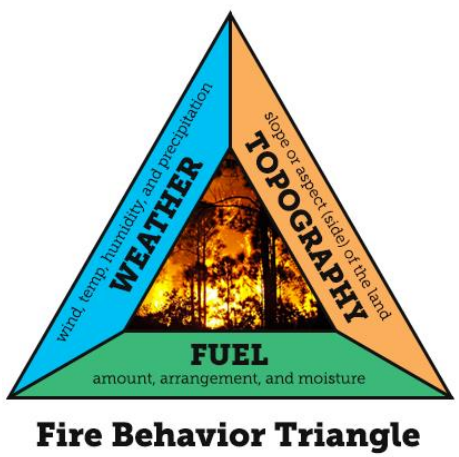
Relative to the likely severity on a national scale for wildfire impacts, Great Barrington is at a relatively low risk. The “wildfire behavior triangle” reflects how three primary factors influence wildfire behavior: fuel, topography, and weather. Each point of the triangle represents one of the three factors, and arrows along the sides represent the interplay between the factors. For example, drier and warmer weather with low relative humidity combined with dense fuel loads and steeper slopes can result in dangerous to extreme fire behavior. How a fire behaves primarily depends on the characteristics of available fuel, weather conditions, and terrain.

Fuel:

−Lighter fuels such as grasses, leaves, and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs, and trunks take longer to warm and ignite.
−Snags and hazard trees, especially those that are diseased or dying, become receptive to ignition when influenced by environmental factors such as drought, low humidity, and warm temperatures. Weather:
−Strong winds, especially wind events that persist for long periods or ones with significant sustained wind speeds, can exacerbate extreme fire conditions or accelerate the spread of wildfire.
−Dry spring and summer conditions, or drought at any point of the year, increases fire risk. Similarly, the passage of a dry, cold front through the region can result in sudden wind speed increases and changes in wind direction.
−Thunderstorms in Massachusetts are usually accompanied by rainfall; however, during periods of drought, lightning from thunderstorm cells can result in fire ignition. Thunderstorms with little or no rainfall are rare in New England but have occurred.

Terrain

−Topography of a region or a local area influences the amount and moisture of fuel.
−Barriers such as highways and lakes can affect the spread of fire.



Source: WeatherSTEM.com

−Elevation and slope of landforms can influence fire behavior because fire spreads more easily uphill compared to downhill.

Probability

It is difficult to predict the likelihood of wildfires in a probabilistic manner because a number of factors affect fire potential and because some conditions (e.g., ongoing land use development patterns, location, and fuel sources) exert changing pressure on the wildland-urban interface zone. However, based on the frequency of past occurrences, there will likely be at least one notable wildfire in the Commonwealth each year, narrowing down the probably of Great Barrington being affected even lower. Brush fires that are routinely handled by the local fire department are much more common.

Geographic Areas Likely Impacted

Great Barrington is vulnerable to wildfire across the municipality. It is not uncommon for fires to be started along train tracks such as the Housatonic Railroad cutting through Great Barrington. According to the local Building Inspector, Great Barrington eventually built all the buildings along the railroad tracks from brick because of the frequency of fires and building loss.

Fire risk and associated damages increases where there is a mix of development and forested land. While the risk of fire is relatively low for Great Barrington compared to the Commonwealth, there is some hazard still posed by wildfire. Given increasing temperature and evaporation, drought and forest fire concerns are growing because of the potential for more fuel in forested land.

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. The SILVIS Lab at the University of Wisconsin-Madison Department of Forest Ecology and Management classifies exposure to wildlife hazard as “interface” or “intermix.” Intermix communities are those where housing and vegetation intermingle and where the area includes more than 50 percent vegetation and has a housing density greater than one house per 16 hectares (approximately 6.5 acres). 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. Inventoried assets (population, building stock, and critical facilities) were overlaid with interface data to determine potential exposure and impacts related to this hazard, and can be seen in Figure 3.20 (MEMA & EOEEA, 2018). Figure 3.21 shows the results of a geospatial analysis of fire risk by the Northeast Wildfire Risk Assessment Geospatial Work Group.

Figure 3.20: Wildland-Urban Interface and Intermix for the Commonwealth of Massachusetts

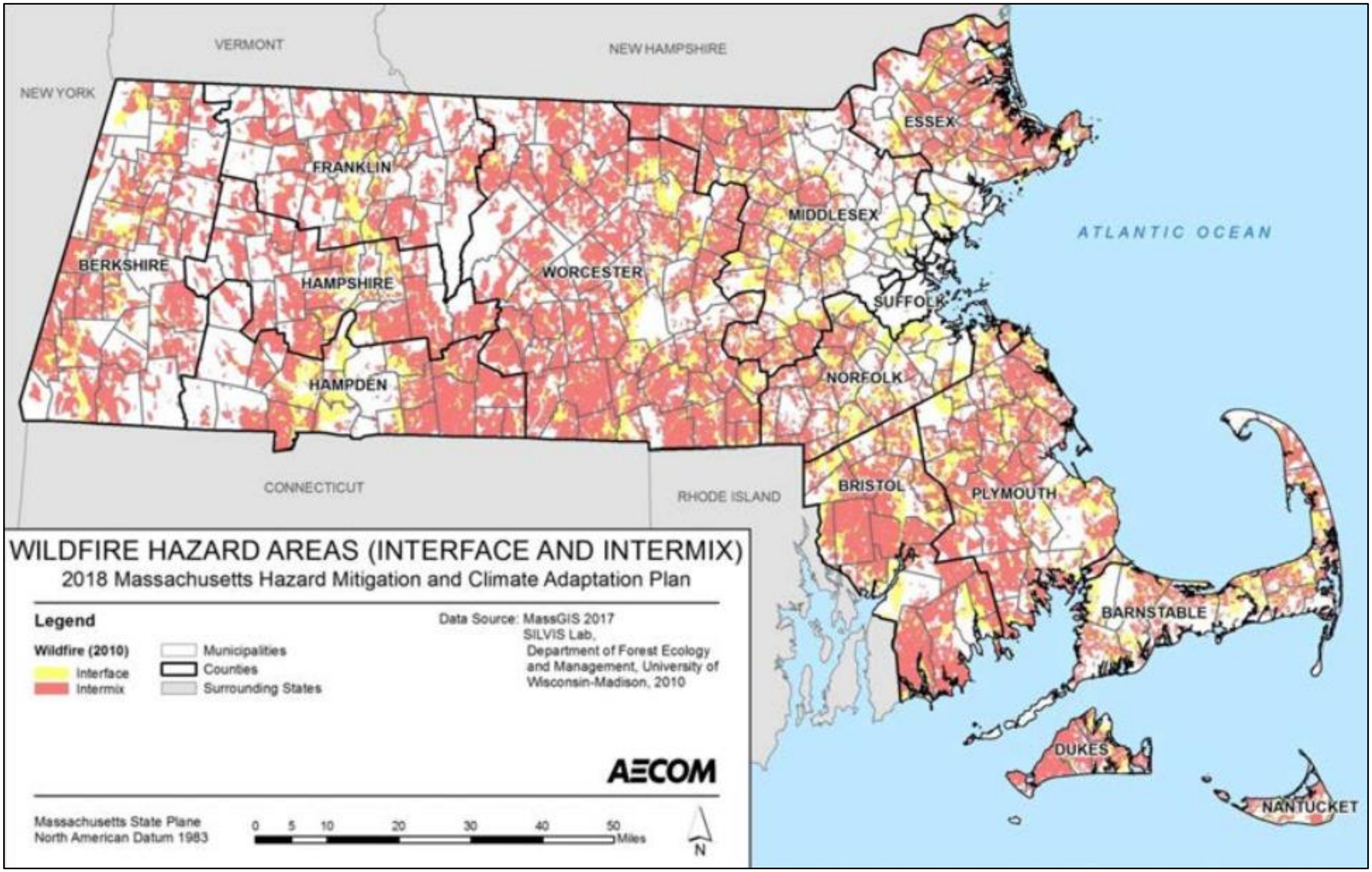
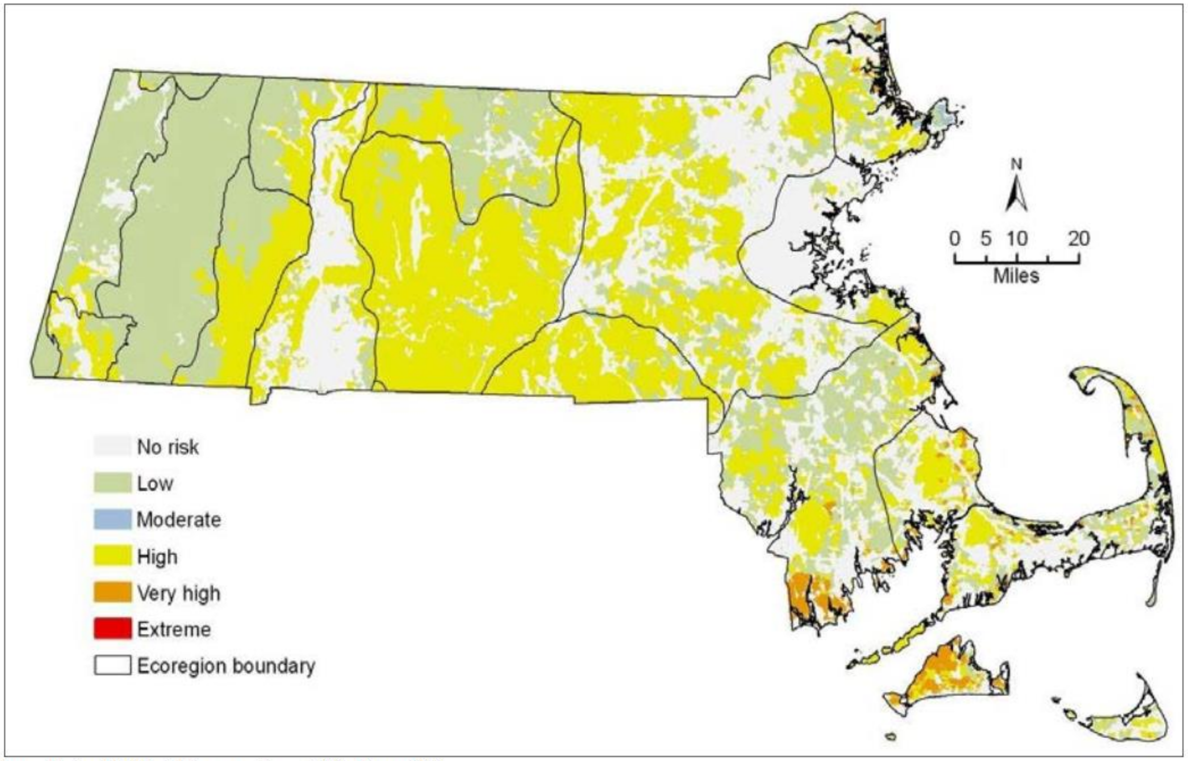


Figure 3.21: Wildfire Risk Areas for the Commonwealth of Massachusetts



Source: Northeast Wildfire Risk Assessment Geospatial Work Group, 2009

Historic Data

The wildfire season in Massachusetts usually begins in late March and typically culminates in early June, corresponding with the driest live fuel moisture periods of the year. April is historically the month in which wildfire danger is the highest. Drought, snowpack level, and local weather conditions can impact the length of the fire season (MEMA & EOEEA, 2018).

Based on the DCR Bureau of Forest Fire Control and Forestry records, in 1911, more than 34 acres were burned on average during each wildfire statewide. Since then, that figure has been reduced to 1.17 acres burned annually statewide (MEMA, 2013). According to the Massachusetts Fire Incident Reporting System, wildfires reported to DCR in the past five years are generally trending downward. According to this system there were 901 fire incidents, combined urban and wildland, in Berkshire County during the years 2007-2016, and of these 411 (46% of total) occurred in the City of Pittsfield, the urban center of the region. This same data reports that a total of 832 acres were burned in the county during those 10 years, 631 (76%) of which are reported as acres of wildland burned. This indicates that over this 10-year span an average of 63 acres of wildland burned annually in Berkshire County. Of the 901 incidents, only 12 burned more than 10 acres and two of these burned more than 100 acres. It should be noted that during this same time period there were two large wildland fires in the county: 168 acres in Lanesborough in 2008 and 272 acres in Clarksburg near the Williamstown border in 2015. If these incidents were considered statistic outliers and removed from the data, the average totaled burned acres during 2007-2016 would be 39 and the average wildland acres burned would be 19. Berkshire County fire officials respond rapidly through mutual aid and through a coordinated effort with the DCR.

Vulnerability Assessment

People

As demonstrated by historical wildfire events, potential losses from wildfire include human health and the lives of residents and responders. The most vulnerable populations include emergency responders and those within a short distance of the interface between the built environment and the wildland environment. In 2018 MEMA and EOEEA estimated the population vulnerable to the wildfire hazard by overlaying the interface and intermix hazard areas with the 2010 U.S. Census population data. The Census blocks identified as interface or intermix were used to calculate the estimated population exposed to the wildfire hazard. Interface or intermix areas are those where buildings intermingle with forest. In Berkshire County 131,219 persons were in Wildlife Hazard Areas. 55,486 in Interface areas, and 39,171 in Intermix areas.

All individuals whose homes or workplaces are located in wildfire hazard zones are exposed to this hazard, as wildfire behavior can be unpredictable and dynamic. However, 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. Landowners with pets or livestock may face additional challenges in evacuating if they cannot easily transport their animals. Outside of the area of immediate impact, sensitive populations, such as those with compromised immune systems or cardiovascular or respiratory diseases, can suffer health impacts from smoke inhalation. Individuals with asthma are more vulnerable to the poor air quality associated with wildfire. Finally, firefighters and first responders are vulnerable to this hazard if they are deployed to fight a fire in an area they would not otherwise be in.

Smoke and air pollution from wildfires can be a severe health hazard. Smoke generated by wildfire consists of visible and invisible emissions containing particulate matter (soot, tar, and minerals), gases (water vapor, carbon monoxide, carbon dioxide (CO_2), and nitrogen oxides), and toxics (formaldehyde and benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Other public health impacts associated with wildfire include difficulty in breathing, reactions to odor, and reduction in visibility. Due to the high prevalence of asthma in Massachusetts, there is a high incidence of emergency department visits when respiratory irritants like smoke envelop an area. Wildfires may also threaten the health and safety of those fighting the fires. First responders are exposed to dangers from the initial incident and the aftereffects of smoke inhalation and heat-related illness.

Built Environment

All buildings, municipal, residential, ancillary and utility are vulnerable to wildfire. Communications and electrical systems would be cut off by wildfire if affected at portion of the system. Drinking water for Great Barrington would also be at risk of contamination. Most road and railroads would be without damage except in the worst scenarios. However, fires can create conditions that block or prevent access, and they can isolate residents and emergency service providers. The wildfire hazard typically does not have a major direct impact on bridges, but wildfires can create conditions in which bridges are obstructed (MEMA & EOEEA, 2018).

Natural environment

Fire is a natural part of many ecosystems and serves important ecological purposes, including facilitating the nutrient cycling from dead and decaying matter, removing diseased plants and pests, and regenerating seeds or stimulating germination of certain plants. However, many wildfires, particularly man-made wildfires, can also have significant negative impacts on the environment. In addition to direct mortality, wildfires and the ash they generate can distort the flow of nutrients through an ecosystem, reducing the biodiversity that can be supported. Frequent wildfires can eradicate native plant species and encourage the growth of fire-resistant invasive species. Some of these invasive species are highly flammable; therefore, their establishment in an area increases the risk of future wildfires. There are other possible feedback loops associated with this hazard. For example, every wildfire contributes to atmospheric CO_2 accumulation, thereby contributing to global warming and increasing the probability of future wildfires (as well as other hazards). There are also risks related to hazardous material releases during a wildfire. During wildfires, containers storing hazardous materials could rupture due to excessive heat and act as fuel for the fire, causing rapid spreading of the wildfire and escalating it to unmanageable levels. In addition, these materials could leak into surrounding areas, saturating soils and seeping into surface waters to cause severe and lasting environmental damage (MEMA & EOEEA, 2018).

Economy

Wildfire events can have major economic impacts on a community, both from the initial loss of structures and the subsequent loss of revenue from destroyed businesses and a decrease in tourism. Individuals and families also face economic risk if their home is impacted by wildfire. The exposure of homes to this hazard is widespread. Additionally, wildfires can require thousands of taxpayer dollars in fire response efforts and can involve hundreds of operating hours on fire apparatus and thousands of man-hours from volunteer firefighters. There are also many direct and indirect costs to local businesses that excuse volunteers from work to fight these fires (MEMA & EOEEA, 2018).

Future Conditions

Climate change alter the weather and fuel factors of wildfires. Climate scenarios project summer temperature increases between 3°F and 9°F and precipitation increases of up 5 inches (Northeast Climate Science Center, 2018). Hot dry spells create the highest fire risk, due to decreased soil moisture and increased evaporation and evapotranspiration. While in general annual precipitation has slightly increased Massachusetts in the past decades, the timing of snow and rainfall is changing. Less snowfall can lead to drier soils earlier in the spring and possible drought conditions in summer. More of our rain is falling in downpours, with higher rates of runoff and less soil infiltration. Such conditions would exacerbate summer drought and further promote high elevation wildfires where soil depths are generally thin. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods (MEMA, 2013).

- Without an increase in summer precipitation (greater than any predicted by climate models), future areas burned is very likely to increase.

- Infestation from insects is also a concern as it may affect forest health. Potential insect populations may increase with warmer temperatures and infested trees may increase fuel amount.

- Tree species composition will change as species respond uniquely to a changing climate.

- Wildfires cause both short-term and long-term losses. Short-term losses can include destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and the destruction of cultural and economic resources and community infrastructure (MEMA, 2013).

Hurricanes/Tropical Storms

Hazard Profile

Likely Severity

Tropical cyclones (tropical depressions, tropical storms, and hurricanes) form over the warm, moist waters of the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico:

- A tropical depression is declared when there is a low-pressure center in the tropics with sustained winds of 25 to 33 mph.
- A tropical storm is a named event defined as having sustained winds from 34 to 73 mph.
- If sustained winds reach 74 mph or greater, the storm becomes 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. Hurricanes are categorized based on sustained winds; wind gusts associated with hurricanes may exceed the sustained winds and cause more severe localized damage (NOAA, n.d.[b]).

When water temperatures are at least 80°F, hurricanes can grow and thrive, generating enormous amounts of energy, which is released in the form of numerous thunderstorms, flooding, rainfall, and very damaging winds. The damaging winds help create a dangerous storm surge in which the water rises above the normal astronomical tide. In the lower latitudes, hurricanes tend to move from east to west. However, when a storm drifts further north, the westerly flow at the mid-latitudes tends to cause the storm to curve toward the north and east. When this occurs, the storm may accelerate its forward speed. This is one of the reasons why some of the strongest hurricanes of record have reached New England (MEMA & EOEEA, 2018).

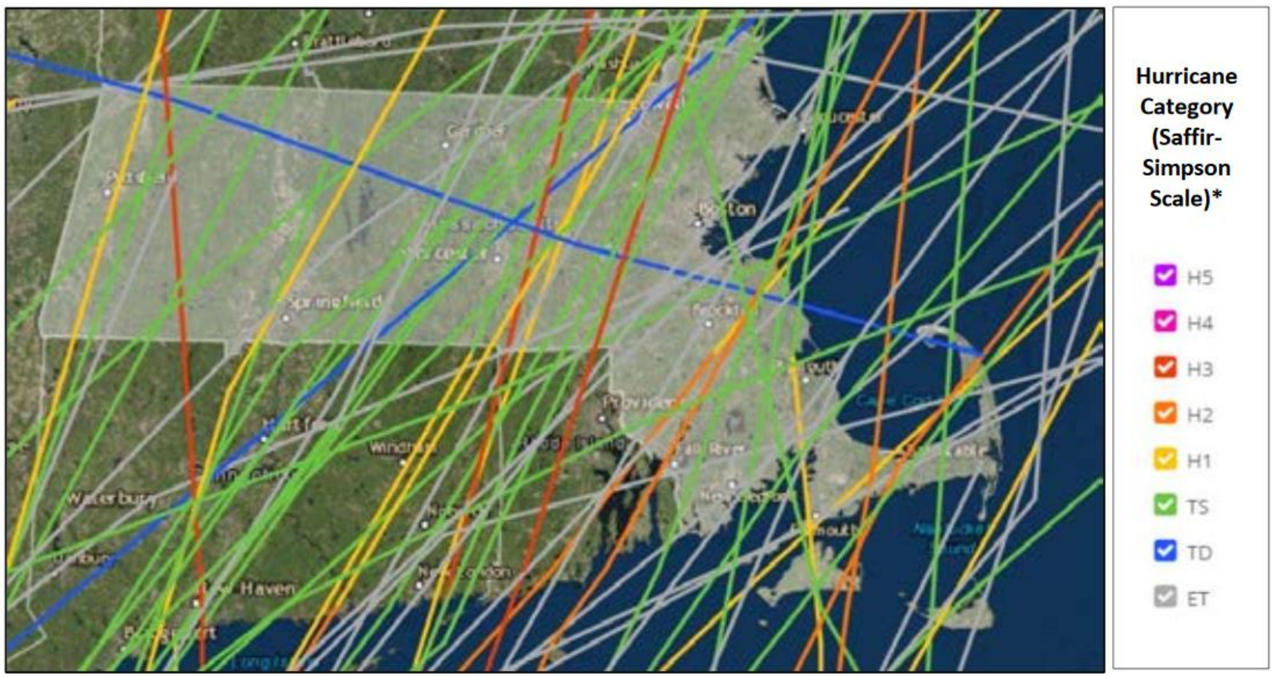
The severity of a hurricane is categorized by the Saffir-Simpson Hurricane Scale. This scale categorizes or rates hurricanes from 1 (Minimal) to 5 (Catastrophic) based on their intensity. This is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale. In Berkshire County flooding tends to be the impact of greatest concern because hurricane-force winds here occur less often. Historical data show that most tropical storms and hurricanes that hit landfall in New England are seldom of hurricane force, and of those most are a category 1 hurricane. The category hurricanes that stand out are those from 1938 and 1954 (BRPC, 2012).

Probability

Based on past reported hurricane and tropical storm data, the region can expect a tropical depression, storm or hurricane to cross the region every 14.5 years. However, the community may also be impacted by a tropical event whose path is outside of the region every 0.75 years. Based on past storm events and given that the center of the county is approximately 85 miles to the Long Island Sound and 115 miles to Boston Harbor, the Berkshires will continue to be impacted by hurricanes and tropical storms.

The NOAA Hurricane Research Division published a map showing the chance that a tropical storm or hurricane (of any intensity) will affect a given area during the hurricane season (June to November). This analysis was based on historical data from 1944 to 1999. Based on this analysis, the community has a 20-40% chance of a tropical storm or hurricane affecting the area each year (MEMA, 2013).

Figure 3.22: Historical Hurricane Paths within 65 miles of Massachusetts



Source: NOAA, n.d. as cited in MEMA & EOEEA, 2018 (*TS= Tropical Storm, TD = Tropical Depression)

The official hurricane season runs from June 1 to November 30. In New England, these storms are most likely to occur in August, September, and the first half of October. This is due in large part to the fact that it takes a considerable amount of time for the waters south of Long Island to warm to the temperature necessary to sustain the storms this far north. Also, as the region progresses into the fall months, the upper-level jet stream has more dips, meaning that the steering winds might flow from the Great Lakes southward to the Gulf States and then back northward up the eastern seaboard. This pattern would be conducive for capturing a tropical system over the Bahamas and accelerating it northward.

Geographic Areas Likely Impacted

The entire Commonwealth is vulnerable to hurricanes and tropical storms, depending on each storm's track. The coastal areas are more susceptible to damage due to the combination of both high winds and tidal surge. Inland areas, especially those in floodplains, are also at risk for flooding from heavy rain and wind damage. The majority of the damage following hurricanes and tropical storms often results from residual wind damage and inland flooding, as was demonstrated during recent tropical storms. Historic storm tracks can be seen in the NOAA graphic, figure 3.22. The graphic shows tracks that have cut through Great Barrington.

Historic Data

The National Oceanic and Atmospheric Administration (NOAA) has been keeping records of hurricanes since 1842 (Table 3.9). From 1842 to 2018, there have been five (5) Tropical Depressions, five (5) Tropical Storms, one (1) Category 1 Hurricane and one (1) Category 2 Hurricane pass directly through Berkshire County.

Table 3.9: Tropical Depressions, Storms, and Hurricanes Traveling Across Berkshire County

Name	Category	Date
Not Named	Tropical Depression	8/17/1867
Unnamed	Tropical Storm	9/19/1876
Unnamed	Tropical Depression	10/24/1878
Unnamed	Category 1 Hurricane	8/24/1893
Unnamed	Tropical Storm	8/29/1893
Unnamed	Tropical Depression	11/1/1899
Unnamed	Tropical Depression	9/30/1924
Unnamed	Category 2 Hurricane	9/21/1938
Able	Tropical Storm	9/1/1952
Gracie	Tropical Depression	10/1/1959
Doria	Tropical Storm	8/28/1971
Irene	Tropical Storm	8/28/2011

The Hurricane Floods of 1938 remains one of the most memorable historic storms. In 1940 the USGS wrote "The floods of September 1938 coming so shortly after the wide-spread floods of March 1936 and only 11 years after the New England flood of November 1927 have not only impressed upon the inhabitants of the affected regions the magnitude of the problem of controlling and confining the flood waters but have also indicated a prevailing frequency of occurrence that may have an important bearing on the economics of flood control. Each local, State, or Federal organization engaged in formulating plans for protective measures requires sound and adequate basic information relating to the stages, discharges, and other characteristics of all out-standing floods that have affected their particular areas." The hurricane came after 4 days of rainfall where streams were already at bankfull levels, pushing flood waters over the edge and into communities that had developed in the floodplain.

Hurricane Gloria caused extensive damage along the east coast of the U.S. and heavy rains and flooding in western Massachusetts in 1985. This event resulted in a federal disaster declaration (FEMA DR-751). In October 2005 the remnants of Tropical Storm Tammy followed by a subtropical depression produced significant rain and flooding across western Massachusetts. It was reported that between nine and 11 inches of rain fell. The heavy rainfall washed out many roads in Hampshire and Franklin Counties. The Green River flooded a mobile home park in Greenfield, with at least 70 people left homeless. Following these events, the mobile home park was demolished, and the site was turned into a town park. Localized flooding in Berkshire County was widespread, with several road washouts. This series of storms resulted in a federal disaster declaration (FEMA DR-1614) and Massachusetts received over $13 million in individual and public assistance. (MEMA, 2013)

Tropical Storm Irene (August 27-29, 2011) produced significant amounts of rain, storm surge, inland and coastal flooding, and wind damage across southern New England and much of the east coast of the U.S. In Massachusetts, rainfall totals ranged between 0.03 inches (Nantucket Memorial Airport) to 9.92 inches (Conway, MA). Wind speeds in Massachusetts ranged between 46 and 67 mph. These heavy rains caused flooding throughout the Commonwealth and a presidential disaster was declared (FEMA DR-4028). The Commonwealth received over $31 million in individual and public assistance from FEMA (MEMA, 2013)

Vulnerability Assessment

People

High winds from tropical storms and hurricanes can knock down trees, limbs and electric lines, can damage buildings, and send debris flying, leading to injury or loss of life. Economically distressed, elderly and other vulnerable populations are most susceptible, based on several factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Populations that live or work in proximity to facilities that use or store toxic substances are at greater risk of exposure to these substances during a flood event such as near the railroad tracks, town garage, or transfer station.

The most vulnerable include people with low socioeconomic status, people over the age of 65, people with medical needs, and those with low English language fluency. For example, people with low socioeconomic status are likely to consider the economic impacts of evacuation when deciding whether to evacuate. Individuals with medical needs may have trouble evacuating and accessing needed medical care while displaced. Those who have low English language fluency may not receive or understand the warnings to evacuate. Findings reveal that human behavior contributes to flood fatality occurrences. For example, people between the ages of 10 and 29 and over 60 years of age are found to be more vulnerable to floods. During and after an event, rescue workers and utility workers are vulnerable to impacts from high water, swift currents, rescues, and submerged debris. Vulnerable populations may also be less likely to have adequate resources to recover from the loss of their homes and jobs or to relocate from a damaged neighborhood (MEMA & EOEEA, 2018).

Built Environment

Hurricanes and tropical storms can destroy homes with wind, flooding, or even fire that results from the destructive forces of the storm. Critical facilities are mostly impacted during a hurricane by flooding, and these impacts are discussed in the flooding section of this plan. Wind-related damages from downed trees, limbs, electricity lines and communications systems would be at risk during high winds. Local and state-owned police and fire stations, other public safety buildings, and facilities that serve as emergency operation centers may experience direct loss (damage) during a hurricane or tropical storm. Emergency responders may also be exposed to hazardous situations when responding to calls. Road blockages caused by downed trees may impair travel.

Heavy rains can lead to contamination of well water and can release contaminants from septic systems (DPH, 2014 as cited in MEMA & EOEEA, 2018). Additionally, hurricanes and tropical storms often result in power outages and contact with damaged power lines during and after a storm, which may result in electrocution.

Natural Environment

The environmental impacts of hurricanes and tropical storms are similar to those described for other hazards, including inland flooding, severe winter storms and other severe weather events. As the storm is occurring, flooding may disrupt normal ecosystem function and wind may fell trees and other vegetation. Additionally, wind-borne or waterborne detritus can cause mortality to animals if they are struck or transported to a non-suitable habitat. In the longer term, impacts to natural resources and the environment as a result of hurricanes and tropical storms are generally related to changes in the physical structure of ecosystems. For example, flooding may cause scour in riverbeds, modifying the river ecosystem and depositing the scoured sediment in another location. Similarly, trees that fall during the storm may represent lost habitat for local species, or they may decompose and provide nutrients for the growth of new vegetation. If the storm spreads pollutants into natural ecosystems, contamination can disrupt food and water supplies, causing widespread and long-term population impacts on species in the area.

Economy

Hurricane/tropical storm events can greatly impact the economy, including loss of business function, damage to inventory, relocation costs, wage loss, and rental loss due to the repair/replacement of buildings. Due to the wind and water damage, and transportation issues that result, the impact to the economy can potentially be very high.

Future conditions

The Northeast has been experiencing more frequent days with temperatures above 90°F, increasing sea surface temperatures and sea levels, changes in precipitation patterns and amounts, and alterations in hydrological patterns. According to the Massachusetts Climate Change Adaptation Report, large storm events are becoming more frequent. Although there is still some level of uncertainty, research indicates the warming climate may double the frequency of Category 4 and 5 hurricanes by the end of the century and decrease the frequency of less severe hurricane events. More frequent and intense storm events will cause an increase in damage to the built environment and could have devastating effects on the economy and environment. As stated earlier, cooler water temperatures along the Northeast Atlantic Ocean help to temper the strength of tropical storms, but if the ocean continues to warm, this tempering force could be lessened, leading to greater intensity of storms that make landfall in New England.

Hazard Profile

Other severe weather captures the natural hazardous events that occur outside of notable storm events, but still can cause significant damages. These events include high winds and thunderstorms. The Town of Great Barrington and the entire region has experienced numerous thunderstorms and high wind events including microbursts. Wind is air in motion relative to the surface of the earth. A thunderstorm is a storm originating in a cumulonimbus cloud. Cumulonimbus clouds produce lightning, which locally heats the air to 50,000 degrees Celsius, which in turn produces an audible shock wave, known as thunder. Frequently during thunderstorm events, heavy rain and gusty winds are present. Less frequently, hail is present, which can become very large in size. Tornadoes can also be generated during these events (MEMA & EOEEA, 2018).

Likely Severity

High Winds

Effects from high winds can include downed trees and/or power lines and damage to roofs, windows, and other structural components. High winds can cause scattered power outages. Massachusetts is susceptible to high winds from several types of weather events: before and after frontal systems, hurricanes and tropical storms, severe thunderstorms and tornadoes, and nor'easters. Sometimes, wind gusts of only 40 to 45 mph can cause scattered power outages from downed trees and wires. This is especially true after periods of prolonged drought or excessive rainfall, since both are situations that can weaken the root systems and make them more susceptible to the winds' effects. Winds measuring less than 30 mph are not considered to be hazardous under most circumstances. Wind speeds are measured using the Beaufort wind scale shown in table 3.10.

Thunderstorms

A thunderstorm is classified as "severe" when it produces damaging wind gusts in excess of 58 mph (50 knots), hail that is 1 inch in diameter or larger (quarter size), or a tornado (NWS, 2013). The severity of thunderstorms can vary widely, from commonplace and short-term events to large-scale storms that result in direct damage and flooding. Widespread flooding is the most common characteristic that leads to a storm being declared a disaster. The severity of flooding varies widely based both on characteristics of the storm itself and the region in which it occurs. Lightning can occasionally also present a severe hazard (MEMA & EOEEA, 2018).

Table 3.10: Beaufort Wind Scale – Effects on Land

Force	Wind (Knots)	WMO Classification	Appearance of Wind Effects On Land
0	Less than 1	Calm	Calm, smoke rises vertically
1	1-3	Light Air	Smoke drift indicates wind direction, still wind vanes
2	4-6	Light Breeze	Wind felt on face, leaves rustle, vanes begin to move
3	7-10	Gentle Breeze	Leaves and small twigs constantly moving, light flags extended
4	11-16	Moderate Breeze	Dust, leaves, and loose paper lifted, small tree branches move
5	17-21	Fresh Breeze	Small trees in leaf begin to sway
6	22-27	Strong Breeze	Larger tree branches moving, whistling in wires
7	28-33	Near Gale	Whole trees moving, resistance felt walking against wind
8	34-40	Gale	Twigs breaking off trees, generally impedes progress
9	41-47	Strong Gale	Slight structural damage occurs, slate blows off roofs
10	48-55	Storm	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	56-63	Violent Storm	
12	64+	Hurricane	

Source: NOAA Storm Prediction Center. Developed in 1805 by Sir Francis Beaufort
ft = feet; WMO = World Meteorological Organization

Probability

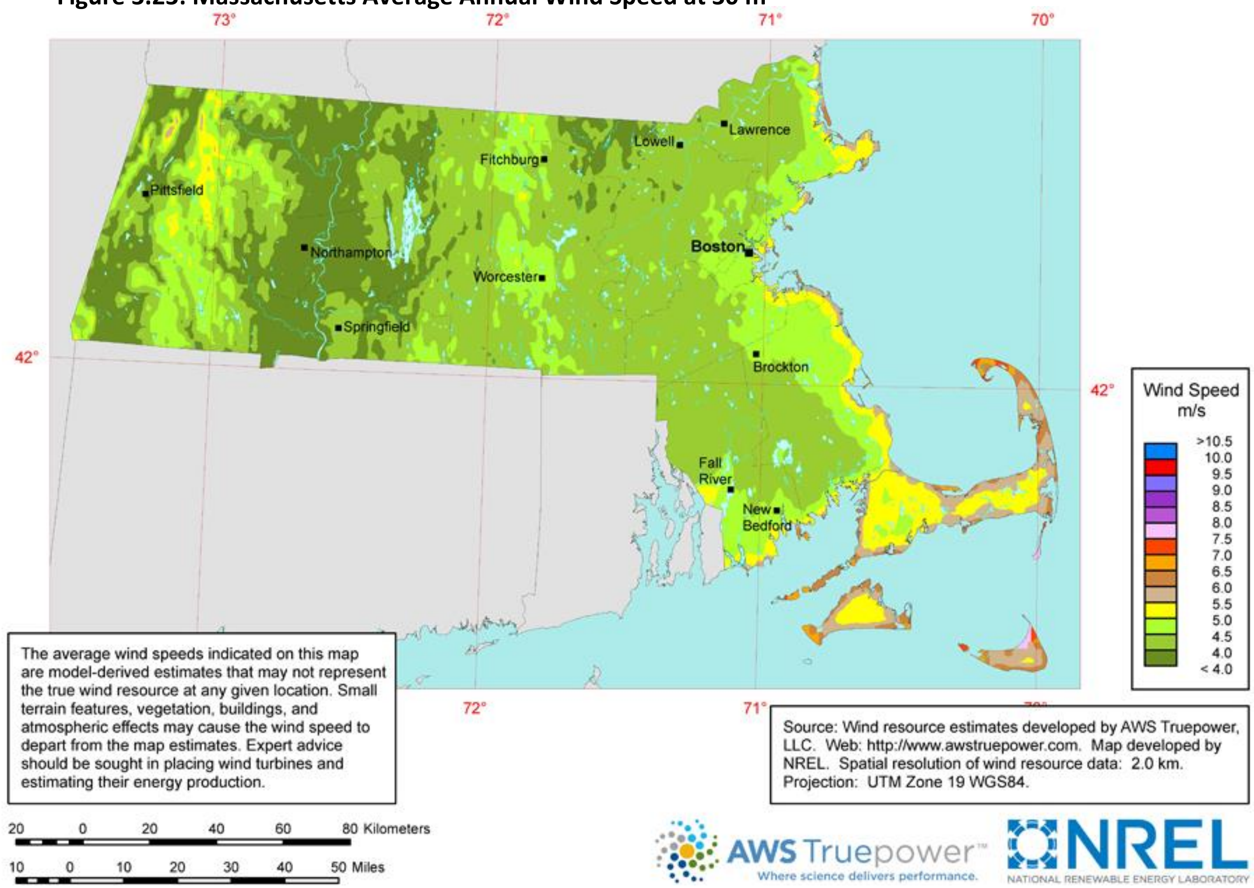
High Winds

Over the last 10 years (between January 1, 2008, and December 31, 2017), a total of 435 high wind events occurred in Massachusetts on 124 days, and an annual average of 43.5 events occurred per year. High winds are defined by NWS 10-1605 as sustained non-convective winds of 35 knots (40 mph) or greater lasting for 1 hour or longer, or gusts of 50 knots (58 mph) or greater for any duration (NCDC, 2018). However, many of these events may have occurred as a result of the same weather system, so this count may overestimate the frequency of this hazard. The probability of future high wind events is expected to increase as a result of climate projections for the state that suggest a greater occurrence of severe weather events in the future.

Thunderstorms

Three basic components are required for a thunderstorm to form: moisture, rising unstable air, and a lifting mechanism. The sun heats the surface of the earth, which warms the air above it. If this warm surface air is forced to rise—by hills or mountains, or areas where warm/cold or wet/dry air bump together causing a rising motion—it will continue to rise as long as it weighs less and stays warmer than the air around it. As the warm surface air rises, it transfers heat from the surface of the earth to the upper levels of the atmosphere (the process of convection). The water vapor it contains begins to cool, releasing the heat, and the vapor condenses into a cloud. The cloud eventually grows upward into areas where the temperature is below freezing. Some of the water vapor turns to ice, and some of it turns into water droplets. Both have electrical charges. When a sufficient charge builds up, the energy is discharged in a bolt of lightning, which causes the sound waves we hear as thunder. An average thunderstorm is 15 miles across and lasts 30 minutes; severe thunderstorms can be much larger and longer. Southern New England typically experiences 10 to 15 days per year with severe thunderstorms (MEMA & EOEEA, 2018).

Figure 3.23: Massachusetts Average Annual Wind Speed at 30 m



Geographic Areas Likely Impacted

High Winds

The entire Town of Great Barrington is vulnerable to high winds that can cause extensive damage. Relative to the rest of the Commonwealth and surrounding areas of Berkshire county, wind speeds on average are typically higher in parts of Great Barrington as shown in figure 3.23. Some areas are more susceptible to wind than others. The Housatonic Valley having lower wind speeds, and the Berkshire Plateau having higher wind speeds.

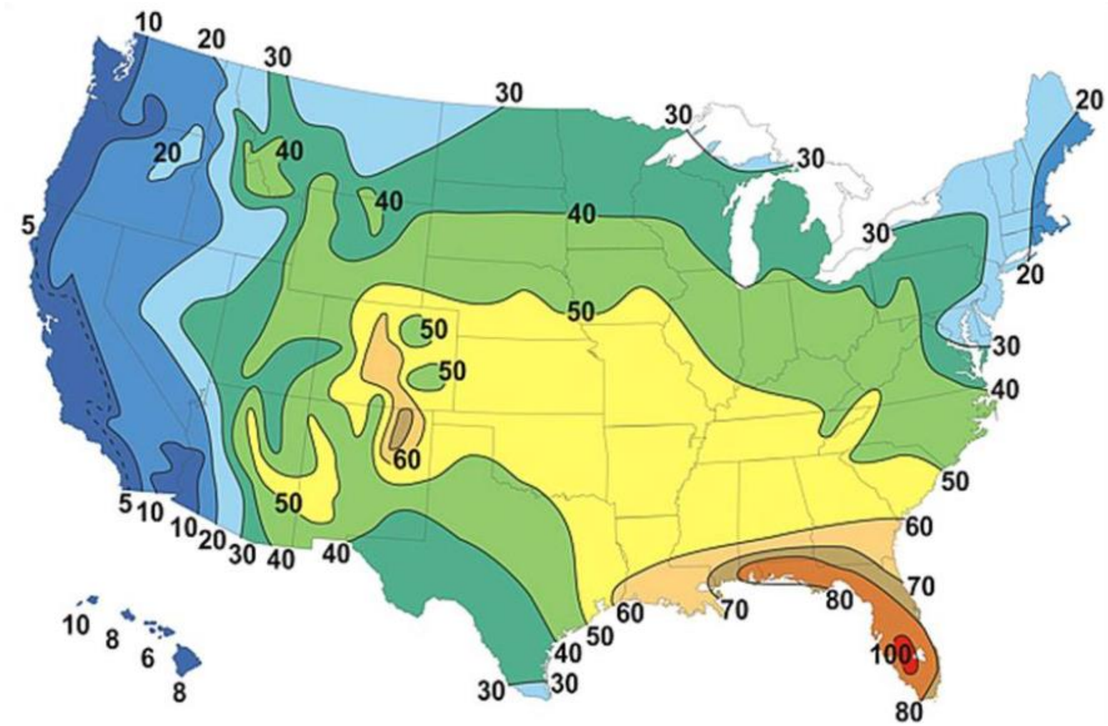
THUNDERSTORMS

Even more so than high wind, thunderstorms have the potential of impacting all Great Barrington. Microbursts can also occur anywhere associated with thunderstorms.

Historic Data

It is difficult to define the number of other severe weather events experienced by Great Barrington each year. Figure 3.24 shows number of annual thunderstorm days across the United States. Massachusetts experiences 20 to 30 thunderstorm days each year.

Figure 3.24: Annual Average Number of Thunderstorm Days in the U.S.



Source: NOAA NWS, n.d.

Vulnerability Assessment

People

The entire population of the Commonwealth is considered exposed to high-wind and thunderstorm events. Downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss of life.

Socially vulnerable populations are most susceptible to severe weather based on a number of factors, including their physical and financial ability to react or respond during a hazard, and the location and construction quality of their housing. In general, vulnerable populations include people over the age of 65, the elderly living alone, people with low socioeconomic status, people with low English language fluency, people with limited mobility or a life- threatening illness, and people who lack transportation or are living in areas that are isolated from major roads. The isolation of these populations is a significant concern. Power outages can be life-threatening to those dependent on electricity for life support. Power outages may also result in inappropriate use of combustion heaters, cooking appliances and generators in indoor or poorly ventilated areas, leading to increased risks of carbon monoxide poisoning. People who work or engage in recreation outdoors are also vulnerable to severe weather.

Both high winds and thunderstorms present potential safety impacts for individuals without access to shelter during these events. Extreme rainfall events can also affect raw water quality by increasing turbidity and bacteriological contaminants leading to gastrointestinal illness. Additionally, research has found that thunderstorms may cause the rate of emergency room visits for asthma to increase to 5 to 10 times the normal rate (Andrews, 2012). Much of this phenomenon is attributed to the stress and anxiety that many individuals, particularly children, experience during severe thunderstorms. The combination of wind, rain, and lightning from thunderstorms with pollen and mold spores can exacerbate asthma (UG, 2017). The rapidly falling air temperatures characteristic of a thunderstorm as well as the production of nitrogen oxide gas during lightning strikes have also both been correlated with asthma (SKMCAP, 2018).

Built Environment

All elements of the built environment are exposed to severe weather events such as high winds and thunder storms. Damage to buildings is dependent upon several factors, including wind speed, storm duration, path of the storm track, and building construction. According to the Hazus wind model, direct wind-induced damage (wind pressures and windborne debris) to buildings is dependent upon the performance of components and cladding, including the roof covering (shingles, tiles, membrane), roof sheathing (typically wood-frame construction only), windows, and doors, and is modeled as such. Structural wall failures can occur for masonry and wood-frame walls, and uplift of whole roof systems can occur due to failures at the roof/wall connections. Foundation failures (i.e., sliding, overturning, and uplift) can potentially take place in manufactured homes (MEMA & EOEEA, 2018).

The most common problem associated with severe weather is loss of utilities. Severe windstorms causing downed trees can create serious impacts on power and aboveground communication lines. High winds caused one of the 24 NERC-reported electric transmission outages between 1992 and 2009, resulting in disruption of service to 225,000 electric customers in the Commonwealth (DOE, n.d.). During this period, lightning caused nearly 25,000 disruptions (DOE, n.d.). Downed power lines can cause blackouts, leaving large areas isolated. Loss of electricity and phone connections would leave certain populations isolated because residents would be unable to call for assistance. Additionally, the loss of power can impact heating or cooling provision to citizens (including the young and elderly, who are particularly vulnerable to temperature-related health impacts). Utility infrastructure (power lines, gas lines, electrical systems) could suffer damage, and impacts can result in the loss of power, which can impact business operations. After an event, there is a risk of fire, electrocution, or an explosion.

Public safety facilities and equipment may experience a direct loss (damage) from high winds. Roads may become impassable due to flash or urban flooding, or due to landslides caused by heavy, prolonged rains. Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting) transportation needs. The hail, wind, and flash flooding associated with thunderstorms and high winds can cause damage to water infrastructure. Flooding can overburden stormwater, drinking water, and wastewater systems. Water and sewer systems may not function if power is lost (MEMA & EOEEA, 2018).

Natural Environment

As described under other hazards, such as hurricanes and nor'easters, high winds can defoliate forest canopies and cause structural changes within an ecosystem that can destabilize food webs and cause widespread repercussions. Direct damage to plant species can include uprooting or total destruction of trees and an increased threat of wildfire in areas of tree debris. High winds can also erode soils, which can damage both the ecosystem from which soil is removed as well as the system on which the sediment is ultimately deposited. Environmental impacts of extreme precipitation events often include soil erosion, the growth of excess fungus or bacteria, and direct impacts to wildlife. For example, research by the Butterfly Conservation Foundation shows that above-average rainfall events have prevented butterflies from successfully completing their mating rituals, causing population numbers to decline. Harmful algal blooms and associated neurotoxins can also be a secondary hazard of extreme precipitation events as well as heat. Public drinking water reservoirs may also be damaged by widespread winds uprooting watershed forests and creating serious water quality disturbances (MEMA & EOEEA, 2018).

Economy

According to the NOAA's Technical Paper on Lightning Fatalities, Injuries, and Damage Reports in the U.S. from 1959 to 1994, monetary losses for lightning events range from less than $50 to greater than $5 million (the larger losses are associated with forest fires, with homes destroyed, and with crop loss) (NOAA, 1997). Lightning can be responsible for damage to buildings; can cause electrical, forest and/or wildfires; and can damage infrastructure, such as power transmission lines and communication towers (MEMA & EOEEA, 2018).

Agricultural losses due to lightning and the resulting fires can be extensive. Forestry species and agricultural crops, equipment, and infrastructure may be directly impacted by high winds. Trees are also vulnerable to lightning strikes.

Future Conditions

Increased frequency of severe weather events in general is an effect of climate change, and thus we can expect to see more severe wind event and thunderstorms in Great Barrington in the future. Research into the impact of climate change on severe storms such as thunderstorms has looked at the impact of the increased convective available potential energy (CAPE) on frequency and intensity of storms, and a decrease in wind shear as the Artic warms. Some studies show no change in the number of storms, but an increase in intensity due to more energy and evaporated moisture available to fuel storms. Other studies have shown an increase in the number and intensity of storms because the increase in CAPE compensated for a decrease in wind shear[16]. We can expect greater impacts of severe storms in the region while the exact changes are still being determined.

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[16] https://earthobservatory.nasa.gov/features/ClimateStorms

Hazard Profile

The threat of invasive species, both plant and animal, was in the top four hazards identified by stakeholders through the MVP planning process. Invasive species are defined as non-native species that cause or are likely to cause harm to ecosystems, economies, and/or public health (NISC 2006).

Likely Severity

The damage rendered by invasive species is significant. The Massachusetts Invasive Plant Advisory Group (MIPAG), a collaborative representing organizations and professionals concerned with the conservation of the Massachusetts landscape, is charged by EOEEA to provide recommendations to the Commonwealth to manage invasive species of plants. MIPAG defines invasive plants as "non-native species that have spread into native or minimally managed plant systems in Massachusetts, causing economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems" (MIPAG, n.d.). These species have biological traits that provide them with competitive advantages over native species, particularly because in a new habitat they are not restricted by the biological controls of their native habitat. As a result, these invasive species can monopolize natural communities, displacing many native species and causing widespread economic and environmental damage (MEMA & EOEEA, 2018).

Invasive species are a widespread problem in Massachusetts and throughout the country. The geographic extent of invasive species varies greatly depending on the species in question and other factors, including habitat and the range of the species (MEMA & EOEEA, 2018).

Probability

Increased rates of global trade and travel have created many new pathways for the dispersion of exotic species. As a result, the frequency with which these threats have been introduced has increased significantly. Increased international trade in ornamental plants is particularly concerning because many of the invasive plants species in the U.S. were originally imported as ornamentals.

Geographic Areas Likely Impacted

Areas most likely impacted by invasive species are those that have experienced some form of disturbance or human activity that allows the species of plant or animal to establish itself in an area. It is common to find invasive species in residential areas where people have mowed lawns, plowed fields, or even planted invasive species believing them to be aesthetically beneficial in their yards. Waterways are also likely areas where invasive plants can be found because of the ability of the plants to travel along the water, particularly during a highwater event.

Experts estimate that about 3 million acres within the U.S. (an area twice the size of Delaware) are lost each year to invasive plants (Pulling Together, 1997, from Mass.gov "Invasive Plant Facts"). The massive scope of this hazard means that the entire Commonwealth experiences impacts from these species. Furthermore, the ability of invasive species to travel far distances (either via natural mechanisms or accidental human interference) allows these species to propagate rapidly over a large geographic area. Similarly, in open freshwater and marine ecosystems, invasive species can quickly spread once introduced, as there are generally no physical barriers to prevent establishment, outside of physiological tolerances, and multiple opportunities for transport to new locations (by boats, for example).

Historic Data

Invasive species are a human-caused hazard, often spread when shipping goods between continents, forest products are transported, or people plant nonnative species on their properties for their aesthetic value. Because the presence of invasive species is ongoing rather than a series of discrete events, it is difficult to quantify the frequency of these occurrences.

The terrestrial and freshwater species listed on the MIPAG website as "Invasive" (last updated April 2016) are listed in Table 3.11. The table also includes details on the nature of the ecological and economic challenges presented by each species as well as information on when and where the species was first detected in Massachusetts (MEMA & EOEEA, 2018). Invasive insects are a significant threat, particularly to trees and everything that depends on those trees from wildlife to people. The Emerald Ash borer was confirmed in Great Barrington in April 2019. The Emerald Ash Borer can kill ash trees quickly by drilling holes through the trunks.


Japanese Knotweed

Table 3.11: Invasive Plants in Massachusetts

Species	Common name	Notes
Terrestrial/Freshwater		
Acer platanoides	Norway maple	A tree occurring in all regions of the state in upland and wetland habitats, and especially common in woodlands with colluvial soils. It grows in full sun to full shade. Escapes from cultivation; can form dense stands; outcompetes native vegetation, including sugar maples; dispersed by wind, water, and vehicles.
Acer pseudoplatanus	Sycamore maple	A tree occurring mostly in southeastern counties of Massachusetts, primarily in woodlands and especially near the coast. It grows in full sun to partial shade. Escapes from cultivation inland as well as along the coast; salt-spray tolerant; dispersed by wind, water, and vehicles.
Aegopodium podagraria	Bishop's goutweed, bishop's weed; goutweed	A perennial herb occurring in all regions of the state in uplands and wetlands. Grows in full sun to full shade. Escapes from cultivation; spreads aggressively by roots; forms dense colonies in floodplains.
Ailanthus altissima	Tree of Heaven	This tree occurs in all regions of the state in upland, wetland, and coastal habitats. Grows in full sun to full shade. Spreads aggressively from root suckers, especially in disturbed areas.
Alliaria petiolata	Garlic mustard	A biennial herb occurring in all regions of the state in uplands. Grows in full sun to full shade. Spreads aggressively by seed, especially in wooded areas.
Berberis thunbergii	Japanese barberry	A shrub occurring in all regions of the state in open and wooded uplands and wetlands. Grows in full sun to full shade. Escapes from cultivation; spread by birds; forms dense stands.
Cabomba caroliniana	Carolina fanwort; fanwort	A perennial herb occurring in all regions of the state in aquatic habitats. Common in the aquarium trade; chokes waterways.
Celastrus orbiculatus	Oriental bittersweet; Asian or Asiatic bittersweet	A perennial vine occurring in all regions of the state in uplands. Grows in full sun to partial shade. Escapes from cultivation; berries spread by birds and humans; overwhelms and kills vegetation.
Cynanchum louiseae	Black swallow-wort; Louise's swallow-wort	A perennial vine occurring in all regions of the state in upland, wetland, and coastal habitats. Grows in full sun to partial shade. Forms dense stands, outcompeting native species: deadly to Monarch butterflies.
Elaeagnus umbellata	Autumn olive	A shrub occurring in uplands in all regions of the state. Grows in full sun. Escapes from cultivation; berries spread by birds; aggressive in open areas; has the ability to change soil.
Euonymus alatus	Winged euonymus, burning bush	A shrub occurring in all regions of the state and capable of germinating prolifically in many different habitats. It grows in full sun to full shade. Escapes from cultivation and can form dense thickets and dominate the understory; seeds are dispersed by birds.
Euphorbia esula	Leafy spurge; wolf's milk	A perennial herb occurring in all regions of the state in grasslands and coastal habitats. Grows in full sun. An aggressive herbaceous perennial and a notable problem in the western U.S..

Species	Common name	Notes
Frangula alnus	European buckthorn, glossy buckthorn	Shrub or tree occurring in all regions of the state in upland, wetland, and coastal habitats. Grows in full sun to full shade. Produces fruit throughout the growing season; grows in multiple habitats; forms thickets.
Glaucium flavum	Sea or horned poppy, yellow hornpoppy	A biennial and perennial herb occurring in southeastern MA in coastal habitats. Grows in full sun. Seeds float; spreads along rocky beaches; primarily Cape Cod and Islands.
Hesperis matronalis	Dame's rocket	A biennial and perennial herb occurring in all regions of the state in upland and wetland habitats. Grows in full sun to full shade. Spreads by seed; can form dense stands, particularly in floodplains.
Iris pseudacorus	Yellow iris	A perennial herb occurring in all regions of the state in wetland habitats, primarily in floodplains. Grows in full sun to partial shade. Outcompetes native plant communities.
Lepidium latifolium	Broad-leaved pepperweed, tall pepperweed	A perennial herb occurring in eastern and southeastern regions of the state in coastal habitats. Grows in full sun. Primarily coastal at upper edge of wetlands; also found in disturbed areas; salt tolerant.
Lonicera japonica	Japanese honeysuckle	A perennial vine occurring in all regions of the state in upland, wetland, and coastal habitats. Grows in full sun to full shade. Rapidly growing, dense stands climb and overwhelm native vegetation; produces many seeds that are dispersed by birds; more common in southeastern Massachusetts.
Lonicera morrowii	Morrow's honeysuckle	A shrub occurring in all regions of the state in upland, wetland, and coastal habitats. Grows in full sun to full shade. Part of a confusing hybrid complex of non-native honeysuckles commonly planted and escaping from cultivation via bird dispersal.
Lonicera x bella [morrowii x tatarica]	Bell's honeysuckle	This shrub occurs in all regions of the state in upland, wetland, and coastal habitats. Grows in full sun to full shade. Part of a confusing hybrid complex of non-native honeysuckles commonly planted and escaping from cultivation via bird dispersal.
Lysimachia nummularia	Creeping jenny, moneywort	A perennial herb occurring in all regions of the state in upland and wetland habitats. Grows in full sun to full shade. Escaping from cultivation; problematic in floodplains, forests and wetlands; forms dense mats.
Lythrum salicaria	Purple loosestrife	A perennial herb or subshrub occurring in all regions of the state in upland and wetland habitats. Grows in full sun to partial shade. Escaping from cultivation; overtakes wetlands; high seed production and longevity.
Myriophyllum heterophyllum	Variable water-milfoil; two-leaved water-milfoil	A perennial herb occurring in all regions of the state in aquatic habitats. Chokes waterways, spread by humans and possibly birds.
Myriophyllum spicatum	Eurasian or European water-milfoil; spike water- milfoil	A perennial herb found in all regions of the state in aquatic habitats. Chokes waterways, spread by humans and possibly birds.
Phalaris arundinacea	Reed canary-grass	This perennial grass occurs in all regions of the state in wetlands and open uplands. Grows in full sun to partial shade. Can form huge colonies and overwhelm wetlands; flourishes in disturbed areas; native and introduced strains; common in agricultural settings and in forage crops.

Species	Common name	Notes
Phragmites australis	Common reed	A perennial grass (USDA lists as subshrub, shrub) found in all regions of the state. Grows in upland and wetland habitats in full sun to full shade. Overwhelms wetlands forming huge, dense stands; flourishes in disturbed areas; native and introduced strains.
Polygonum cuspidatum / Fallopia japonica	Japanese knotweed; Japanese or Mexican bamboo	A perennial herbaceous subshrub or shrub occurring in all regions of the state in upland, wetland, and coastal habitats. Grows in full sun to full shade, but hardier in full sun. Spreads vegetatively and by seed; forms dense thickets.
Polygonum perfoliatum	Mile-a-minute vine or weed; Asiatic tearthumb	This annual herbaceous vine is currently known to exist in several counties in MA, and has also has been found in RI and CT. Habitats include streamsides, fields, and road edges in full sun to partial shade. Highly aggressive; bird and human dispersed.
Potamogeton crispus	Crisped pondweed, curly pondweed	A perennial herb occurring in all regions of the state in aquatic habitats. Forms dense mats in the spring and persists vegetatively.
Ranunculus ficaria	Lesser celandine; fig buttercup	A perennial herb occurring on stream banks, and in lowland and uplands woods in all regions of the state. Grows in full sun to full shade. Propagates vegetatively and by seed; forms dense stands, especially in riparian woodlands; an ephemeral that outcompetes native spring wildflowers.
Rhamnus cathartica	Common buckthorn	A shrub or tree occurring in all regions of the state in upland and wetland habitats. Grows in full sun to full shade. Produces fruit in fall; grows in multiple habitats; forms dense thickets.
Robinia pseudoacacia	Black locust	A tree that occurs in all regions of the state in upland habitats. Grows in full sun to full shade. While the species is native to central portions of Eastern North America, it is not indigenous to MA. It has been planted throughout the state since the 1700s and is now widely naturalized. It behaves as an invasive species in areas with sandy soils.
Rosa multiflora	Multiflora rose	A perennial vine or shrub occurring in all regions of the state in upland, wetland, and coastal habitats. Grows in full sun to full shade. Forms impenetrable thorny thickets that can overwhelm other vegetation; bird dispersed.
Salix atrocinerea/Salix cinerea	Rusty Willow/Large Gray Willow complex	A large shrub or small tree most commonly found in the eastern and southeastern areas of the state, with new occurrences being reported further west. Primarily found on pond shores but is also known from other wetland types and rarely uplands. Forms dense stands and can outcompete native species along the shores of coastal plain ponds.
Trapa natans	Water chestnut	An annual herb occurring in the western, central, and eastern regions of the state in aquatic habitats. Forms dense floating mats on water.

Invasive and nuisance (native) insects and their host trees are described in table 3.12.

Table 3.12: Invasive and Nuisance Insects with Potential Threat to Berkshire County Forest Health

Insect	Origin	Host Trees	DCR-Management Approach
Gypsy Moth	Introduced	Oaks, other deciduous species	Discovered in 1869, the current management approach relies on natural population controls- naturally abundant virus and fungus populations regulate gypsy moth population cycles.
Hemlock Woolly Adelgid	Introduced	Eastern hemlock	Discovered in 1989, two biocontrol species, Psedudoscymnus tsugae and Laricobius nigrinus, have been released in MA to limited establishment success.
Southern Pine Beetle	Native	Pitch pine	Population densities are being monitored through annual trapping. The impacts of climate change could significantly alter southern pine beetle generation periods and devastate pitch pine stands.
Emerald Ash Borer	Introduced	All ash species	Discovered in 2012, three biocontrol species, Tetrastichus planipennisi, Spathius galinae, and Oobius agrili, have successfully been released in MA. Continued releases are planned.
White Pine Needlecast	Native	Eastern white pines	White pine defoliation is being monitored across the state. Needlecast has been identified to be caused by multiple fungal pathogens; the most prevalent agent in Massachusetts is Lecanosticta acicola.

Source: https://www.mass.gov/service-details/current-forest-health-threats


Emerald Ash Borer


Forest Impact of Emerald Ash Borer

Vulnerability Assessment

People

Invasive species rarely result in direct impacts on humans, but sensitive people may be vulnerable to specific species that may be present in the state in the future. These include people with compromised immune systems, children under the age of 5, people over the age of 65, and pregnant women. Those who rely on natural systems for their livelihood or mental and emotional well-being are more likely to experience negative repercussions from the expansion of invasive species.

An increase in species not typically found in Massachusetts could expose populations to vector-borne disease. A major outbreak could exceed the capacity of hospitals and medical providers to care for patients.

Built Environment

Because invasive species are present throughout the Commonwealth, all elements are considered exposed to this hazard; however, the built environment is not expected to be impacted by invasive species to the degree that the natural environment is. Buildings are not likely to be directly impacted by invasive species. Amenities such as outdoor recreational areas that depend on biodiversity and ecosystem health may be impacted by invasive species. Facilities that rely on biodiversity or the health of surrounding ecosystems, such as outdoor recreation areas or agricultural/forestry operations, could be more vulnerable to impacts from invasive species.

Invasive species may lead to reduced water quality, which has implications for the drinking water supplies and the cost of treatment.

Natural Environment

An analysis of threats to endangered and threatened species in the U.S. indicates that invasives are implicated in the decline of 42 percent of the endangered and threatened species. In 18 percent of the cases, invasive species were listed as the primary cause of the species being threatened, whereas in 24 percent of the cases they were identified as a contributing factor (Somers, 2016). A 1998 study found that competition or predation by alien species is the second most significant threat to biodiversity, only surpassed by direct habitat destruction or degradation (Wilcove et al., 1998). This indicates that invasive species present a significant threat to the environment and natural resources in the Commonwealth. Aquatic invasive species pose a particular threat to water bodies. In addition to threatening native species, they can degrade water quality and wildlife habitat. Impacts of aquatic invasive species include:

- Reduced diversity of native plants and animals
- Impairment of recreational uses, such as swimming, boating, and fishing
- Degradation of water quality
- Degradation of wildlife habitat
- Increased threats to public health and safety

- Diminished property values
- Declines in fin and shellfish populations
- Loss of coastal infrastructure due to the habits of fouling and boring organisms
- Local and complete extinction of rare and endangered species (EOEEA, 2002 as cited by MEMA & EOEEA, 2018)

Economy

The agricultural sector is vulnerable to increased invasive species associated with increased temperatures. More pest pressure from insects, diseases, and weeds may harm crops and cause farms to increase pesticide use. In addition, floodwaters may spread invasive plants that are detrimental to crop yield and health. Agricultural and forestry operations that rely on the health of the ecosystem and specific species are likely to be vulnerable to invasive species.

Invasive species are widely considered to be one of the costliest natural hazards in the U.S. A widely cited paper (Pimental et al., 2005) found that invasive species cost the U.S. more than $120 billion in damages every year. One study found that in 1 year alone, Massachusetts agencies spent more than $500,000 on the control of invasive aquatic species through direct efforts and cost-share assistance. This figure does not include the extensive control efforts undertaken by municipalities and private landowners, lost revenue due to decreased recreational opportunities, or decreases in property value due to infestations (Hsu,2000). Individuals who are particularly vulnerable to the economic impacts of this hazard would include all groups who depend on existing ecosystems in the Commonwealth for their economic success. This includes all individuals working in agriculture-related fields, as well as those whose livelihoods depend on outdoor recreation activities such as hunting, hiking, or aquatic sports. Additionally, homeowners whose properties are adjacent to vegetated areas could experience property damage in a number of ways. For example, the roots of the Tree of Heaven (Ailanthus altissima) plant are aggressive enough that they can damage both sewer systems and house foundations up to 50 to 90 feet from the parent tree (MEMA & EOEEA, 2018).

Future Conditions

Temperature, concentration of CO2 in the atmosphere, frequency and intensity of hazardous events, atmospheric concentration of CO2, and available nutrients are key factors in determining species survival. It is likely that climate change will alter all of these variables. As a result, climate change is likely to stress native ecosystems and increase the chances of a successful invasion. Additionally, some research suggests that elevated atmospheric CO2concentrations could reduce the ability of ecosystems to recover after a major disturbance, such as a flood or fire event. As a result, invasive species—which are often able to establish more rapidly following a disturbance—could have an increased probability of successful establishment or expansion. Other climate change impacts that could increase the severity of the invasive species hazard include the following (Bryan and Bradley, 2016; Mineur et al., 2012; Schwartz, 2014; Sorte,2014; Stachowicz et al., 2002 as cited in MEMA & EOEEA, 2018):

- Elevated atmospheric CO2 levels could increase some organisms' photosynthetic rates, improving the competitive advantage of those species.
- Changes in atmospheric conditions could decrease the transpiration rates of some plans, increasing the amount of moisture in the underlying soil. Species that could most effectively capitalize on this increase in available water would become more competitive.
- Fossil fuel combustion can result in widespread nitrogen deposition, which tends to favor fast-growing plant species. In some regions, these species are primarily invasive, so continued use of fossil fuels could make conditions more favorable for these species.
- As the growing season shifts to earlier in the year, several invasive species (including garlic mustard, barberry, buckthorn, and honeysuckle) have proven more able to capitalize by beginning to flower earlier, which allows them to outcompete later-blooming plants for available resources. Species whose flowering times do not respond to elevated temperatures have decreased in abundance.
- Some research has found that forests pests (which tend to be ectotherms, drawing their body heat from environmental sources) will flourish under warming temperatures. As a result, the population sizes of defoliating insects and bark beetles are likely to increase.
- Warmer winter temperatures also mean that fewer pests will be killed off over the winter season, allowing populations to grow beyond previous limits.
- There are many environmental changes possible in the aquatic environment that can impact the introduction, spread, and establishment of aquatic species, including increased water temperature, decreased oxygen concentration, and change in pH. For example, increases in winter water temperatures could facilitate year-round establishment of species that currently cannot overwinter in New England (Sorte, 2014 as cited in MEMA & EOEEA, 2018).

Invasive species can trigger a wide-ranging cascade of lost ecosystem services. Additionally, they can reduce the resilience of ecosystems to future hazards by placing a constant stress on the system (MEMA & EOEEA, 2018).

Vector-Borne Disease

Hazard Profile

Likely severity

The Town of Great Barrington chose to examine the hazard of vector-borne diseases in their community. Vector-borne disease are defined by the CDC as illnesses in humans derived from a vector, including mosquitoes, ticks, and fleas that spread pathogens. Examples of mosquito-borne diseases include Chikungunya, Eastern Equine Encephalitis (EEE), Zika, and the West Nile Virus. Examples of tick-borne diseases include Lyme Disease, Anaplasmosis/Ehrlichiosis, Babesiosis, and Powassan. The damage rendered by vector-borne diseases can be significant in a community, and can drastically affect quality of life, ability to work, loss of specific bodily functions, increase life-long morbidity and increase mortality.

Probability

According to the CDC, the geographic and seasonal distribution of vector populations, and the diseases they can carry depends not only on the climate, but also on land use, socioeconomic and cultural factors, pest control, access to health care, and human responses to disease risk. Climate variability can result in vector/pathogen adaptation and shifts or expansions in their geographic ranges. Infectious disease transmission is sensitive to local, small-scale differences in weather, human modification of the landscape, the diversity of animal hosts, and human behavior that affects vector/human contact.

The Berkshires provide outdoor recreation opportunities for both residents and visitors, including hiking, swimming, mountain biking, and camping. Increased exposure to the outdoors, particularly to areas with heavy tree and forest cover, and areas with tall grass or standing water, significantly increase a person’s exposure to vector-borne illnesses. Increases in average year-round temperature during the past few decades has also led to the over-wintering of ticks in Berkshire County, and a lengthening warm season, among other characteristics of the Berkshire environment, has increased tick and mosquito populations significantly. Cases of Lyme in Berkshire County have increased. Additionally, Massachusetts has seen cases of once non-existent or very rare tick borne illnesses rise, including Anaplasmosis/Ehrlichiosis (848 cases in 2016, can be fatal), Babesiosis (518 cases in 2016, significantly higher than any other state, can be fatal), Lyme (198 cases in 2016), Powassan (5 cases in 2016, fatality rate is 10%), Spotted fever rickettsiosis (8 cases in 2016, 20% untreated cases are fatal), and Tularemia (5 cases in 2016).

Geographic Areas Likely Impacted

The Town of Great Barrington in its entirety is likely already impacted by vector-borne disease and is likely to be increasingly impacted. Exposure to any outdoor area with tall grasses, standing water, and trees increases risk. Residents and visitors can be exposed at home and in more commercial areas, although exposure in commercial areas is generally less likely.

Historic Data

In the United States in 2016, a total of 96,075 cases were reported, 1,827 of which were reported in the state of Massachusetts. In Berkshire County, [drop in local data and data source]. The CDC indicates that cases of vector-borne diseases are substantially underreported. Tickborne illnesses more than doubled between 2004 and 2016 and accounted for 77% of all vector-borne disease reports in the United States. Lyme disease accounted for 82% of all tickborne cases, but spotted fever rickettsioses, babesiosis, and anaplasmosis/ehrlichiosis cases also increased. During the years of 2004 to 2016, nine vector-borne human diseases were reported for the first time from the United States and US territories. According to the CDC, vector-borne diseases have been difficult to prevent and control, and a Food and Drug Administration (FDA) approved vaccine is only available for yellow fever virus. Insecticide resistance is widespread and is increasing.

Vulnerability Assessment

People

Vector-borne illness have a significant impact on humans and on a community, and significantly affect health, long-term morbidity and mortality, quality of life, and can significantly reduce a persons' ability to work or contribute to the community in other ways. In addition to the direct effect of vector-borne illnesses on a person, pesticides and herbicides used to control populations of vectors can also negatively impact human health.

Built Environment

Vector-borne illnesses pose little threat to the built environment in a community. Overtime we may see changes in development as people respond to the increase in disease carrying insects.

Natural Environment

Increases in vector-borne illnesses can increase the likelihood that a community needs to use chemical pesticides and herbicides to control vector populations. The increased use of these products and chemicals can significantly affect the natural environment, including vegetation and other animal populations. Reducing populations of ticks and mosquitos can reduce the food source for other dependent animal populations. Additionally, diseases carried by insects can affect wildlife as they do humans. There is also the risk of people reacting to the threat of disease by altering the environment to not support habitat, severely damaging long-term ecosystem health.

Economy

The economy is susceptible to the indirect impacts of vector-borne illnesses. If a community decides to engage in a pest-control program or another program to reduce vector populations, this can significantly affect their operating budget. Incorporation of any program to reduce vector populations in a community will likely cause tax increases within the municipality. Long-term, the more individuals in a population affected by vector-borne disease that can cause life-long morbidity or mortality will reduce the overall economic participation and output of the population in a municipality. There will also be the impacts on outdoor recreation, which is a major revenue driver for Berkshire County. People today choose to or are advised by officials to avoid outdoor activities in fear of tick and mosquito bites.

Future Conditions

Continued changes to the climate, extreme precipitation events, issues with control of stormwater, changes to animal and vector populations, and continued increases in insecticide resistance will lead to a continued and growing threat to individuals, governments, and businesses. Local governments will need to invest in methods to reduce or prevent exposure to vector-borne diseases and should strongly consider methods that do not include the increased use of insecticides and herbicides. This may include methods such as promoting populations of bats, opossums and other animals that consume vectors of concern, increase opportunities for residents to get ticks from tick bites tested, reduce the cost and burden of testing ticks for individuals, and increase the level of education and awareness of current and new vector-borne illnesses with the public and practitioners so treatment can be expedited. Municipalities should implement educational programs for residents and visitors for bite-prevention and detection.

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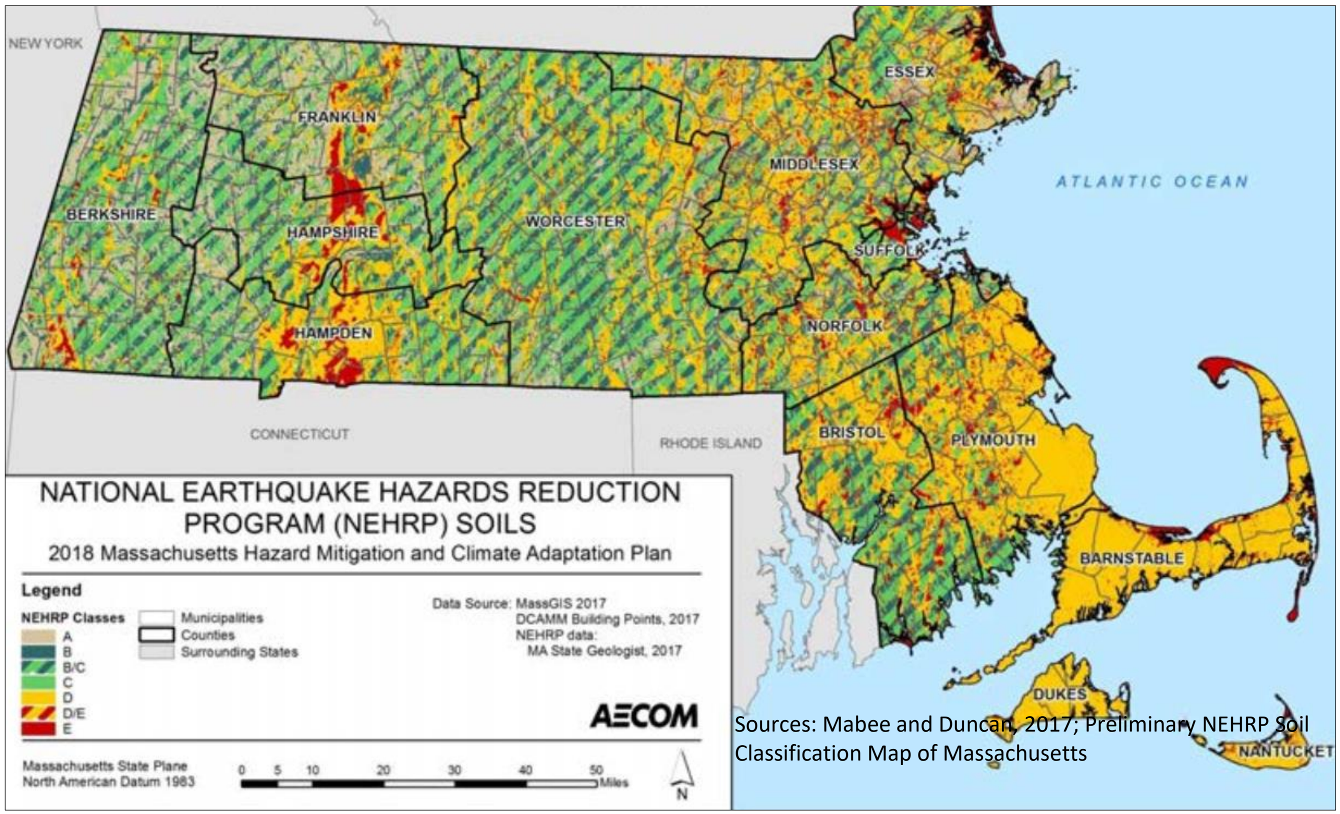
Hazard Profile

An earthquake is the vibration of the Earth's surface that follows a release of energy in the Earth's crust. These earthquakes often occur along fault boundaries. As a result, areas that lie along fault boundaries—such as California, Alaska, and Japan—experience earthquakes more often than areas located within the interior portions of these plates, including the Town of Great Barrington (MEMA & EOEEA, 2018).

Likely severity

Ground shaking is the primary cause of earthquake damage to man-made structures. This damage can be increased due to the fact that soft soils amplify ground shaking. A contributor to site amplification is the velocity at which the rock or soil transmits shear waves (S waves). The National Earthquake Hazards Reduction Program (NEHRP) developed five soil classifications, which are defined by their S-wave velocity, that impact the severity of an earthquake. The soil classification system ranges from A to E, where A represents hard rock that reduces ground motions from an earthquake and E represents soft soils that amplify and magnify ground

Figure 3.25: NEHRP Soil Types in Massachusetts



Sources: Mabee and Duncan, 2017; Preliminary NEHRP Soil Classification Map of Massachusetts shaking and increase building damage and losses. These soil types are shown in Figure 3.22. Soil types A, B, C, and D are reflected in the Hazus analysis that generated the exposure and vulnerability results later in the section (MEMA & EOEEA, 2018).

The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth. The focal depth of an earthquake is the depth from the surface to the region where the earthquake's energy originates (the focus). Earthquakes with focal depths up to about 43.5 miles are classified as shallow. Earthquakes with focal depths of 43.5 to 186 miles are classified as intermediate. The focus of deep earthquakes may reach depths of more than 435 miles. The focus of most earthquakes is concentrated in the upper 20 miles of the Earth's crust. The depth to the Earth's core is about 3,960 miles, so even the deepest earthquakes originate in relatively shallow parts of the Earth's interior. The epicenter of an earthquake is the point on the Earth's surface directly above the focus. Seismic waves are the vibrations from earthquakes that travel through the Earth and are recorded on instruments called seismographs. 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 sizes of earthquakes. The Richter scale is the most widely known scale for measuring earthquake magnitude. It has no upper limit and is not used to express 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. The perceived severity of an earthquake is based on the observed effects of ground shaking on people, buildings, and natural features, and severity varies with location. Intensity is expressed by the Modified Mercalli Scale, which describes how strongly an earthquake was felt at a particular location. The Modified Mercalli Scale expresses the intensity of an earthquake's effects in a given locality in values ranging from I to XII. Seismic hazards are also expressed in terms of PGA, which is defined by USGS as "what is experienced by a particle on the ground" in terms of percent of acceleration force of gravity. More precisely, seismic hazards are described in terms of Spectral Acceleration, which is defined by USGS as "approximately what is experienced by a building, as modeled by a particle on a massless vertical rod having the same natural period of vibration as the building" in terms of percent of acceleration force of gravity (percent g).

Because of the low frequency of earthquake occurrence and the relatively low levels of ground shaking that are usually experienced, the entirety of the Commonwealth and the Town of Great Barrington can be expected to have a low to moderate risk to earthquake damage as compared to other areas of the country. However, impacts at the local level can vary based on types of construction, building density, and soil type, among other factors (MEMA & EOEEA, 2018). In Great Barrington few buildings are steel-reinforced and ready to withstand a major earthquake.

Probability

New England experiences intraplate earthquakes because it is located deep within the interior of the North American plate. Scientists are still exploring the cause of intraplate earthquakes, and many believe these events occur along geological features that were created during ancient times and are now weaker than the surrounding areas (MEMA & EOEEA, 2018).

A 1994 report by the USGS, based on a meeting of experts at the Massachusetts Institute of Technology, provides an overall probability of occurrence. Earthquakes above about magnitude 5.0 have the potential for causing damage near their epicenters, and larger magnitude earthquakes have the potential for causing damage over larger areas. This report found that the probability of a magnitude 5.0 or greater earthquake centered somewhere in New England in a 10-year period is about 10 percent to 15 percent. This probability rises to about 41 percent to 56 percent for a 50-year period. The last earthquake with a magnitude above 5.0 that was centered in New England took place in the Ossipee Mountains of New Hampshire in 1940 (MEMA & EOEEA, 2018).

Geographic Areas Likely Impacted

New England is located in the middle of the North American Plate. One edge of the North American Plate is along the West Coast where the plate is pushing against the Pacific Ocean Plate. The eastern edge of the North American Plate is located at the middle of the Atlantic Ocean, where the plate is spreading away from the European and African Plates. New England's earthquakes appear to be the result of the cracking of the crustal rocks due to compression as the North American Plate is being very slowly squeezed by the global plate movements. As a result, New England epicenters do not follow the major mapped faults of the region, nor are they confined to particular geologic structures or terrains. Because earthquakes have been detected all over New England, seismologists suspect that a strong earthquake could be centered anywhere in the region. Furthermore, the mapped geologic faults of New England currently do not provide any indications detailing specific locations where strong earthquakes are most likely to be centered. Instead, a probabilistic assessment conducted through a Level 2 analysis in Hazus (using a moment magnitude value of 5) provides information about where in Massachusetts impacts would be felt from earthquakes of various severities. For this plan, an assessment was conducted for the 100-, 500-, 1,000-, and 2,500-year mean return periods. The results of that analysis are discussed later in this section (MEMA & EOEEA, 2018).

Historic Data

In some places in New England, including locations in Massachusetts, small earthquakes seem to occur with some regularity. For example, since 1985 there has been a small earthquake approximately every 2.5 years within a few miles of Littleton, Massachusetts. It is not clear why some localities experience such clustering of earthquakes, but a possibility suggested by John Ebel of Boston College's Weston Observatory is that these clusters occur where strong earthquakes were centered in the prehistoric past. The clusters may indicate locations where there is an increased likelihood of future earthquake activity (MEMA & EOEEA, 2018).

Although it is well documented that the zone of greatest seismic activity in the U.S. is along the Pacific Coast in Alaska and California, in the New England area, an average of six earthquakes are felt each year. Damaging earthquakes have taken place historically in New England. According to the Weston Observatory Earthquake Catalog, 6,470 earthquakes have occurred in New England and adjacent areas. However, only 35 of these events were considered significant (MEMA & EOEEA, 2018).

Vulnerability Assessment

People

The entire population of Massachusetts is potentially exposed to direct and indirect impacts from earthquakes. 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. In addition, the time of day also exposes different sectors of the community to the hazard. There are many ways in which earthquakes could impact the lives of individuals across the Commonwealth. Business interruptions could keep people from working, road closures could isolate populations, and loss of utilities could impact populations that suffered no direct damage from an event itself. People who reside or work in unreinforced masonry buildings are vulnerable to liquefaction.

The populations most vulnerable to an earthquake event include people over the age of 65 and those living below the poverty level. These socially vulnerable populations are most susceptible, based on a number of factors, including their physical and financial ability to react or respond during a hazard, the location and construction quality of their housing, and the inability to be self-sustaining after an incident due to a limited ability to stockpile supplies.

Hazus performed for the State Hazard Mitigation and Climate Adaptation Plan estimates the number of people that may be injured or killed by an earthquake depending on the time of day the event occurs. Estimates are provided for three times of day representing periods when different sectors of the community are at their peak: peak residential occupancy at 2:00 a.m.; peak educational, commercial, and industrial occupancy at 2:00 p.m.; and peak commuter traffic at 5:00 p.m. Table 3.13 shows the number of injuries and casualties expected for events of varying severity, occurring at various times of the day.

Table 3.13: Estimated Number of Injuries, Causalities and Sheltering Needs in Berkshire County

Severity	***100-Year MRP***			***500-Year MRP***			***1,000-Year MRP***			***2,500-Year MRP***		
Time	**2am**	**2pm**	**5pm**	**2am**	**2pm**	**5pm**	**2am**	**2pm**	**5pm**	**2am**	**2pm**	**5pm**
Injuries	0	0	0	4	6	4	9	13	10	22	35	25
Hospitalization	0	0	0	0	1	1	1	2	1	3	6	5
Casualties	0	0	0	0	0	0	0	0	0	1	1	1
Displaced Households	0			21			51			143		
Short-Term Sheltering Needs	0			12			29			82		

Source: SCMCAP, 2018 HAZUS

MRP= Mean Return Period

Built Environment

All elements of the built environment in the planning area are exposed to the earthquake hazard. In addition to direct impacts, there is increased risk associated with hazardous materials releases, which have the potential to occur during an earthquake from fixed facilities, transportation-related incidents (vehicle transportation), and pipeline distribution. These failures can lead to the release of materials to the surrounding environment, including potentially catastrophic discharges into the atmosphere or nearby waterways, and can disrupt services well beyond the primary area of impact (MEMA & EOEEA, 2018).

Earthquakes can damage power plants, gas lines, liquid fuel storage infrastructure, transmission lines, utilities poles, solar and wind infrastructure, and other elements of the energy sector. Damage to any components of the grid can result in widespread power outages (MEMA & EOEEA, 2018). Damage to road networks and bridges can cause widespread disruption of services and impede disaster recovery and response (MEMA & EOEEA, 2018).

Earthquakes can also cause large and sometimes disastrous landslides and wildfires. Soil liquefaction is a secondary hazard unique to earthquakes that occurs when water-saturated sands, silts, or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. Liquefaction may occur along the shorelines of rivers and lakes, and can also happen in low-lying areas away from water bodies but where the underlying groundwater is near the Earth's surface. Earthen dams and levees are highly susceptible to seismic events, and the impacts of their eventual failures can be considered secondary risks for earthquakes (MEMA & EOEEA, 2018).

Natural Environment

Earthquakes can impact natural resources and the environment in a number of ways, both directly and through secondary impacts. For example, damage to gas pipes may cause explosions or leaks, which can discharge hazardous materials into the local environment or the watershed if rivers are contaminated. Fires that break out as a result of earthquakes can cause extensive damage to ecosystems, as described in Section 4.3.2. Primary impacts of an earthquake vary widely based on strength and location. For example, if strong shaking occurs in a forest, trees may fall, resulting not only in environmental impacts but also potential economic impacts to any industries relying on that forest. If shaking occurs in a mountainous environment, cliffs may crumble and caves may collapse. Disrupting the physical foundation of the ecosystem can modify the species balance in that ecosystem and leave the area more vulnerable to the spread of invasive species (MEMA & EOEEA, 2018).

Economy

Earthquakes also have impacts on the economy, including loss of business functions, damage to inventories, relocation costs, wage losses, and rental losses due to the repair or replacement of buildings. The business interruption losses are the losses associated with the inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses of those people displaced from their homes because of the earthquake.

Additionally, earthquakes can result in loss of crop yields, loss of livestock, and damage to barns, processing facilities, greenhouses, equipment, and other agricultural infrastructure. Earthquakes can be especially damaging to farms and forestry if they trigger a landslide (MEMA & EOEEA, 2018).

Future Conditions

Earthquakes cannot be predicted and may occur at any time. Peak Ground Acceleration (PGA) maps are used as tools to determine the likelihood that an earthquake of a given Modified Mercalli Intensity may be exceeded over a period of time, but they are not useful for predicting the occurrence of individual events. Therefore, geospatial information about the expected frequency of earthquakes throughout Massachusetts is not available. Unlike previous hazards analyzed, there is little evidence to show that earthquakes are connected to climate change (MEMA & EOEEA, 2018). However, there are some theories that earthquakes may be associated with a thawing Earth as the temperature increases.

Hazard Profile

Likely severity

A dam is an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material for the purpose of storage or control of water. The height of the dam is determined by the height of the dam at the maximum water storage elevation. The storage capacity of the dam is the volume of water contained in the impoundment at maximum water storage elevation. Size class may be determined by either storage or height, whichever gives the larger size classification. See table 3.14.

Table 3.14: Dam Size Classification

Category	Storage (acre-feet)	Height (feet)
Small	>= 15 and <50	>= 6 and <15
Intermediate	>= 50 and <1000	>= 15 and <40
Large	>= 1000	>= 40

Table 3.15: Dam Hazard Potential Classification

Hazard Classification	Hazard Potential
High Hazard (Class I):	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 Hazard (Class II):	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 of relatively important facilities.
Low Hazard (Class III):	Dams located where failure or mis-operation may cause minimal property damage to others. Loss of life is not expected.

The classification for potential hazard shall be in accordance with table 3.15. The Hazard Potential Classification rating pertains to potential loss of human life or property damage in the event of failure or improper operation of the dam or appurtenant works. The hazard potential classification for a dam has no relationship to the current structural integrity, operational status, flood routing capability, or safety condition of the dam or its appurtenances[17]. Poor condition indicates a dam that presents a significant risk to public safety due to deficiencies such as significant seepage, erosion or sink holes, cracking of structural elements, or vegetation undermining the structural stability of the dam.

Probable future development of the area downstream from the dam that would be affected by its failure shall be considered in determining the classification. Even dams which, theoretically, would pose little threat under normal circumstances can overspill or fail under the stress of a cataclysmic event such as an earthquake or sabotage.

Dam owners are legally responsible for having their dams inspected on a regular basis. High hazard dams must be inspected every two years, Significant Hazard dams must be inspected every five years, and Low Hazard dams must be inspected every 10 years. In addition, owners of High Hazard dams must develop Emergency Action Plans (EAPs) that outline the activities that would occur if the dam failed or appeared to be failing. Owners of Significant Hazard dams are strongly encouraged to also develop EAPs. The Plan would include a notification flow chart, list of response personnel and their responsibilities, a map of the inundation area that would be impacted, and a procedure for warning and evacuating local residents in the inundation area. The EAP must be filed with local and state emergency agencies (BRPC, 2012).

Probability

Factors that contribute to dam failure include design flaw, age, over-capacity stress and lack of maintenance (BRPC, 2012). Maintenance, or the lack thereof, is a serious concern for many Berkshire communities. By law dam owners are responsible for the proper maintenance of their dams. If a dam were to fail and cause flooding downstream, the dam owner would be liable for damages and loss of life that were a result of the failure. As a result of difficulty in getting information on private dams, local officials are largely unaware of the age and condition of the dams within their communities (BRPC, 2012).

There are two primary types of dam failure: catastrophic failure, characterized by the sudden, rapid, and uncontrolled release of impounded water, or design failure, which occurs as a result of minor overflow events. Dam overtopping is caused by floods that exceed the capacity of the dam, and it can occur as a result of inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors. Overtopping accounts for 34 percent of all dam failures in the U.S.

There are a number of ways in which climate change could alter the flow behavior of a river, causing conditions to deviate from what the dam was designed to handle. For example, more extreme precipitation events could increase the frequency of intentional discharges. Many other climate impacts—including shifts in seasonal and geographic rainfall patterns—could also cause the flow behavior of rivers to deviate from previous hydrographs. When flows are greater than expected, spillway overflow events (often referred to as “design failures”) can occur. These

[17] https://www.mass.gov/files/documents/2017/10/30/302cmr10.pdf

overflows result in increased discharges downstream and increased flooding potential. Therefore, although climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failures (MEMA & EOEEA, 2018).

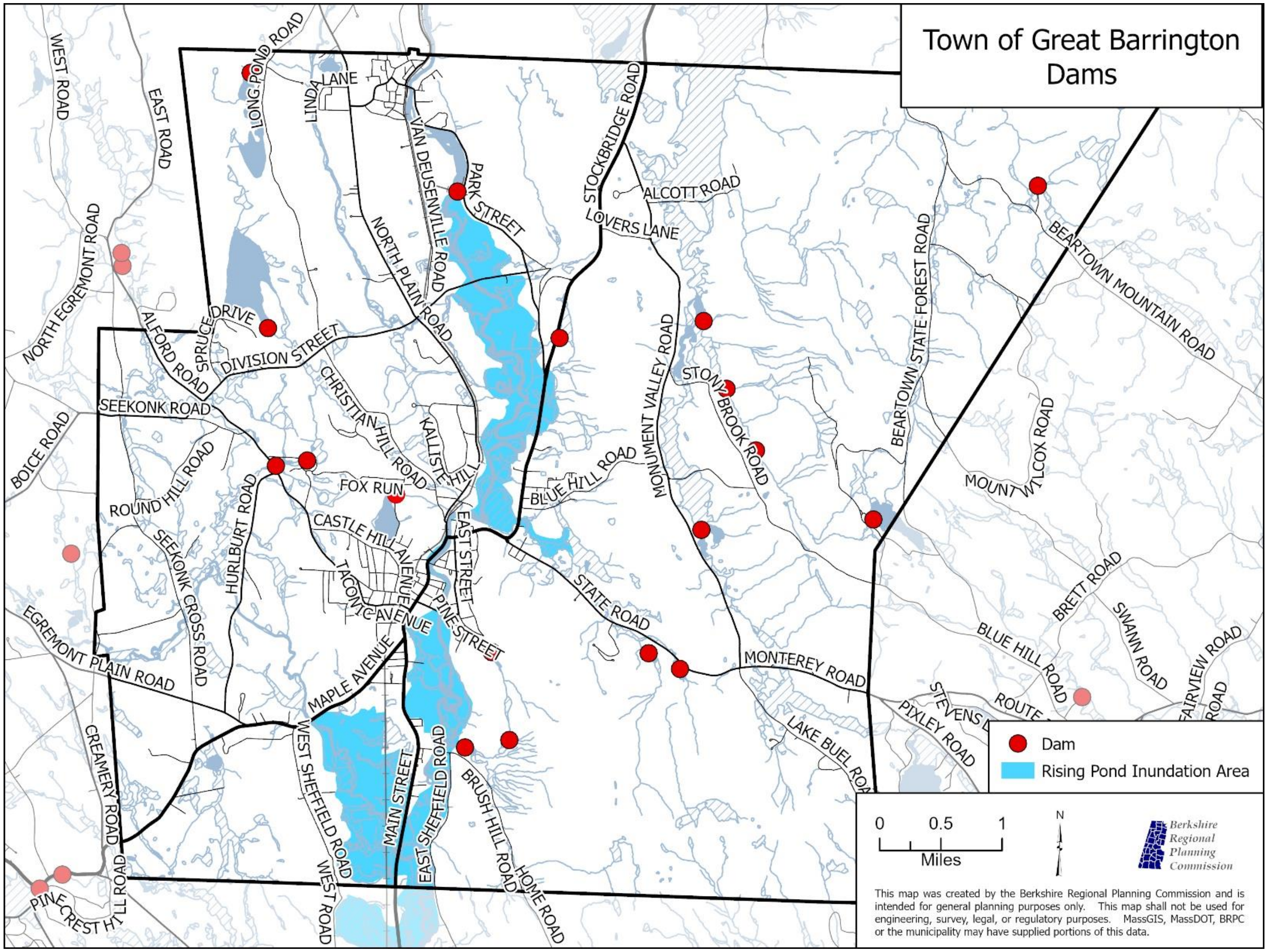
Geographic Areas Likely Impacted

Table 3.16: Dam Hazard Status for Great Barrington

Name	Hazard Code	Size Class	Inspection Condition	Owner	Water Source	Impounded Waterbody
Barbieri	Low	Intermediate		Lawrence Barbieri	Muddy Brook	Barbieri
Beinecki Pond Dam	Low	0		Carrie Beinecki		Beinecki Pond
Benedict Pond Dam	Low	Intermediate	Poor / Unsafe	Comm of Mass - DCR	Stony Brook	Benedict Pond
Berle Pond Dam	Low	Small		Peter A. Berle	Konkapot Brook	Berle Pond
Brookside Lower Pond Dam		0		Eisner Camp Institute		Brookside Lower Pond
Brookside Rd. Pond Dam	Low	4		Eisner Camp Institute		Brookside Rd. Pond
Brookside Road Upper Pond Dam	Low	0		Eisner Camp Institute		Brookside Road Upper Pond
East Mt. Reservoir Dam	Significant	Small	Poor	G.Barrington Fire District	N/A - Drains To Housatonic	East Mt. Reservoir
Flowering Branch Pond Dam	Low	0		Flowering Branch Farm		Flowering Branch Pond
Fountain Park Pond Dam	Low	Small	Fair	Comm of Mass - DCR	Tri To Housatonic	Fountain Park Pond
Kirchoff Pond Dam	Low	0		C.M. Kirchoff		Kirchoff Pond
Long Pond Dam	Significant	Large	Good	Housatonic Water Works Co.	Long Pond Brook	Long Pond Reservoir
Lower Blodgett Pond Dam	Low	0		Simons Rock Inc.		Lower Blodgett Pond
Riggs Pond Dam	Low	0		Bear Mt. Fish & Game		Riggs Pond
Rising Paper Co. Dam	Significant	Large	Good	General Electric	Housatonic River	Housatonic River
Round Pond Dam	Low	Intermediate	Poor	Frederick Mercer Jr.	Tr Williams River	Round Pond
Simons Rock Pond Dam	Low	0		Simons Rock Inc.		Simons Rock Pond
South Pond Dam (Butternut)	Low	Small	Fair	Butternut Ski Area	Unnamed	South Pond

Table 3.16: provides a summary of information on the dams located in Great Barrington. The DCR Office of Dam Safety lists 18 dams in Great Barrington. Information was last acquired from the Massachusetts Office of Dam Safety in 2004. Figure 3.26 provides a map of dam locations and the inundation area for Rising Pond dam for the potential instance of dam failure. The inundation area closely reflects the natural floodplain.

Figure 3.26: Town of Great Barrington Dams



Historic Data

Historically, dam failure has had a low occurrence in Berkshire County. However, many of the dams within the region are more than 100 years old. The Long Pond and Rising Paper Company dams two of the oldest dams in Great Barrington, recorded as being completed in 1900 according to Massachusetts Office of Dam Safety data.

Vulnerability Assessment

People

All populations in a dam failure inundation zone would be exposed to the risk of a dam failure. The potential for loss of life is affected by severity of the dam failure, the warning time, the capacity of dam owners and emergency personnel to alert the public and the capacity and number of evacuation routes available to populations living in areas of potential inundation. Vulnerable populations are all populations downstream from dam failures that are incapable of escaping the area within the needed time frame. There is often limited warning time for a dam failure event. While dam failure is rare, when events do occur, they are frequently associated with other natural hazard events such as earthquakes, landslides, or severe weather, which limits their predictability and compounds the hazard. Populations without adequate warning of the event from a television, radio or phone emergency warning system are highly vulnerable to this hazard. This population includes the elderly, young, and large groups of people who may be unable to get themselves out of the inundation area. (Massachusetts Emergency Management Agency, 2013)

Built Environment

All critical facilities and transportation infrastructures in the dam failure inundation zone are vulnerable to damage. Flood waters may potentially cut off evacuation routes, limit emergency access, and destroy power lines and communication infrastructure. (Massachusetts Emergency Management Agency, 2013)

Natural environment

A dam failure would cause significant destruction to the natural environment. Before the dam changed the volume and area of water that would flow downstream of the dam, only vegetation able to withstand inundation would grow where the water flowed or saturated soils. Dam failure would likely cause the accumulation of downed trees downstream including at culverts and bridges leading to further damage.

Economy

Damage to buildings and infrastructure can impact a community's economy and tax base. Buildings and property located within or closest to the dam inundation areas have the greatest potential to experience the largest, most destructive surge of water.

Future Conditions

According to MEMA, dams are designed partly based on assumptions about a river's flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If severe rain events cause hygrographic changes, it is conceivable that the dam can lose some or all of its designed margin of safety, also known as freeboard. If freeboard is reduced, dam operators may be forced to release increased volumes earlier in a storm cycle in order to maintain the required margins of safety. If the number of severe storms increases, or becomes the new norm, early releases of water will impact lands and waterways downstream more often.

Dams are constructed with safety features such as spillways and lower level outlets to allow release of additional water discharges. Spillways are put in place on dams as a safety measure in the event of the reservoir filling too quickly. Spillway overflow events, often referred to as "design failures," result in increased discharges downstream and increased flooding potential. Although climate change may not increase the probability of catastrophic dam failure, it may increase the probability of design failures. (Massachusetts Emergency Management Agency, 2013)

If climate change results in a greater number of severe precipitation events and shortens recurrence intervals them, as is predicted, it will require dam operators to become more vigilant in monitoring precipitation and temperature patterns. Individual rain events, particularly if occurring during periods of saturated or frozen soils that cannot absorb rainfall, may require that dam operators open spillways, flashboards and other safety features more often, causing a greater number of high discharge events and possible flooding on properties downstream of the dam.

Hazard Profile

Likely Severity

The Town of Great Barrington chose to examine the hazard of cybersecurity. Cybersecurity is defined as the defending of computers, servers, mobile devices, electronic systems, networks, and data from malicious attacks. The term can be divided into a few common categories, including: Network security, Application security, Information security, Operational security, Disaster recovery and business continuity and End-user education (Kaspersky 2020).

The damage rendered by cybersecurity can be significant. Municipalities may see their entire system compromised by cyber attacks and may need to expend significant financial resources to recover from an attack.

Probability

Increased computer usage, internet access and improved programming skills by the public, including potential hackers, all lead to an increase in the probability of a cyber-attack. The frequency of attacks impacting the government has increased over the last few years, leading to a higher probability that any one entity will be attacked. In 2018, government was the 7th most targeted industry for cybercrime and experienced 8% of the total attacks. Nation-state sponsored groups are the most likely to target this sector. These groups are likely to use, sell, or deliver compromised information to their respective governments, typically for economic or political gain (IBM 2019). The most likely reason for attacks on a community like Great Barrington is for ransom or to access personal information about residents.

As computers and connectivity become more pervasive in our lives, the number of vulnerabilities increases. Over the last three years, more than 42,000 vulnerabilities within software programs have been publicly disclosed. Vulnerabilities have increased over 5400% in the last five years (IBM 2019). These vulnerabilities provide more ways that criminals can access computer networks and compromise systems.

Geographic Areas Likely Impacted

The Town in its entirety is likely to be impacted. Town facilities are more likely to be targeted for cybercrime, however all residents are also at risk. In addition, the electrical grid and telecommunications network throughout town are at risk to attacks and could result in large sections of town being without power or communications.

Historic Data

Cyberattacks are a human-caused hazard, often spread by users who have inadvertently allowed access to their systems. Over the last 3 years, more than 11.7 billion records and over 11 Terabytes of data were leaked or stolen in publicly disclosed incidents. These compromised records contain information such as social security numbers, addresses, phone numbers, banking/payment card information, and passport data. In some cases, health data may also be stolen (IBM 2019).

Locally, at least two municipalities in the county and numerous municipalities in the state have been attacked with Ransomware. These attacks have cost the communities anywhere from tens of thousands of dollars to millions of dollars in ransom and countless hours restoring their systems and improving their resilience to a future attack. Luckily, little, if any, personal data was taken, but the impact on the municipalities ability to function was severely limited for some time.

Vulnerability Assessment

People

Cyberattacks rarely have direct impacts on humans, however the disruption they cause will impact people. Personal identifiable information that may be stolen can cause disruption to people's lives, impacting their finances, security, and future. Cyberattacks that impact the utilities may cause potential harm to those who rely on electricity for life support, heat, and water. Hospitals and medical facilities utilizing networked monitoring systems are vulnerable to hacking. Services provided by a municipality such as those necessary for purchasing a home can be put on hold as well.

Built Environment

Cyberattacks on the built environment may result in the loss of power, communications and equipment failure in government offices. Attacks on the utilities would likely result in temporary loss of service, however utilities can also be attacked where the systems are taken control of and purposely overloaded, damaging the physical infrastructure, which will result in a costlier recovery and a longer recovery time.

Government computer equipment can also be damaged or locked, preventing the use of that equipment unless a ransom is paid. This equipment can be replaced, but the data on the computers may not be recoverable, resulting in the loss of data unless the computers have been properly backed up.

Natural Environment

Cyberattacks pose a threat to the natural environment as well. Systems such as wastewater or drinking water treatment plants are vulnerable to ransomware. One study at Georgia Institute of Technology simulated a hacker gaining access to a water treatment plant and overdosing the system with chlorine. Hackers could also control pumps, valves, or many other parts of the system if they are connected to the internet (Toon, 2017).

Economy

The economy is most susceptible to the threat of cyberattacks due to the loss of utilities and computers causing a reduction in economic output. The power outage in 2003 that impacted most of the Northeast was a result of a cyber-attack. This outage caused an estimated $6 billion in economic damages over 2 days (IRMI 2020). The US government estimates that malicious cyber activity costs the US economy between $57 billion and $109 billion in 2016 (White House 2018). In addition, local government need to invest in cybersecurity or to respond to a cyber attack will result in higher taxes within that municipality.

Future Conditions

Continued expansion and connectivity of cyber assets will lead to a continued and growing threat to businesses, governments and individuals. Local governments will need to invest in cybersecurity to help mitigate the future risk of a cyber-attack. This will include upgrading computer systems, deploying security protections such as firewalls, and training users on identifying malicious activity and emails. Governments will also need to utilize professional computer staff or consultants to assist in protecting their assets and the data of their constituents.

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CHAPTER 4: MITIGATION STRATEGY

44 CFR § 201.6(c)(3)

The Mitigation Strategy lays out how the Town of Great Barrington intends to reduce losses identified in the Risk Assessment chapter. The goals and objectives of Great Barrington guide the selection of actions to mitigate and reduce potential losses. A prioritized list of cost-effective, environmentally sound, and technically feasible mitigation actions. The Town will apply to fund projects that have been reviewed for benefits and costs of implementation.

At Great Barrington's November 2019 MVP Workshop, five top priorities were identified by participants. While in some instances the priorities voted on capture multiple projects, the broader categories of priority actions identified for the purposes of this planning document were:

Soil Health • Educational Facilities • Engaging All Demographics • Emergency Shelters & Resource Distribution • Bridges & Culverts

Sustainable agricultural practices that protect soil health, prevent erosion into waterways, and enable local self-sufficiency are important to Great Barrington residents and stakeholders as a part of their holistic goals for ecosystem health. The ability for students to be able to take initiatives such as edible gardens and composting from vision to realization on their own school campus is also of great importance in fostering future leadership in resilience.

Great Barrington wants to plan for the future, including ensuring students in the regional schools as well as continuing education students have the resources and curriculum to prepare them for the jobs that need to be filled. A unique challenge for local students is internet access. Having access to reliable internet can determine if a student can complete assignments and stay up to speed with other students locally and nationally as they compete for college and job positions. A heavy snowstorm should not mean a student falls behind their peers who live closer to school and being prepared to stay home will improve preparedness for multiple emergency situations.

Great Barrington seeks to strategize how to engage the hard to reach residents that are part of the community. This challenge is not unique to Great Barrington, and is immensely difficult to solve because it deals with systemic racism that is deeply ingrained in our society and present day fears of discrimination or deportation from the Country. All demographics need to be included in the resilience planning process in order to make Great Barrington truly resilient, accounting for everyone's needs, and ensuring everyone is out of harms way. If there is an emergency, the

Town of Great Barrington utilizes a CodeRED to alert residents of the hazardous conditions, and expanding the use of this system is just one piece of identified priority.

Shelters and ensuring continued resources distribution during an emergency event are planned for in emergency response plans, with aspects integrated into the hazard mitigation plan. Great Barrington would like to see the establishment of additional shelters throughout the town. Additionally, ensuring stockpiles of food, and the ability to grow and process food locally will improve resilience.

A regional challenge with the increase in heavy precipitation events and an aging infrastructure is the need to replace culverts and bridges, or road-stream crossings. Often culverts and bridges have been designed for lower flows of water, and without accounting for the need to allow fish and other organisms or wildlife to pass through them. A road-stream crossing that has been designed and constructed to allow wildlife pass through, is also likely to be resilient to high flows of water during precipitation events including hurricanes and tropical storms.

Existing Protections

Great Barrington maintains and enforces floodplain management and wetland regulations designed to reduce or avoid future flood or flood-related erosion damages for continued compliance with NFIP. As mentioned earlier in the Inland Flooding Hazard Profile, Great Barrington enforces a floodplain bylaw for zones A indicated on the effective FIRM. Work altering the floodplain requires a Special Permit. Applications must be submitted through the Select Board and reviewed by the Planning Board in coordination with the Building Inspector and Board of Health to ensure structures will withstand the effects of flood, living spaces are elevated above flood levels, natural functions of the floodplain are unimpeded, and flooding of septic systems will not cause waterway contamination. Construction or alteration in the floodplain is subject to the Massachusetts Wetlands Protection Act and requires permitting through the Conservation Commission.

The Chief of Police also serves as Emergency Management Director for the Town. The Great Barrington Fire Department is called upon for natural hazards response. The Public Safety Town staff work in coordination with the Public Works Superintendent and the Director of Planning and Community Development for hazard mitigation planning.

The Town of Great Barrington is fortunate in having natural mitigative infrastructure in their preserved and retained forests and wetlands. Great Barrington's undeveloped land serves as important green infrastructure performing ecosystem services including stormwater management, flood control and reduction, soil stabilization, wind mitigation, water filtration, and drought prevention amongst other benefits not easily quantified. There are many tools available for calculating ecosystem services such as FEMA's Ecosystem Service Benefits Calculator[18]. One study by the Trust for Public Land found that for every $1 invested through the Land and Water Conservation Fund, there was a return on that investment of $4 from the value of natural goods and services[19]. In the Town of Great Barrington, the natural features and facilities are managed

[18] https://www.fema.gov/media-library/assets/documents/110202

[19] http://cloud.tpl.org/pubs/benefits-LWCF-ROI%20Report-11-2010.pdf

and maintained for their services to the community by the Town and regional partners. The Town will continue to maintain the natural features for the beneficial ecosystem services provided, with goals to fully inventory and quantify their benefits.

The mitigation projects listed in table 3.17 fall within the primary *Categories of Actions*:

- Local plans and regulations
- Structural projects
- Natural systems protection
- Education programs
- Preparedness and response actions

The column containing *Description of Action* is the brief summary of the mitigation action the community has identified to reduce their vulnerability to a hazard or more broadly increase resilience. The *Benefit* column will explain what the action mitigates or how it to increase resilience.

Project *Cost* was estimated and categorized as follows:
High: Over $100,000
Medium: Between $50,000 - $100,000
Low: Less than $50,000
For some projects, cost is not applicable (N/A).

The *Implementation Responsibility* will reflect ownership and/or jurisdiction of a facility or action that will be mitigated or otherwise receive funding for improved resilience.

Timeframe is listed at Short, Long, and Ongoing to reflect the timeframe identified for projects through the MVP Community Resilience Building process. A project that has been identified as short term is one that can and need to be implemented within a one to two-year timeframe. These projects are likely to pass a benefit-cost analysis, have the political and community support necessary, and are practicable. Long term projects require multiple steps before implementation, including studies, engineering, and gaining community support. The estimated time for long term projects is two to ten years. Ongoing projects are those that may be implemented immediately but will require constant investment of resources for maintenance or other project requirements such as education. The *Priority* of a project is determined by factors including conditions due to climate change or disaster events and recovery priorities; local resources, community needs, and capabilities; State or Federal policies and funding resources; hazard impacts identified in the risk assessment; development patterns that could influence the effects of hazards; and partners that have come to the table

Resources and Funding listed for each action are known potential technical assistance, materials, and funding for the type of project identified.

Table 4.1 provides a roadmap for Great Barrington to increase resiliency and will be updated with the new plan in five years. A table of Great Barrington's completed mitigation actions from the 2012 hazard mitigation plan is included in Appendix B: Completed Mitigation Actions.

Table 4.1: Mitigation Action Plan - Great Barrington

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Structural Project	Implement engineering and design for the Lake Mansfield road embankment.	Prevent erosion, loss of the road, property, potential risk to life, and flooding impacts that could result from road embankment failure.	High	Town of Great Barrington Planning Dept.	Short/ High	Town, FEMA, EOEEA
Structural Project	Conduct engineering study on the Green River / Seekonk Cross Road flooding to determine solution to flooding and implement findings	Improving the drainage will reduce the risk of flooding and reduce the cost of maintaining the road.	Low	Town of Great Barrington DPW	Short/ High	Town, FEMA
Structural Project	Conduct engineering study on the drainage pond off of downtown Main Street to determine potential solutions to alleviate flooding in winter and implement findings	Improving the drainage will reduce the risk of flooding on downtown Main St	Low	Town of Great Barrington DPW	Short/ Medium	Town, FEMA
Structural Project / Natural Systems Protection	Implement findings from the Stormwater Master Plan for Castle Hill drainage area	Improving the drainage will reduce the risk of flooding and reduce the cost of maintaining the roads	Medium	Town of Great Barrington DPW	Short/ Medium	Town, Private Landowners, FEMA
Structural Project / Natural Systems Protection	Implement findings from Stormwater Master Plan for the village of Housatonic	Implementing the findings of the master plan will reduce the risk of flooding due to stormwater	Medium	Town of Great Barrington DPW	Short/ Medium	Town, Private Landowners, FEMA

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Local Plans and Regulations	Expand the current Stormwater Master Plan to include the entire town.	Covering the entire town in the master plan will give a complete picture of the stormwater problems and how to address them	Low	Town of Great Barrington DPW	Short/ High	Town
Local Plans and Regulations	Work with property owners in Housatonic to get easements on stormwater drains underneath buildings.	Obtaining easements on existing stormwater systems will enable to town to proactively maintain and repair them without delays.	Low	Town of Great Barrington DPW with property owners	Short/ Medium	Town, Private Landowners
Local Plans and Regulations	Identify historic structures, businesses and critical facilities located in hazard-prone areas, including floodplains and dam failure inundation areas.	Identifying historic structures, businesses and critical facilities in floodplain and inundation areas will enable those facilities to be better prepared for the hazards and to	Low	Town of Great Barrington Planning Dept, MEMA, Massachusetts Historical Commission	Short/ Medium	Town
Local Plans and Regulations / Natural Systems Protection	Conduct engineering study of floodplain around Wastewater Treatment Plant to determine solutions for potential flooding	Reducing the flooding around the wastewater treatment plan will ensure the continued operation of the facility during a flooding event.	Medium	Town of Great Barrington DPW	Short/ High	Town, FEMA
Education and Awareness Programs	Facilitate networking and prospective opportunities within the community/region for those looking for ways get more involved and volunteer in the community.	Build capacity for trained volunteers ready for disaster response deployment.	Low	Town Sustainability Committee, Non-Profit Organizations	Ongoing / Low	Town, Non-profit funding, FEMA

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Education and Awareness Programs	Encourage greater coordination and collaboration among non-profit organizations that provide networking/job-fair events to maximize reach and effectiveness.	Build internal capacity to develop a resilient workforce – one that is not dependent on one industry.	Low	Town Planning Dept., Non-Profit Organizations	Ongoing / Low	Town, Non-Profit funding, FEMA
Education and Awareness Programs	Continue to promote GB/Berkshires as a hub of cultural creativity and arts/performing arts and assess pathways to incentivize artists and creative performers to move to Town.	Attract potential new residents to Great Barrington to offset aging population trend and maintain the Town's economic viability.	Low	Town Planning Dept.	Ongoing / Low	Town
Local Plans and Regulations	Create a Destination Management Plan to build a diverse a resilient economy.	Build a diverse and resilient economy that can withstand a diverse set of disturbances.	Low	Town Sustainability Committee	Short / High	Town
Local Plans and Regulations	Identify vulnerabilities and needs for business continuity planning.	Build on and enhance municipal financial and resource resiliency.	Medium	Town Planning Dept.	Ongoing / Medium	Town, Cultural District, BID
Local Plans and Regulations	Assess pathways to transition away from an economy heavily dependent on tourism for economic generation.	Create a more resilient workforce that can withstand a diverse set of disturbances.	Low	Town Planning Dept.	Ongoing / High	Town
Local Plans and Regulations	Incorporate environmental stewardship into municipal job description(s) and duties and provide training where gaps in knowledge exist.	Prevent environmental damage from daily municipal operations/duties and identify proactive infrastructure improvements such as culvert upsizing that	Medium	Town Manager	Ongoing / High	Town, FEMA

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
		account for climate change projections.				
Local Plans and Regulations	Establish more trade programs to diversify workforce.	Ensure diverse workforce skills and craftsmanship for local self-sufficiency.	High	Berkshire Hills Regional School District, local colleges	Ongoing / High	Town
Local Plans and Regulations	Encourage municipal staff to participate in workforce development skill training and passing along their knowledge/expertise.	Ensure institutional knowledge is archived and retrievable by current and future staff/municipal personnel.	Medium	Town Manager	Ongoing / High	Town
Structural Projects	Ensure reliable internet connection to provide equitable information access.		High	Berkshire Municipalities, Town Planning Dept.	Ongoing / High	Town
Education and Awareness Programs	Establish an on-campus agricultural program, farm-to-school programs or other programs to encourage younger generations to farm locally.	Pass on agricultural knowledge to upcoming generation to increase capacity to grow food and reduce dependency on imports. Students of programs can provide technology (email, phone, internet) and assistance with labor needs.	Medium	Berkshire Hills Regional School District, local colleges	Short / High	Town

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Education and Awareness Programs	Develop a climate change curriculum for the Town's Schools.	Foster and enhance climate science literacy among upcoming generations.	High	Berkshire Hills Regional School District	Short / High	Town
Local Plans and Regulations	Analyze alternatives to the centralized education that can still support social connectivity.	Provide educational alternatives to students who cannot travel from rural/inclement condition areas.	Medium	Berkshire Hills Regional School District	Short / High	Town
Local Plans and Regulations	Upgrade education facilities and transportation modes to alternative fuels.	Reduce dependency on fossil-fuels and decrease municipal contributions of GHG emissions causing climate change.	High	Berkshire Hills Regional School District	Short / High	Town, DOER
Structural Project	Provide "real" and functional kitchen at the schools.	Enhance municipal emergency sheltering capacities and enable farm-to-school program.	High	Berkshire Hills Regional School District	Short / Low	Town, FEMA
Local Plans and Regulations	Create program to engage second homeowners about volunteerism and community activities.	Build capacity for trained volunteers ready for disaster response deployment.	Medium	Nonprofit organizations	Ongoing / Low	Town
Local Plans and Regulations	Create a program that will engage funding sources and explore crowd source funding and public-private partnerships.	Expand resources available for municipal disaster response/recovery.	Medium	Nonprofit organizations	Ongoing / High	Town
Local Plans and Regulations	Develop drought regulations to ensure efficient use of water resources during times of drought.	Protect Town's water supply.	Low	Town Conservation Agent	Ongoing / High	Town, FEMA

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Structural Project	Replace aging water distribution infrastructure including pipe replacement.	Ensure reliable access and distribution to clean drinking water.	High	GB Fire District; Housatonic Water Co.	Long / high	Town, FEMA, Mass DEP
Local Plans and Regulations	Pursue public ownership of Housatonic water supply.	Improve decision making power over the future of local water resources.	High	Town Manager	Long / High	Town, FEMA
Local Plans and Regulations	Prepare an emergency plan for the public water supplies.	Ensure redundancy of drinking water supplies and ensure drinking water is available during periods of hazards and recovery.	Medium	Town Planning Dept.	Long / High	Town, FEMA
Local Plans and Regulations	Initiate focused wastewater treatment plant (WWTP) and climate change audit to better understand hazards and potential solutions to strengthen the resilience of the Town's wastewater system.	Minimize the risk of disruptions to critical municipal operations.	Medium	Town DPW	Long / Medium	Town, FEMA
Local Plans and Regulations	Assess feasibility and determine site suitability for decentralized neighborhood scale wastewater treatment systems as advised by the EPA.	Allow for decentralization of wastewater systems.	Medium	Town Board of Health	Long / High	Town, FEMA, Mass DEP
Education and Awareness Programs	Engage in better stormwater management techniques, such as providing education to residents on how best to mitigate nutrient use and other chemical use that contributes to non-point source pollution.	Minimize the contributions of and environmental damage caused by non-point source pollution generated from residential, commercial, industrial, and municipal activities.	Low	Town Conservation Commission	Ongoing / High	Town, FEMA, Mass DEP

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Local Plans and Regulations	Explore regulations to prevent nutrient runoff/use.	Reduce non-point source pollution.	Low	Town Conservation Commission	Ongoing / High	Town, FEMA, Mass DEP
Structural Project / Natural Systems Protection	Utilize erosion controls along Seekonk Road and Route 7 at Sheffield Border – using vegetated swales, and traditional approaches.	Reduce non-point source pollution and stabilize road bank.	High	Town DPW, MassDOT	Ongoing / Medium	Town, FEMA, EOEEA, DER
Local Plans and Regulations / Natural Systems Protection	Update culvert list and plan for improvements in capital budget.	Increase resilience at road-stream crossings.	Medium	Town DPW, MassDOT	Ongoing / Medium	Town, FEMA, EOEEA, DER
Local Plans and Regulations	Conduct regular maintenance and cleanouts of culverts.	Reduce the risk of road deterioration and washouts.	Medium	Town DPW, MassDOT	Ongoing / Medium	Town, FEMA
Local Plans and Regulations	Assessment of roadway vulnerability and project prioritization for essential transportation routes.	Ensure resilient transportation routes.	Medium	Town DPW, MassDOT	Short and Ongoing / High	Town, FEMA
Local Plans and Regulations / Natural Systems Protection	Continue and update culvert assessment utilizing the NAACC standardized process to determine connectivity potential and condition of structure.	Ensure resilience of road-stream crossings and thus roadway stability.	Medium	Town DPW, MassDOT	Short and Ongoing / High	Town, FEMA, EOEEA, DER

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Local Plans and Regulations / Natural Systems Protection	Initiate forest management best management practices to address tree health and invasive species along waterways.	Proactively mitigate invasive species that may be transferred downstream by flood events.	High	Town Conservation Commission	Short and Ongoing / High	Town, EOEEA, DER, FEMA
Local Plans and Regulations / Education and Awareness Programs	Develop legislation or bylaws to guide private land management coupled with education of best management practices.	Ensure best management practices are implemented on both public and private property.	Low	Town Conservation Commission	Short and Ongoing / High	Town, DCR
Local Plans and Regulations	Review existing management plans and prioritize culvert repairs/replacements based on community needs.	Ensure culvert replacements account for and align with community needs.	Low	Town DPW	Ongoing / High	Town, DER, EOEEA, FEMA
Structure and Infrastructure Projects	Proactively maintain bridges and fix bridges in need of repair.	Ensure road-stream crossing resilience.	High	Town DPW, MassDOT	Ongoing / High	Town, FEMA, EOEEA, DER
Local Plans and Regulations	Investigate Housatonic River erosion concerns around the Claire Teague senior center and adjacent housing.	Ensure necessary actions are taken to protect vulnerable populations from bank erosion	Low	Town DPW	Ongoing / Medium	Town, FEMA
Structural Project	Retrofit senior center to function as shelter during emergency events – install generator and commercial kitchen to allow shelter functions.	Provide additional sheltering capacities.	High	Town DPW	Short / High and Low	Town, FEMA

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Local Plans and Regulations	Improve the relationship between emergency responders (i.e. Police) and the community protesting and taking action against climate change.	Improve social resilience.	Medium	Town Manager	Ongoing / Low	Town
Education and Awareness Programs	Educate the public on emergency response procedures.	Improved emergency preparedness.	Low	Town Emergency Management Director	Short and Ongoing / High	Town, FEMA
Preparedness and response actions	Practice shelter in place for tornado incidents.	Increase emergency preparedness for tornados.	Low	Town Emergency Management Director	Ongoing / Low	Town, FEMA
Preparedness and response actions	Evaluate Berkshire South and BCC South as shelters and stock with emergency food supplies.	Establish additional shelter capacity.	Medium	Town Emergency Management Director	Short / High	Town, FEMA
Preparedness and response actions	Establish shelters throughout Town that can also serve as warming/cooling centers, particularly for senior access, during temperature extremes.	Establish additional shelter capacity that serve as warming/cooling shelters to prevent illness and deaths from weather extremes.	High	Town Emergency Management Director	Short / Medium	Town, FEMA
Preparedness and response actions	Assess capacity for shelters to take in residents from the “social region” because Great Barrington can serve as a “resiliency hub.”	Increase Great Barrington’s capacity to serve as a resiliency hub.	Low	Town Emergency Management Director	Short / Medium	Town
Preparedness and response actions	Conduct formal preparedness outreach for faith community leaders and agree upon coordination during emergency.	Increase emergency preparedness.	Low	Town EMD, Faith Community Leaders	Short / High	Town

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Preparedness and response actions	Educate the public on CodeRED procedures.	Increase emergency preparedness and range of emergency communication.	Low	Town Manager	Ongoing / High	Town, FEMA
Education and Awareness Programs	Explore alternative ways to disseminate information to residents.	Increase emergency preparedness and range of emergency communication.	Low	Town Emergency Management Director	Ongoing / Medium	Town, FEMA
Local Plans and Regulations	Provide additional venues for face to face networking – either themed gatherings or 'meet-your-neighbor' gatherings to increase social cohesion and develop community ties.	Increase social resilience.	Low	Town Sustainability Committee	Ongoing / Medium	Town
Preparedness and response actions	Coordinate preparedness with medical facilities.	Increase emergency preparedness.	Low	Town EMD, Medical Facilities	Long / Low	Town, FEMA
Preparedness and response actions	Adequately prepare the hospital for higher heat and other climate change impacts.	Increase resilience to climate extremes.	High	Hospital	Ongoing / Low	Town, FEMA
Preparedness and response actions	Ensure Walter J. Koladza airport is included in Emergency Operations Plan.	Emergency preparedness for the airport.	Low	Town EMD	Ongoing / Low	Town
Local Plans and Regulations	Initiate research on successful examples of public transit in rural communities and understand what makes those models effective and assess potential replication.	Improved rural public transit and accessibility for the senior population.	Low	Town Transit Committee	Short / Medium	Town

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Education and Awareness Programs	Initiate public campaign to promote public transit in Berkshire County.	Increase the capacity of the public transit system to serve low-income and elderly populations.	Low	Town Transit Committee and BRTA	Short / Medium	Town
Structural Project	Allocate more funding to construct additional pedestrian connections to make the Town more walkable.	To establish better pedestrian pathways to prevent loss of life and property.	High	Town Planning Dept.	Long / High	Town, MassDOT
Local Plans and Regulations / Preparedness and response actions	Develop and ensure emergency routes for EMS services provide access into and out of neighborhoods that might need assistance during emergency events.	Ensure emergency routes for EMS services provide access into and out of neighborhoods that might need assistance during emergency events.	High	Town EMD	Long / High	Town
Local Plans and Regulations	Establish more programs such as a "Wood Bank" – where wood is donated so families in need can come and take donated wood for home heating purposes. Make more of these programs available and accessible.	Provide alternative heating to low-income residents and prevent build-up of downed trees that may fuel wildfire or attract pests.	Low	Town Sustainability Committee	Long / Medium	Town, FEMA
Preparedness and response actions / Local Plans and Regulations	Create programs that provide financial alleviation to those recovering from an emergency or disaster.	Establish resources to assist the recovery of vulnerable populations.	High	Nonprofit organizations	Long / Medium	Town

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Local Plans and Regulations / Structural Project	Identify/build-up additional housing stock, particularly affordable housing units and track demographic trends to adequately match housing stock with expected demographic variables.	Ensure affordable housing and emergency housing availability during recovery.	High	Town Planning Dept.	Ongoing / High	Town, Massachusetts Department of Housing and Community Development
Preparedness and response actions / Education and Awareness Programs	Explore ways to leverage CHP's existing outreach to include information about hazards / emergency situations. Coordinate with CHP to engage in a publicity campaign so that residents know about resources.	Maximize reach of emergency preparedness information.	Low	Town EMD, CHP	Medium / Low	Town, FEMA
Local Plans and Regulations	Initiate programming to encourage greater community cohesion and understanding among diverse groups.	Ensure neighbors are looking after each other and ensure the community is aware of the unique cultural requirements of residents.	Low	Town Planning Dept	Ongoing / Low	Town
Local Plans and Regulations	Initiate programming to educate residents on nature-based solutions to hazards.	Promote the use of nature-based adaptation solutions on privately funded projects.	Low	Town Conservation Commission	Ongoing / Low	Town, EOEEA
Natural Systems Protection	Plan for wildlife habitat and migration in conjunction with mitigation actions.	Establish wildlife corridors that provide flood adaptation/protection.	Medium	Town Planning Dept	Ongoing / Medium	Town, EOEEA
Natural Systems Protection	Plan conservation lands so that they align with hazard prone areas and protect threatened habitat.	Establish wildlife corridors that provide flood adaptation/protection.	Low	Town Planning Dept	Ongoing / Medium	Town, EOEEA

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Education and Awareness Programs	Implement homeowner education program on use of native species and pollinator habitat for landscaping.	Establish resilient landscapes.	Low	Town Agricultural Committee	Ongoing / High	Town, EOEEA
Local Plans and Regulations / Natural Systems Protection	Map and create network of private property to serve as wildlife and flooding corridor.	Establish wildlife corridors that provide flood adaptation/protection.	High	Town Planning Dept	Medium / Medium	Town, FEMA
Local Plans and Regulations / Natural Systems Protection	Prioritize natural alternatives to pesticide and herbicide use.	Reduce toxins in the local environment.	Low	Town Conservation Commission	Short / High	Town
Local Plans and Regulations / Natural Systems Protection	Update Town development plan and consider designation / protection of wildlife corridors.	Encourage the integration of plans and establish wildlife corridors that provide flood adaptation/protection.	Low	Town Planning Dept	Ongoing / Medium	Town, EOEEA
Local Plans and Regulations / Natural Systems Protection	Update Town's Open Space Plan to reflect updated floodplain management techniques.	Integrate planning efforts and establish multiple and compatible uses for land in the floodplain.	Low	Town Planning Dept	Ongoing / Medium	Town

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Local Plans and Regulations / Natural System Protection	Conduct an ecological inventory – to see what ecological assets the Town has, to formulate different strategies to preserve/protect it, and to quantify the value of ecosystems services afforded by the Town's natural areas.	Establish natural infrastructure as facilities to enable FEMA recovery assistance for these facilities.	Medium	Town Planning Dept	Ongoing / High	Town, EOEEA
Local Plans and Regulations	Develop an invasive species management plan.	Provide a path for eliminating invasive species.	Medium	Town Planning Dept	Ongoing / High	Town, EOEEA
Natural Systems Protection	Identify property with high ecological diversity and critical species in Town.	Plan for protection of ecological diversity that could be threatened by disturbances.	Low	Town Planning Dept	Ongoing / High	Town, EOEEA
Local Plans and Regulations / Natural Systems Protection	Develop a forest management plan to capitalize on carbon sequestration of natural areas – encourage participation in carbon market – cap-and-trade/invest programs and work with DCR on sustainable logging practices.	Improve resiliency of local forests and provide alternative revenues for forest landowners to strategically guide development while mitigating climate change.	Medium	Town Planning Dept	Ongoing / High	Town, EOEEA
Education and Awareness Programs	Provide education on benefits of and best management practices for Wetlands.	Create a better-informed public on benefits of wetlands and protection of wetlands for ecosystem services such as flood mitigation and nutrient capture.	Low	Town Conservation Agent	Ongoing / High	Town, EOEEA

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Structural Project/ Natural Systems Protection	Restore and protect wetlands, and engineer wetlands for ecosystems services, particularly water treatment.	Establish more resource efficient methods of wastewater treatment utilizing nature-based solutions that allow for moving wastewater treatment out of the floodplain.	High	Property owners	Ongoing / High	Town, FEMA, EOEEA
Education and Awareness Programs	Provide public education opportunities for homeowners and new construction on green topics.	Allow for stormwater mitigation on individual property-level to prevent larger-scale issues.	Low	Town Conservation Agent	Ongoing / High	Town, EOEEA
Local Plans and Regulations	Implement invasive species identification and management action plan and conduct targeted removal of invasive species.	Strategically eliminate threats posed by invasive species.	High	Town Conservation Agent	Long / Medium	Town, EOEEA
Education and Awareness Programs	Initiate education on invasive species.	Create a more informed public to prevent the spread of invasive species.	Low	Town Conservation Agent	Short / Medium	Town, EOEEA
Local Plans and Regulations	Allow backyard chickens as natural solution to mitigate the abundance/spread of disease-carrying ticks.	Mitigate increase in tick population utilizing natural methods. Increase local food resiliency.	Low	Town Planning Dept	Short / Medium and Long	Town

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Education and Awareness Programs	Develop more educational resources including information on symptoms, prevention, and healthcare options from contact with pests such as ticks, mosquitoes, and other vector-species.	Prevent the spread of disease and loss of life.	Low	Town Health Dept	Short / High	Town, FEMA
Preparedness and response actions / Education and Awareness Programs	Create a Town wide tick alert system in which a mass message is sent to cell phone of people who have signed-up for notification system to alert them to the prevalence of ticks in certain areas during specific times of the year.	Prevent the spread of disease and loss of life.	Low	Town Health Dept	Short / High	Town, FEMA
Local Plans and Regulations	Continue to monitor the outbreak/spread of illnesses as they move across the state.	Prevent the spread of disease and loss of life.	Low	Town Health Dept	Short / High	Town, FEMA
Structural Project/ Natural Systems Protection	Address property erosion around the Green River area.	Prevent loss of property and damage to water quality by stabilizing riparian banks.	High	Town Conservation Agent	Ongoing / High	Town, FEMA, EOEEA
Education and Awareness Programs	Develop an education strategy to inform people about floodplain management, where the floodplain is, its services, and the dangers of developing within the floodplain.	Prevent floodplain development and loss of life and property.	Low	Town Planning Dept	Ongoing / High	Town, FEMA

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Structural Project	Redesign Lake Mansfield Road as a recreation path not a vehicular roadway.	Prevent loss of life or property.	High	Town Planning Dept	Long / High	Town
Education and Awareness Programs / Preparedness and response actions	Publicize shelter locations and capabilities to inform the public.	Ensure that residents know shelter locations prior to disaster and prevent loss of life.	Low	Town EMD	Ongoing / Low	Town, FEMA
Structural Project	Implement bank stabilization solutions on the Housatonic, Lake Mansfield and the Green River where erosion is occurring.	Prevent erosion, water quality issues, and loss of property.	High	Town DPW	Short / High	Town, FEMA, EOEEA
Local Plans and Regulations	Provide invasive species control in Housatonic and Lake Mansfield.	Protect aquatic species habitat, reduce maintenance strains due to dead plant matter removal and prevent spread of Zebra Mussels which cause infrastructure damage.	Medium	Town DPW and all Watershed Towns	Short / High	Town, EOEEA
Structural Project	Address stormwater runoff with living shorelines on lake Mansfield.	Remove contaminants from stormwater before flowing into lake Mansfield to protect water quality and human health.	Medium	Town DPW	Short / High	Town, EOEEA
Structural Project	Implement watershed-based plan.	Implement projects that will restore water quality and protect beneficial uses.	High	Town Planning Dept	Short / High	Town, EOEEA

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Structural Project	Implement Lake Mansfield Improvement Plan.	Improve public safety, use and accessibility and improve water quality.	High	Town Planning Dept	Short / High	Town
Local Plans and Regulations	Increase the size of buffers on all waterbodies and increase the use of native plantings along buffers.	Protect water quality and floodplain function.	Low	Town Conservation Agent	Short / High	Town, EOEEA
Local Plans and Regulations	Utilize less tilling around the Green River and prevent erosion with cover crops (i.e. clover).	Reduce erosion and loss of property and prevent water quality issues.	Low	Town Agricultural Committee, Farmers	Ongoing / High	Town
Local Plans and Regulations	Promote and incentivize growing and producing local food, over importing food, to support the local population.	Establish the ability to provide food locally and reduce dependence on carbon heavy imports.	High	Town Sustainability Comm., Agricultural Committee, Farmers	Ongoing / High	Town
Local Plans and Regulations	Ensure crop diversity over monoculture corn crops for feed and biofuel.	Prevent the spread of pests that can easily travel across a monoculture prioritize food to feed the local population.	Medium	Town Agricultural Committee, Farmers	Long / High	Town
Preparedness and response actions	Study the development of reliable food distribution networks and bulk food storage for emergency situations.	Ensure emergency preparedness for food supplies.	Medium	Town Planning Dept	Long / High	Town, FEMA
Local Plans and Regulations	Increase the use of seed banks / seed storage to prepare for disaster recovery.	Enable the restoration of natural landscapes with native species after a disturbance.	Low	Town Sustainability Committee, Local Farmers	Long / High	Town

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Education and Awareness Programs	Establish more ‘buy local’ initiatives and farmers markets and provide more educational and financial resources for increasing sustainable farming practices.	Establish the ability to provide food locally and reduce dependence on carbon heavy imports while improving the resiliency of the local economy.	Medium	Town Sustainability Committee, Local Farmers	Long / High	Town, EOEEA
Local Plans and Regulations	Create more programs to encourage younger generations to continue farming locally (providing technology and assisting with labor needs).	Establish the ability to provide food locally and reduce dependence on carbon heavy imports while improving the resiliency of the local economy.	High	Town Sustainability Committee, Local Farmers	Long / High	Town, EOEEA
Local Plans and Regulations	Explore developing a robust recycling and composting program to sustainably dispose of materials.	Establish sustainable material recovery and disposal systems that can upscaled during disaster response.	Medium	Town Sustainability Committee	Ongoing / High	Town, EOEEA, MassDEP
Local Plans and Regulations	Ban glyphosate to maintain healthy soils.	Prevent agricultural collapse and evolution of crops pests of invasive species while maintaining healthy soils.	Low	Town Health Dept	Short / High	Town
Local Plans and Regulations / Education and Awareness Programs	Provide technical assistance programs for the transition to more sustainable agricultural practices and improve soil health.	Establish the ability to provide food locally, improve the resiliency of the local economy and prevent the deterioration of local soils.	High	Town Agricultural Commission	Short / High	Town, EOEEA

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Local Plans and Regulations	Evaluate risk posed to local food and import routes to determine a plan for providing food to the Town in case of long-term hazardous conditions.	Establish preparedness plan for food distribution in disaster response and recovery.	Medium	Town Planning Dept	Ongoing / High	Town, EOEEA
Local Plans and Regulations	Determine medical supply reserves.	Ensure medical supplies are sufficient in disaster.	Low	EMD, Medical Facilities		Town, FEMA
Preparedness and response actions	Obtain backup energy power supply for utilities needed to ensure redundancy. Eventually work towards energy independence.	Establish back-up energy supply for hazardous conditions to maintain water, communication and electrical distribution.	High	Town DPW, Public utilities	Long / High	Town, MassDEP
Local Plans and Regulations	Continue to use alternative energy sources (renewables) town wide.	Reduce climate forcers and establish local back-up energy sources that are not dependent on petroleum supplies.	High	Property owners	Long / High	Town, MassDEP
Preparedness and response actions / Local Plans and Regulations	Assess the potential for microgrids at various scales including a town wide microgrid that can be connected to alternative energy sources or a microgrid for critical facilities including shelters, EMS, and resiliency hubs or gathering points.	Strengthen grid resilience and help mitigation grid disturbances as well as function as a grid resource for faster system response and recovery.	Medium	Town Sustainability Committee	Short / High	Town, MassDEP

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Local Plans and Regulations / Preparedness and response actions	Assess power station vulnerability.	Avoid potential power outages due to avoidable risks.	Low	National Grid and Mass DPU	Short / High	Town, FEMA
Local Plans and Regulations	Conduct a cost-benefit analysis to determine financial viability/payback for burying power lines underground to protect from weather.	Determine financial viability and benefit of burying power lines.	Low	Planning Dept., National Grid and Mass DPU	Long / Medium	Town, FEMA
Local Plans and Regulations	Require the burying of power lines during new construction.	Improve the resilience of electrical infrastructure in the most resource efficient method.	High	Town, National Grid, MassDOT	Long / Low	Town
Local Plans and Regulations	Incentivize innovative technological upgrades that improve energy efficiency/use and renewable energy sources.	Ensure utilization of best available technologies for greater resilience.	Low	Town Sustainability Committee	Ongoing / Low	Town
Local Plans and Regulations	Develop energy efficient bylaws and codes for passive design.	Proactively improve the energy efficiency and resiliency of the built environment.	Low	Town Sustainability Committee	Ongoing and Short / Low	Town
Preparedness and response actions	Create stronger neighbor to neighbor programs – this could include a face-to-face check in among neighbors who are vulnerable.	Establish a method to check on isolated residents and improve social resilience.	Low	Town Sustainability Committee	Long / Low	Town, EOEEA, FEMA

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Preparedness and response actions	Establish emergency hotlines for vulnerable populations including the elderly and those experiencing homelessness to utilize in emergency situations and ensure these resources are disseminated.	Improve emergency communication to maximize reach, especially among isolated populations and reduce loss of life.	Medium	Town Sustainability Committee	Long / Low	Town, FEMA, EOEEA
Local Plans and Regulations / Preparedness and response actions	Identify ways to diversify Town wide communications and ensure a variety of mediums are used to disseminate information.	Improve communication to maximize reach to reduce loss of life and property.	Low	Town Planning	Long / Low	Town
Local Plans and Regulations / Preparedness and response actions	Develop a targeted municipal plan that seeks to ensure the Town's vulnerable populations are adequately protected from the key hazards that have been outlined.	Adequately plan to reduce risk to vulnerable populations.	Low	Town Planning Dept	Ongoing / High	Town, FEMA, EOEEA
Preparedness and response actions	Explore ways to involve populations which may have resources such as financial capital and time to volunteer to assist with the needs of vulnerable populations.	Increase resources available to address risks posed to vulnerable populations.	Low	Town Sustainability Committee	Ongoing / High	Town
Preparedness and response actions	Collaborate with organizations to establish food pantries and/or meal sites.	Improve working relationships with organizations that will need to be upscaled during an emergency.	High	Town Sustainability Committee	Short / High	Town, FEMA

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Local Plans and Regulations	Develop a municipal Climate Refugee Plan that includes the establishment of a climate refugee program along with establishing an ethic for acceptance of climate refugees that will adequately prepare the Town for an influx of potential climate refugees.	Improve capacity to integrate additional population that may not have English as first language or may have limited English proficiency that will need to be accommodated.	Medium	Town Sustainability Committee	Ongoing / Medium	Town, FEMA
Local Plans and Regulations	Replicate VIM's model among other organizations hoping to aid vulnerable populations.	Improve accessibility for needed health services before, during and after hazardous events.		Town Sustainability Committee	Ongoing/Long and Medium	Town, FEMA
Preparedness and response actions	Conduct targeted bi-lingual outreach via VIM, CHP, Multi-Cultural Bridge, ADA translations services at Town Hall.	Ensure emergency and preparedness information is available to limited-English proficiency (LEP) populations.	Low	Town Manager, VIM, CHP, Multi-Cultural Bridge	Short / High	Town
Preparedness and response actions / Education and Awareness Programs	Establish universal accessibility to public health information and center including the translation of materials to multiple languages, or availability of on-demand translation services.	Ensure emergency and preparedness information is available to limited-English proficiency (LEP) populations.	Low	Town Health Dept	Ongoing / High	Town, FEMA
Education and Awareness Programs	Provide Town facility Open-House days with multilanguage material and familiarize the public with services provided.	Break down barriers for minorities in majority spaces to produce a culturally safe environment.	Low	Town Manager	Short / Medium	Town

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Education and Awareness Programs	Identify places and spaces to connect face to face with marginalized populations and going to spaces where the targeted populations feel comfortable in order to encourage greater participation.	Utilize spaces created by minority and marginalized populations to enable candid conversations that will lead to projects that will effectively serve the historically marginalized populations.	Low	Town Sustainability Committee	Ongoing / High	Town
Local Plans and Regulations / Education and Awareness Programs	Provide the opportunity for marginalized populations to organize and hold their own resilience workshop to encourage candid conversations.	Utilize social networks created by minority and marginalized populations to enable candid conversations that will lead to projects that will effectively serve the historically marginalized populations.	Medium	Town Sustainability Committee	Ongoing / High	Town

CHAPTER 5: PLAN ADOPTION

44 CFR § 201.6(c)(5)

This plan has been formally adopted by the governing body of the Town of Great Barrington.

Town of Great Barrington

A RESOLUTION OF ADOPTING THE

the Great Barrington Hazard Mitigation and Climate Adaptation Plan

WHEREAS the Town of Great Barrington recognizes the threat that natural hazards pose to people and property within the Town of Great Barrington; and

WHEREAS the Town of Great Barrington has prepared a hazard mitigation plan, hereby known as the Great Barrington Hazard Mitigation and Climate Adaptation Plan in accordance with the Disaster Mitigation Act of 2000; and

WHEREAS the Great Barrington Hazard Mitigation and Climate Adaptation Plan identifies mitigation goals and actions to reduce or eliminate long-term risk to people and property in the Town of Great Barrington from the impacts of future hazards and disasters; and

WHEREAS adoption by the Great Barrington Select Board demonstrates their commitment to the hazard mitigation and achieving the goals outlined in the Great Barrington Hazard Mitigation and Climate Adaptation Plan.

NOW THEREFORE, BE IT RESOLVED BY THE TOWN OF GREAT BARRINGTON, MASSACHUSETTS, THAT:

In accordance with M.G.L. c. 40. the Great Barrington Select Board adopts the Great Barrington Hazard Mitigation and Climate Adaptation Plan.

ADOPTED by a vote of ____ in favor and ____ against, and ____ abstaining, this _____ day of

___________, ______.

Signature

Print Name

Title

ATTEST:

CHAPTER 6: PLAN MAINTENANCE

44 CFR § 201.6(c)(4)

44 CFR § 201.6(c)(4) asks for a section of local hazard mitigation plans to describe the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle, process by which Great Barrington will incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate, and how the community will continue public participation in the plan maintenance process (44 CFR § 201.6(c)(4)(iii)).

Plan Review and Updates

§201.6(c)(4)(i) (iii)

The Town of Great Barrington will officially review needed updates for the Great Barrington HMCAP on an annual basis. The Director of Planning and Community Development will facilitate the plan review and update process in accordance with FEMA guidance. Active members of the plan review team will depend on specific needs of the community at that time and will be representative of resident and stakeholder interests. Updates will account for completed mitigation actions, new development, changing problem areas, and input from public involvement. Great Barrington has prioritized developing effective strategies to engage residents that have not been reached through this climate change and hazard mitigation planning process. Implementation of continued and meaningful public participation is contingent upon receiving funding applied to through the EEA Municipal Vulnerability Preparedness Action Grant program by the Strategic Sustainability and Livability Committee.

Annual review is scheduled to occur during development of the annual Capital Improvement Plan update and proposed Capital budget. Relevant updates will be shared with BRPC to update GIS data. While the Hazard Mitigation and Climate Adaptation Plan must be updated every five years, Great Barrington will begin the process of organizing and identifying funding for the plan update to be approved by FEMA every three and a half years.

Integration in Future Planning

§201.6(c)(4)(ii)

The Great Barrington HMCAP will be utilized in all future planning efforts in the Town, including integration of the action plan into any new or updated plans. The Town has taken steps to integrate findings of the HMCAP in the Open Space and Recreation Plan, which is updated about every five years. The HMCAP will also be integrated into the Capital Improvement Plan on an annual basis.

The final adopted HMCAP will made publicly available on the Town and BRPC websites for reference and comment. Any regional plans developed by BRPC or the Commonwealth should refer to the publicly available Great Barrington Hazard Mitigation and Climate Adaptation Plan to ensure consistency with the vision for community resilience to hazards.

APPENDICES:

APPENDIX A: MEETING DOCUMENTATION

I. Attendance Rosters
II. CRB Workshop Data Walk Posters
III. Public Listening Session Posters

APPENDIX B: COMPLETED OR WITHDRAWN MITIGATION ACTIONS

APPENDIX C: COMPLETED COMMUNITY RESILIENCE BUILDING WORKSHOP MATRICES

APPRENIX D: REQUEST FOR COMMENT FROM REGIONAL PARTNERS AND JURISDICTIONS

APPENDIX A: MEETING DOCUMENTATION

April 2nd, 2019 Planning Meeting Attendance Roster

#	Name	Affiliation/Title
1	Chris Rembold	Town Planner
2	Rebecca Jurczyk	Health Agent
3	Sean Van Deusen	DPW Director
4	Charles Burger	Fire Chief
5	Caroline Massa	BRPC

July 23rd, 2019 Planning Meeting Attendance Roster

#	Name	Affiliation/Title
1	Chris Rembold	Town Planner
2	Ashlee Shaw	Town Intern
3	Natalie Narotzky	Strategic Sustainability & Livability Committee
4	Thomas Jordan	Strategic Sustainability & Livability Committee
5	Robert Baier	Strategic Sustainability & Livability Committee
6	Michael Feldstein	Strategic Sustainability & Livability Committee
7	Devan Arnold	Strategic Sustainability & Livability Committee
8	Mark Phillips	Strategic Sustainability & Livability Committee
9	Jovanina Pagano	Strategic Sustainability & Livability Committee
10	Jesse Carter	Strategic Sustainability & Livability Committee
11	Ananda Hartzell	Strategic Sustainability & Livability Committee
12	Caroline Massa	BRPC

August 28th, 2019 Planning Meeting Attendance Roster

#	Name	Affiliation/Title
1	Chris Rembold	Town Planner
2	Aretha Whitehead	Strategic Sustainability & Livability Committee
3	Natalie Narotzky	Strategic Sustainability & Livability Committee
4	Thomas Jordan	Strategic Sustainability & Livability Committee
5	Ed Abrahams	Strategic Sustainability & Livability Committee
6	Michael Feldstein	Strategic Sustainability & Livability Committee
7	Devan Arnold	Strategic Sustainability & Livability Committee
8	Mark Phillips	Strategic Sustainability & Livability Committee
9	Jovanina Pagano	Strategic Sustainability & Livability Committee
10	Kate Burke	Strategic Sustainability & Livability Committee
11	Ananda Hartzell	Strategic Sustainability & Livability Committee
12	Caroline Massa	BRPC

September 10th, 2019 Planning Meeting Attendance Roster

#	Name	Affiliation/Title
1	Chris Rembold	Town Planner
2	Sean Van Deusen	DPW Director
3	Charles Burger	Fire Chief
4	Heather Barbieri	Fairview Hospital Director of Emergency Management
5	Mark Phillips	Strategic Sustainability & Livability Committee
6	Peg McDonough	BRPC (Age Friendly Berkshires)
7	Caroline Massa	BRPC

September 11th, 2019 Planning Meeting Attendance Roster

Interviews were conducted with the Building Commissioner, Edwin May and Police Chief Walsh

October 16th, 2019 Planning Meeting Attendance Roster

#	Name	Affiliation/Title
1	Chris Rembold	Town Planner
2	Mark Phillips	Strategic Sustainability & Livability Committee
3	Natalie Narotzky	Strategic Sustainability & Livability Committee
4	Jovanina Pagano	Strategic Sustainability & Livability Committee
5	Justin Gilmore	BRPC (Transportation)
6	Caroline Massa	BRPC

November 14th, 2019 CRB Workshop Planning Meeting Attendance Roster

#	Name	Affiliation/Title
1	Cara Becker	Great Barrington Police Department
2	Mathieu Boudreau	Woven Roots Farm
3	Edward Cheng	Simon's Rock
4	Edwin May	Town
5	Jen Salinetti	Woven Roots Farm
6	Lanna Knoll	Miss Hall's
7	Christine Ward	GB Land Conservancy
8	Philip Morrison	Simon's Rock
9	Emmalyn Gaertner	CDCSB
10	Luke Masiero	Guido's
11	Elia Del Molino	BEAT
12	Rachel Moriarty	Center for New Econ
13	Natalie Narotzky	Strategic Sustainability & Livability Committee
14	Chris Rembold	Town
15	Charles Harner	BHS
16	Aretha Whitehead	Greenagers
17	Joe Grochmal	Town
18	Robby Baier	Resident
19	Ananda Hartzell	Strategic Sustainability & Livability Committee
20	Polly Mann	Town

21	Ed Abrahams	Town
22	Jovanina Pagano	Strategic Sustainability & Livability Committee
23	Charlie Medieros	Student
24	Peter Stanton	Stanton Home
25	Jeremy Higa	PB
26	Mark Pruhenski	Town
27	Mark Phillips	Strategic Sustainability & Livability Committee

January 10th, 2020 Planning Meeting Attendance Roster

#	Name	Affiliation/Title
1	Chris Rembold	Town Planner
2	Jovanina Pagano	Strategic Sustainability & Livability Committee
3	Natalie Narotzky	Strategic Sustainability & Livability Committee
4	Carrieanne Petrik	MVP Regional Coordinator
5	Caroline Massa	BRPC
6	Justin Gilmore	BRPC

February 12th, 2020 Planning Meeting Attendance Roster

#	Name	Affiliation/Title
1	Chris Rembold	Town Planner
2	Jovanina Pagano	Strategic Sustainability & Livability Committee
3	Natalie Narotzky	Strategic Sustainability & Livability Committee
4	Mark Phillips	Strategic Sustainability & Livability Committee
5	Caroline Massa	BRPC
6	Justin Gilmore	BRPC

March 9th, 2020 Public Listening Session Agenda:

Mark Pruhenski
Town Manager

E-mail: mpruhenski@townofgb.org
www.townofgb.org

Town Hall, 334 Main Street
Great Barrington, MA 01230

Telephone: (413) 528-1619 x2
Fax: (413) 528-2290

TOWN OF GREAT BARRINGTON
MASSACHUSETTS

OFFICE OF THE TOWN MANAGER

SELECTBOARD'S MEETING AGENDA

MONDAY, MARCH 9, 2020

7:00 PM – REGULAR SESSION

TOWN HALL, 334 MAIN STREET

ORDER OF AGENDA

7:00 PM - OPEN MEETING

1. CALL TO ORDER:

2. APPROVAL OF MINUTES:
February 10, 2020 SB Regular Meeting

3. SELECTBOARD'S ANNOUNCEMENTS/STATEMENTS:
A. General Comments by the Board.

4. TOWN MANAGER'S REPORT:
A. Department Updates
- COVID – 19 Preparedness
- Former Reid Cleaners Property - Update

B. Project Updates
- Revise Housatonic Improvement Committee Charter from 5 members to 7 members (Discussion/Vote)
- Review of Shared Services in South County

5. LICENSES OR PERMITS:
A. Ross Pierce Cameron/Fastback Motors LLC for 2020 Annual Class II (Second Hand Motor Vehicles) License at 20 Castle Street, Great Barrington, MA. (Discussion/Vote)

B. Phornphimon "Jem" Ezinga/Steam Noodle Café LLC/Steam Noodle Café for 2020 Annual Common Victualler License at 226 Pleasant Street, Housatonic, MA. (Discussion/Vote)

C. Terrence & Terri Coughlin/Granville House LLC d/b/a Granville House for 2020 Annual Common Victualler License at 98 Divison Street, Housatonic, MA. (Discussion/Vote)

D. Terrence & Terri Coughlin/Granville House LLC d/b/a Granville House for 2020 Annual Innholders License at 98 Divison Street, Housatonic, MA. (Discussion/Vote)

6. NEW BUSINESS:
A. SB – Recommendation to the Building Inspector on the T-Mobile Northeast LLC Application for a Building Permit for a New Wireless Telecommunication Installation at a Previously Permitted Wireless Telecommunication Facility at 29 Lewis Avenue (Fairview Hospital. (Discussion/Vote)

B. Karen Christensen – Request for a Letter of Support for Funding a Study of Passenger Service of the Housatonic Rail Line (Senate Bills SB2096 and House Bill HB3110 (HD1892). (Discussion/Vote)

C. SB - re: 40 Grove Street - Request from GB Affordable Housing Trust. (Discussion/Vote)

D. Presentation of Municipal Vulnerability Preparedness (MVP) Planning Program. (Discussion/Vote)

E. SB – Open Meeting Law Complaints from Jean Louis and Holly Hardman. (Discussion/Vote)

F. SB – Rest of River Request – Non Binding/Advisory Warrant Article for Annual Town Meeting. (Discussion/Vote)

7. CITIZEN SPEAK TIME:
Citizen Speak Time is simply an opportunity for the Selectboard to listen to residents. Topics of particular concern or importance may be placed on a future agenda for discussion. This time is reserved for town residents only unless otherwise permitted by the chair, and speakers are limited to 3 minutes each.

8. SELECTBOARD'S TIME:

9. MEDIA TIME:

10. ADJOURNMENT:

NEXT SELECTBOARD MEETINGS:
- **Finance Committee Public Hearing and SB & Fin Com Jt. Meeting, March 17, 2020, 6:00 pm, Town Hall**
- **SB Regular Meeting, March 23, 2020, 7:00 pm, Town Hall**

Mark Pruhenski, Town Manager

Pursuant to MGL 7c 30A sec. 20 (f), after notifying the chair of the public body, any person may make a video or audio recording of an open session of a meeting of a public body, or may transmit the meeting through any medium. At the beginning of the meeting, the chair shall inform other attendees of any such recordings. Any member of the public wishing to speak at the meeting must receive permission of the chair. The listings of agenda items are those reasonably anticipated by the chair which may be discussed at the meeting. Not all items listed may in fact be discussed and other items not listed may also be brought up for discussion to the extent permitted by law.

CRB Workshop Data Walk Posters

CLIMATE CHANGE AND THE ECONOMY

NATIONAL

By 2090, Climate Change is expected to cost over $225 billion/year in the US and most likely much higher. (2017 Climate Change Impacts and Risk Analysis Report, EPA)

US economy will shrink by as much as 10% by the end of the century due to climate change.

BERKSHIRE COUNTY

Berkshire County GDP— $7.1 billion ~$19.5 Million/day

GREAT BARRINGTON

$1.4 billion in building value

Change in Average / Extreme Temperature

Impacts

Increased electrical costs for cooling

Reduction in maple syrup production

Less Snow can mean less winter tourism (impact on Ski Butternut)

Loss of native trees (sugar maple) can reduce fall foliage tourism

Current crops may not be successful

Actions

Establish cooling centers

Develop alternative uses for forested land

Diversify economy

Enhance natural, climate control assets such as tree cover and vegetation

Install energy efficient technologies and building systems to reduce energy use

Educate employers about OSHA requirements for employee protections in times of high heat

Diversify crops and agricultural economy

Consider using renewable energy, performing energy efficiency retrofits, and conserving energy in business processes and in employee commuting

Assess capacity to meet the needs of employees who are vulnerable to health impacts from flooding, extreme heat, or poor air quality

Severe Winter Events (Ice Storm, Blizzard, Nor-easter)

Impacts

Higher impact on infrastructure and businesses when storms do hit

More ice storms may require more sand/salt

Disruption to electrical grid

Actions

Bury electrical lines

Dam Failure

Impacts

Rising Pond Dam—$37.5 Million in building value in inundation area below dam

Actions

Regularly inspect and repair dam. Ensure it is capable of handling larger storms.

Flooding (including Ice Jam, Beaver Activity)

Impacts

Increased flooding leads to increased road maintenance

$168.5 million in potential floodplain loss. (building plus inventory)

42.1% of industrial buildings ($5.3 million)

5.8% of Commercial buildings ($70 million)

Actions

Preemptively plan for Culvert Replacement—$400,000—$1,000,000 /culvert

Proactively work with land owners to address flooding concerns at their properties.

Avoid siting new business facilities in flood prone areas

Ensure remote access and teleworking options are available for employees during extreme weather, flooding and other storm events

Set up emergency communication notification systems so employees know of office closures or evacuations

Consider improvements to the structural stability, water drainage, and weatherproofing of critical infrastructure and other economically vital sites as part of capital improvement projects.

Ensure businesses in potential flood zones are flood-proofed, for example by elevating electrical and HVAC systems above ground level

Improve storm water management at business facilities and conserve water via grey water systems

Identify alternative materials and inventory suppliers to avoid delivery interruptions due to extreme weather or other events

Investigate alternate transportation routes and communication systems for suppliers, customers, and workers to use during emergencies

Urban & Wildfire

Impacts

$877 Million in building values within forested areas

Actions

Develop forest management plans for areas of concern

Landslide /Erosion

Impacts

$18.4 Million building value within Unstable or Moderately Unstable areas

Infrastructure in unstable areas—loss of power, water, sewer, access

Actions

Stabilize banks around buildings and infrastructure at risk

Food and Farming

Agriculture in the Berkshires at a Glance

- 475 farms in operation totaling $23.5M in annual sales, based on 2017 agricultural census data
- Top crops include forage for animals (such as hay for livestock), corn for livestock feed, and vegetables
- Top livestock include cattle (for beef or dairy), laying hens, and horses and ponies
- Agriculture has important cultural benefits and tourism in the Berkshires that cannot be quantified

Key Threats to Farms in the Berkshires from Climate Change

Information adapted from MA Climate Change Clearinghouse

Deerfield, MA farm post - Irene – 40 acres covered in silt. From MassLive

- **Rising temperatures**
  - Crops that rely on specific temperature regimes like apples, cranberries, and maple syrup may fare poorly
  - Increasing heat stress days (above 90°F) will stress livestock and some crops
- **Changes in Precipitation**
  - Increased precipitation will lead to more flooding, soil erosion, and crop damage
  - Wetter springs may delay planting for crops and reduce yields
  - Drier summers and intermittent droughts may strain irrigation water supplies, stress crops, and delay harvests
- **More Extreme Weather Events**
  - Extreme storms may cause catastrophic damage to crops and fields, farm buildings, equipment and drainage systems
  - Heavy rainfall is likely to wash away fertile soils, damage water resources, and potentially increase risk of water supply contamination from farm runoff
- **More Pest Pressure**
  - More pest pressure from insects, diseases and weeds may harm crops and cause farms to increase pesticide use

Mitigation and Adaptation Strategies for Agriculture in the Berkshires

Management Practices: Changes in how food is grown can help farms adapt to climate change (adaptation) while also reducing current levels of emissions (mitigation). Here are a few examples:

- Increasing soil organic matter by planting cover crops, using no-till techniques, and effective livestock management can sequester atmospheric carbon while preparing farms for extreme weather events
- Crop diversification can increase on-farm resilience to weather and also support farm economic stability
- The integration of trees into crop and pastureland through agroforestry can sequester carbon and help farms withstand weather extremes while also adding new income sources to farms

Policy and Planning:

- Farms throughout Massachusetts can apply for a grant for the state-wide ACRE program (Agricultural Climate Resiliency & Efficiencies) to reduce risks from climate change
- At the town level, Great Barrington can bolster support for policies like the Agricultural Preservation Restriction (APR) program which can help with access to land for young and beginning farmers, as well as succession planning for existing farms to keep agricultural land in use
- The Agricultural Commission can take an explicit look at climate change preparedness policies and programs

Additional Areas of Concern Across Great Barrington's Food System

- **Food access and security:** Existing programs like SNAP (Supplemental Nutrition Assistance), WIC (Women, Infants, Children), as well as emergency food banks and distribution services should be bolstered to meet the rising cost of food resulting from the affect of climate change intensification on global supply chains
- **Food waste** is a major contributor to greenhouse gas emissions. Policies and programs in support of reducing food waste locally and regionally should be examined and supported. Examples include the development of town policy around community compost systems and the support of commercial composting enterprises

GB Farmers Market raised an additional $30K in 2019 to double the spending power of SNAP and WIC benefits, a creative solution that incentivizes healthy food purchases for recipients while increasing income for local farm producers.

Key Resources

- Massachusetts' Climate Change Clearinghouse, ResilientMA.org
- Berkshire Regional Planning Commission's 2014 report, *Local Food and Agriculture*
- USDA Northeast Climate Hub: www.climatehubs.usda.gov/hubs/northeast

HOUSING

What type of housing do we have?

Most housing units in our Town are owner-occupied, although more rental housing is now being built near downtown. Most homes are single-family homes, but there are significant number of multifamily homes and people living in group quarters, like nursing homes.

Our housing is expensive, and our housing is old. Almost 60% of our homes are over 80 years old. These older homes can add historic character to our town, but this character comes at a high price tag.

What are some implications of this?

- With a "traditional" housing stock of high value single family homes, few rentals, and low vacancy rates, it can be difficult to find low-cost or transitional living arrangements.
- To be able to afford a typical single family home in Town, based on typical mortgage terms, you need to earn $90,000 per year.
- Renting is just as pricy. At a rent of $1,000 per month, in order not to spend more than 30% of your income on this rent, you would need to earn $17/hour ($36,000/yr)
- Old homes are probably not well insulated, making them expensive to heat, cool, and maintain. Roofs, windows, and furnaces may be outdated, inefficient and susceptible to ice dams, roof leaks, or poor indoor air quality like mold. Electric wiring is likely to be undersized for modern power demands.
- Many of our homes are heated with electricity (13%), gas (36%), or fuel oil (46%). We depend on fossil fuel sources from outside of our Town (or state) which can be subject to supply chain impacts as well as market fluctuations and price swings.

What type of housing do we allow?

Current zoning regulations allow for single-family homes and two-family homes by right anywhere in Town. Even small accessory apartments are allowed in all zoning districts. Multi-family housing (anything of three units or more) is much more closely regulated.

Until very recently, development in Great Barrington was mostly single family homes on large lots outside of core areas. In the 1990s and early 2000s, average residential lot size was about 5.5 acres.

What are some implications of this?

- In our Town and in the County, we are using more land for fewer people. Homes (and therefore people) are spread apart more and further from services. A trend towards physical and social isolation may mean we are less resilient to impacts of climate change.
- Zoning that does not allow for compact development patterns will lead to increased land use ("sprawl") and could decrease natural resources including vegetated ground cover.
- Large homes on large lots tend to be more costly to build and operate than smaller homes or multi-family homes. Large homes are also more resource intensive to build and operate.
- More and larger individual structures could mean more rooftops and driveways with higher heat gain and fewer permeable surfaces than a compact development patter would.
- Homes not on municipal water and sewer rely on potentially unreliable sources. Homes on private wells may be the first to experience problems like drought.

Climate Change Impacts on Housing

Heat >>

- Increased cooling needs, impacting old and poorly insulated homes, and stressing electrical grids and old wiring
- Heat + moisture + poor ventilation = mold, poor indoor air quality

Drought >>

- Increased wildfire risks
- Drinking water wells may fail. Reduced snowpack may reduce groundwater reserves
- Compacted soil, or areas where drought has killed vegetation, cannot absorb extreme precipitation, leading to runoff and erosion

Increased precipitation and extreme storms >>

- Extreme stormwater runoff can overwhelm streams, rivers, and municipal stormwater systems, and can flood even those homes that are not in a designated Flood Zone
- Fallen trees and limbs can cause power failures (including well pump failure) and communications disruptions
- Closured roads and washed out driveways can isolate individual homes or some neighborhoods

Possible Resiliency Actions

Immediate / Short Term

- Allow for modular housing and temporary housing in times of disaster.
- Fund emergency housing assistance, including temporary shelter and emergency repair

Medium Term

- Encourage retrofits and renovations of homes so they more efficient and well insulated, with lower heating and cooling costs and demands.
- Build a diversity of housing types, accommodating the budgets and needs of those who may be most vulnerable to the impacts of climate change
- Increase vegetated ground cover and trees in order to reduce runoff and provide shade
- Reduce reliance on fossil fuels

Longer Term

- Reduce development patterns that sprawl and require more asphalt, in favor of development that restores the environment and reuses resource. Reduce heat-absorbing and impermeable development, in favor of compact development that is cooler and more permeable
- Build homes that are smartly located closer to social networks and municipal infrastructure, for resiliency and ease of emergency response

Actions for a Resilient Great Barrington in the Face of a Changing Climate

Background and Key Hazards:

By 2035, the Northeast is projected to be 3.6°F warmer than the preindustrial era, which represents the largest and soonest temperature increase in the country. Those that are most at risk to increased heat are older, sick, or socially isolated individuals, those working outdoors, and those in older homes and/or those without air conditioning. By 2050, in the Northeast we can expect at least 650 and up to 2,300 excess deaths (depending on progress on emissions mitigation) per year caused by extreme heat. Therefore, to support the health of residents it is important that we consider the community social networks, distributing services, and other community resources and actions we can take to support our most vulnerable who will be affected first and worst.[1]

Sources: 1: National Climate Assessment, Chapter 18 (Northeast), Chapter 14 (Human Health)

Projection for Days Above 90F in Great Barrington

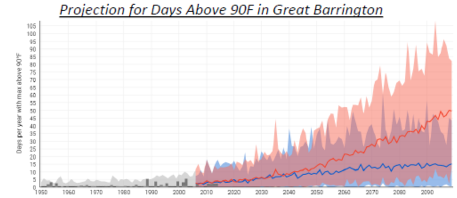


Figure 1: Days per year above 90F are projected to increase under lower (blue) and red (higher) climate emissions scenario. Source: US Climate Resilience Toolkit (https://crt-climate-explorer.nemac.org/)

Short-Term Actions (1-2 years)

Ensure those at most risk have resources & create a foundation for medium & long term action:

- Map existing community social networks/non-profit organizations and gaps in support for those most vulnerable
- Convene community resources and service providers
- Identify immediately vulnerable populations and determine what they need to have access to cooling on high heat days
- Identify community hubs/buildings that can be utilized during high heat days and during a major disruption (power outage, flooding, etc.) but also as a general community gathering space to foster a supportive and cohesive community to prepare for challenges ahead (a resilience hub).

Figure 2: An example resilience hub. Source: USDN's Resilience Hubs Resource Website (http://resilience-hub.org)

Medium (3-5 years)

Build a community network to support resilience to changing conditions and pursue synergistic adaptation and mitigation actions:

- Implement a plan for community hubs for residents to go to during climate disruption and extreme heat days, as well as generally throughout the year to build community.
- Develop Policy and planning solutions to improve access to renewable heating and cooling technologies and weatherization to reduce residents' utility costs, improve resilience to high heat and extreme cold, AND reduce building emissions. These will require investment in community organizations and volunteers to work with community members on options for their homes. For new construction, focus on what can be done at permitting stages to ensure homes are efficient, powered by renewables, and will be resilient to high heat and extreme cold.
- Support town staff and boards and commissions in prioritizing environmental initiatives that also support resilience.
- Ensure access to sustainable transportation, which can reduce emissions from single-use vehicles as well as provide transportation to those most vulnerable when they need to change locations due to dangerous heat or other conditions.

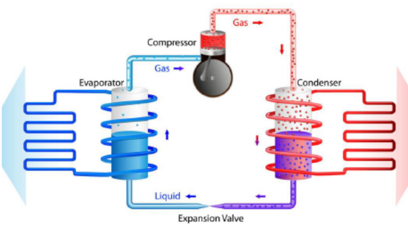


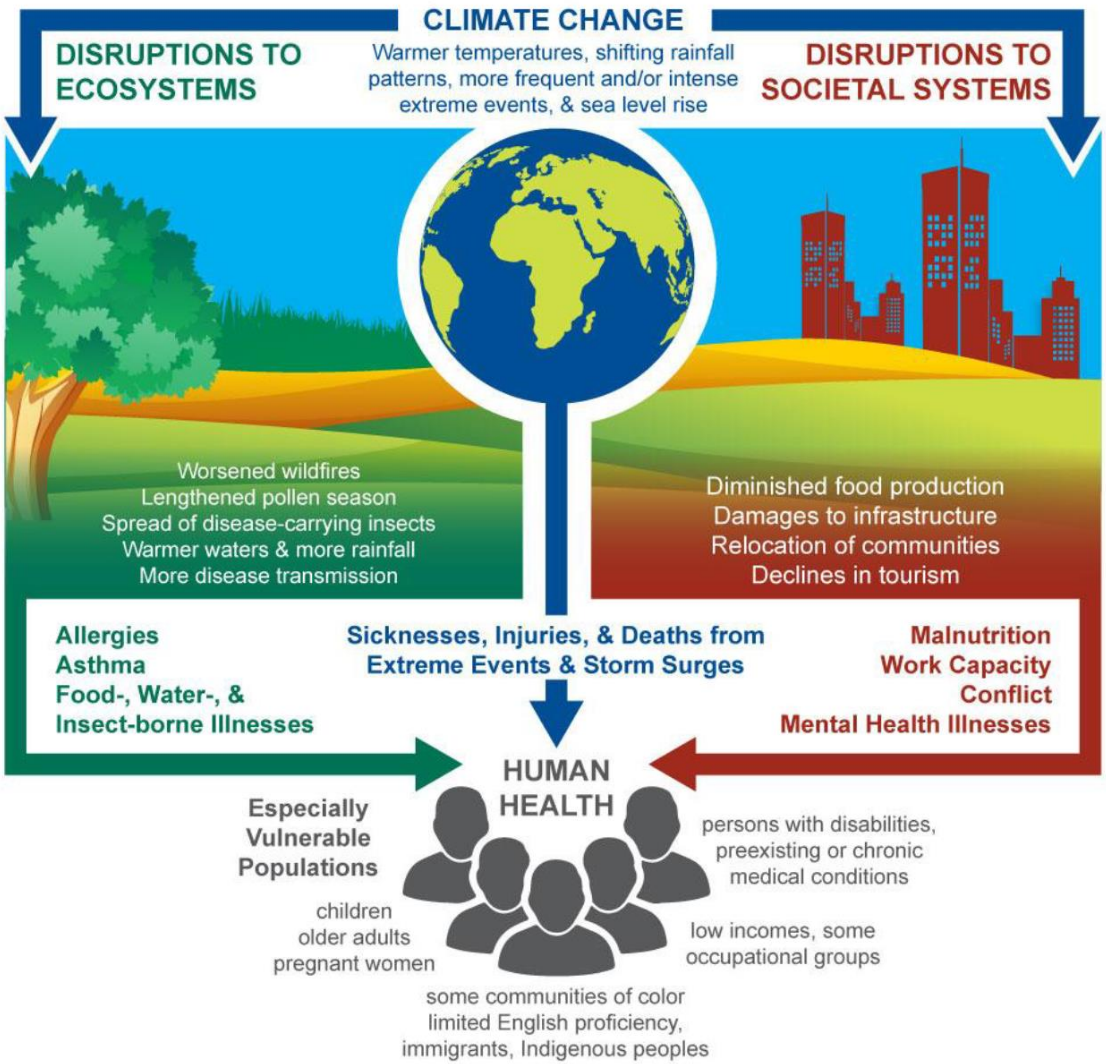
Figure 3: An air-source heat pump (mini split). (Source: bass-air.com

Long-Term (10+ years)

- Ensure we have a stable and reliable community network of volunteers and organizations ready to deploy when disruption, high heat, or severe cold strikes. By 2050 and sooner, we will see significantly warmer temperatures than ever before, regardless of mitigation progress.
- Implement policy and planning solutions to mitigate climate in a way that is resilient to the climactic changes ahead and ensures resources are in place to allow people to adapt.

Figure 4: Source (aging.com)

The Impacts of Climate Change on Human Health

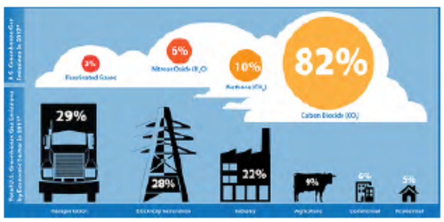


TRANSPORTATION

Background:

Massachusetts' transportation infrastructure spans every part of the state, and includes roads, bridges, tunnels, ferries, subways and commuter and long-distance rail networks. Shifting weather patterns caused by climate change may damage or disrupt this infrastructure and impair our mobility, with far reaching effects on our communities and the state's economy. Nationally, the transportation sector accounts for 29% of all greenhouse gas (GHG) emissions – recently overtaking electricity production as the number one source of GHG emissions. In Massachusetts, transportation accounts for 43% of all emissions and in Berkshire County, 39% of GHG emissions are attributable to transportation habits – the largest source of emissions. Moreover, 93% of Berkshire County's transportation emissions come from gasoline powered vehicles (7% from diesel) – primarily from personal vehicle use.

The Massachusetts legislature signed into law the Global Warming Solutions Act (GWSA) in 2008. The GWSA calls for reducing GHG emissions by 25% by 2020 and 80% by 2050 (using 1990 emission levels as the baseline). MassDOT acknowledges the importance of reducing transportation-based emissions and has set reduction targets. Metropolitan Planning Organizations (MPO), such as the Berkshire MPO, are required to evaluate and track GHG emissions resulting from projects.



General Actions:

- Planning:
  - Incorporate climate change vulnerability assessments and adaptation strategies into transportation plans.
  - Update floodplain mapping using LiDAR and climate models and utilize maps to assess future flood hazard zones for infrastructure.
  - Incorporate climate change projections into siting and design of all new transportation infrastructure and significant retrofits and repairs.
  - Plan for expansion of complete streets that accommodate biking, walking and public transit.
  - Inventory bridges and culverts that should be upsized to accommodate future expected stream flows.
- Management Practices :
  - Formulate risk-based methods to evaluate the service life of infrastructure assets in a changing climate and increase the frequency of routine inspections.
  - Build pipes, culverts, and outfalls with consideration of the potential magnitudes of future storms.
- Nature-Based Solutions (NBS) & Technology:
  - Expand use of green infrastructure such as rain gardens, swales, and porous pavement for stormwater control.
  - Stock up on replacement parts for vehicles and equipment needed for emergency weather.
- Policies / Laws:
  - Coordinate across municipal, state, regional agencies to address the vulnerability of regional infrastructure like rail networks.
  - Consider adopting design standards that account for climate change and provide trainings.
- Research / Monitoring:
  - Research and conduct pilots using resilient materials (e.g. materials that can withstand high heat) for building roads and other infrastructure.
  - Update hydrologic and hydraulic analyses, including engineering methods used in the calculation of peak flood flow rates.
- Funding Options:
  - MVP Grant Program
  - MA Small Bridge Program
  - MA Culvert Replacement Municipal Assistance Grant Program
  - MassWorks Grant Program

Climate Change Impacts & Key Hazards:

- Rising Temperatures/Temperature Fluctuations:
  - Extreme heat may cause heat stress in materials like asphalt and increase the frequency of repairs.
  - As temperature extremes fluctuate from cold to hot, these rapid freeze/thaw cycles can damage road surfaces and including heaving of roads which poses safety and maintenance issues for drivers.
- Changes in Precipitation:
  - Flooding caused by heavier downpours may damage infrastructure like undersized culverts.
  - More nuisance ponding on roads may slow commutes and commerce.
- Extreme Weather:
  - Costly damage to roads, bridges, and rail networks may occur as a result of extreme nor'easters, hurricanes, severe thunderstorms and blizzards.
  - Extensive flood damage to roads and bridges could dramatically affect commerce and public health and safety especially where alternative routes aren't available/
  - High winds could down power lines and poles adjacent to roads and homes.
  - Communities and critical facilities could be cut off after storms.

Key Hazards & Planning Horizons:

Short-term (1 - 3-year horizon):

- Precipitation:
  - Inventory road-stream crossings (culverts) in Great Barrington and identify most critical structures.
  - Begin developing prioritization methodology for addressing culverts and other roadway infrastructure assets.
  - Explore nature-based solutions (NBS) and green infrastructure approaches such as raingardens or bioswales to mitigate stormwater impacts to infrastructure and freshwater streams and rivers.
- Rising Temperatures/Temperature Fluctuations:
  - Identify roads that are susceptible to heaving/cracking due to freeze/thaw cycle.

Medium-Term (3 - 5-year horizon):

- Precipitation:
  - Finalize inventory and surveying of all road-stream crossings in Great Barrington.
  - Refine prioritization method based on priorities and begin to identify and apply for funding programs to repair/replace critical structures.
  - Identify appropriate locations for nature-based solutions and green infrastructure applications, begin exploring funding options, and apply for grant programs and/or apportion municipal budgets to fund projects.
- Rising Temperatures:
  - Develop management plan to address heaving/cracking/degradation of roadway pavement.
- Extreme Weather:
  - Identify actions to mitigate the impacts of wind damage to roads and roadway infrastructure.

Long-Term (10 + year horizon):

- Precipitation:
  - Continue funding replacements of crossing structures while updating priorities to inform decision-making.
  - Expand use of green infrastructure such as rain gardens, swales, and porous pavement for stormwater control.

Precipitation Data

Annual Total Precipitation in Inches

Massachusetts
Maximum: 55.71
Median: 47.56
Minimum: 39.96

Housatonic Basin
Maximum: 55.61
Median: 48.05
Minimum: 38.06

Annual Consecutive Dry Days

Massachusetts
Maximum: 17.57
Median: 14.64
Minimum: 11.80

Housatonic Basin
Maximum: 15.62
Median: 13.70
Minimum: 10.16

Days With Precipitation >1"

Massachusetts
Maximum: 9.30
Median: 6.68
Minimum: 4.38

Housatonic Basin
Maximum: 7.00
Median: 4.74
Minimum: 3.15

Days With Precipitation >2"

Massachusetts
Maximum: 1.26
Median: 0.76
Minimum: 0.23

Housatonic Basin
Maximum: 1.27
Median: 0.48
Minimum: 0.08

Days With Precipitation >4"

Massachusetts
Maximum: 0.26
Median: 0.04
Minimum: 0

Housatonic Basin
Maximum: 0.35
Median: 0
Minimum: 0

Heat Data

Annual Average Maximum Temperature (°F)

Massachusetts
Maximum: 61.95
Median: 60.37
Minimum: 58.50

Housatonic Basin
Maximum: 59.86
Median: 57.90
Minimum: 55.77

Annual Average Temperature (°F)

Massachusetts
Maximum: 51.40
Median: 50.17
Minimum: 48.19

Housatonic Basin
Maximum: 48.59
Median: 47.24
Minimum: 45.1

Annual Days With a Maximum Temp. >90°F

Massachusetts
Maximum: 16.31
Median: 10.41
Minimum: 3.62

Housatonic Basin
Maximum: 9.98
Median: 4.22
Minimum: 1.36

Annual Days With a Maximum Temp. >95°F

Massachusetts
Maximum: 4.49
Median: 1.73
Minimum: 0.49

Housatonic Basin
Maximum: 2.60
Median: 0.25
Minimum: 0.01

Annual Days With a Maximum Temp. >100°F

Massachusetts
Maximum: 1.22
Median: 0.07
Minimum: 0

Housatonic Basin
Maximum: 0.49
Median: 0
Minimum: 0

Cold Data

Annual Days With a Minimum Temp. <0°F

Massachusetts
Maximum: 7.55
Median: 2.54
Minimum: 0.58

Housatonic Basin
Maximum: 13.87
Median: 5.61
Minimum: 1.09

Annual Days With a Minimum Temp. <32°F

Massachusetts
Maximum: 148.2
Median: 130.42
Minimum: 114.52

Housatonic Basin
Maximum: 169.52
Median: 155.66
Minimum: 136.75

Annual Average Minimum Temperature (°F)

Massachusetts
Maximum: 41.45
Median: 39.89
Minimum: 37.87

Housatonic Basin
Maximum: 38.01
Median: 36.48
Minimum: 34.43

SIRI, WHAT WILL THE WEATHER BE LIKE.... IN THE NEAR FUTURE? (2021-2025)

Precipitation Data

Annual Total Precipitation in Inches

Massachusetts
Maximum: 54.23
Median: 46.64
Minimum: 40.96

Housatonic Basin
Maximum: 54.98
Median: 45.45
Minimum: 40.73

Annual Consecutive Dry Days

Massachusetts
Maximum: 21.78
Median: 15.55
Minimum: 12.52

Housatonic Basin
Maximum: 20.42
Median: 13.86
Minimum: 11.48

Days With Precipitation >1"

Massachusetts
Maximum: 9.38
Median: 6.86
Minimum: 4.89

Housatonic Basin
Maximum: 7.50
Median: 5.11
Minimum: 3.17

Days With Precipitation >2"

Massachusetts
Maximum: 1.33
Median: 0.66
Minimum: 0.34

Housatonic Basin
Maximum: 1.19
Median: 0.47
Minimum: 0.05

Days With Precipitation >4"

Massachusetts
Maximum: 0.15
Median: 0.03
Minimum: 0

Housatonic Basin
Maximum: 0.18
Median: 0
Minimum: 0

Heat Data

Annual Average Maximum Temperature (°F)

Massachusetts
Maximum: 62.56
Median: 61.53
Minimum: 59.38

Housatonic Basin
Maximum: 60.21
Median: 59.02
Minimum: 56.51

Annual Average Temperature (°F)

Massachusetts
Maximum: 52.18
Median: 51.09
Minimum: 48.99

Housatonic Basin
Maximum: 49.20
Median: 48.12
Minimum: 45.88

Annual Days With a Maximum Temp. >90°F

Massachusetts
Maximum: 26.05
Median: 14.21
Minimum: 8.88

Housatonic Basin
Maximum: 17.15
Median: 6.90
Minimum: 3.48

Annual Days With a Maximum Temp. >95°F

Massachusetts
Maximum: 8.44
Median: 2.81
Minimum: 1.43

Housatonic Basin
Maximum: 4.46
Median: 0.95
Minimum: 0.17

Annual Days With a Maximum Temp. >100°F

Massachusetts
Maximum: 1.92
Median: 0.26
Minimum: 0.05

Housatonic Basin
Maximum: 0.85
Median: 0
Minimum: 0

Cold Data

Annual Days With a Minimum Temp. <0°F

Massachusetts
Maximum: 4.46
Median: 2.08
Minimum: 0.64

Housatonic Basin
Maximum: 9.44
Median: 4.36
Minimum: 1.99

Annual Days With a Minimum Temp. <32°F

Massachusetts
Maximum: 138.98
Median: 125.41
Minimum: 110.66

Housatonic Basin
Maximum: 166.45
Median: 149.32
Minimum: 131.01

Annual Average Minimum Temperature (°F)

Massachusetts
Maximum: 41.98
Median: 40.66
Minimum: 38.61

Housatonic Basin
Maximum: 38.54
Median: 37.23
Minimum: 35.25

SIRI, WHAT WILL THE WEATHER BE LIKE.... IN THE FUTURE? (2031-2035)

Precipitation Data

Annual Total Precipitation in Inches

Massachusetts
Maximum: 54.23
Median: 46.64
Minimum: 40.96

Housatonic Basin
Maximum: 54.98
Median: 45.45
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Days With Precipitation >1"

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Minimum: 0.05

Days With Precipitation >4"

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Maximum: 0.15
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Minimum: 0

Housatonic Basin
Maximum: 0.18
Median: 0
Minimum: 0

Heat Data

Annual Average Maximum Temperature (°F)

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Minimum: 35.25

SIRI, WHAT WILL THE WEATHER BE LIKE.... IN THE FUTURE? (2031-2035)

Town of Great Barrington, MA

Every Drop Counts

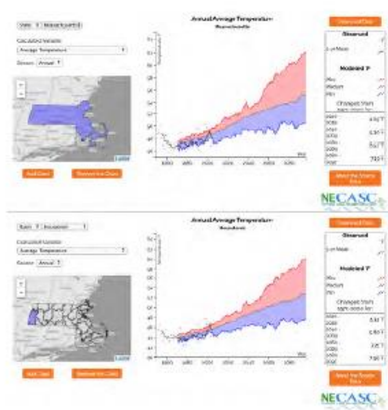
Water and the Future

CRUCIAL FOR...

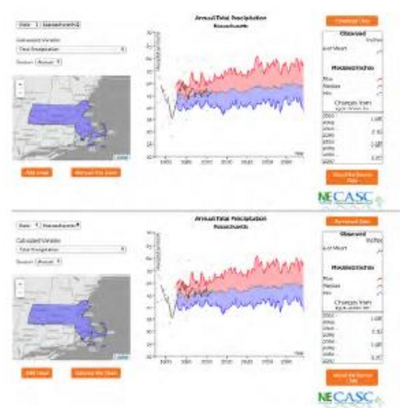
OUR CONSUMPTION

AGRICULTURE

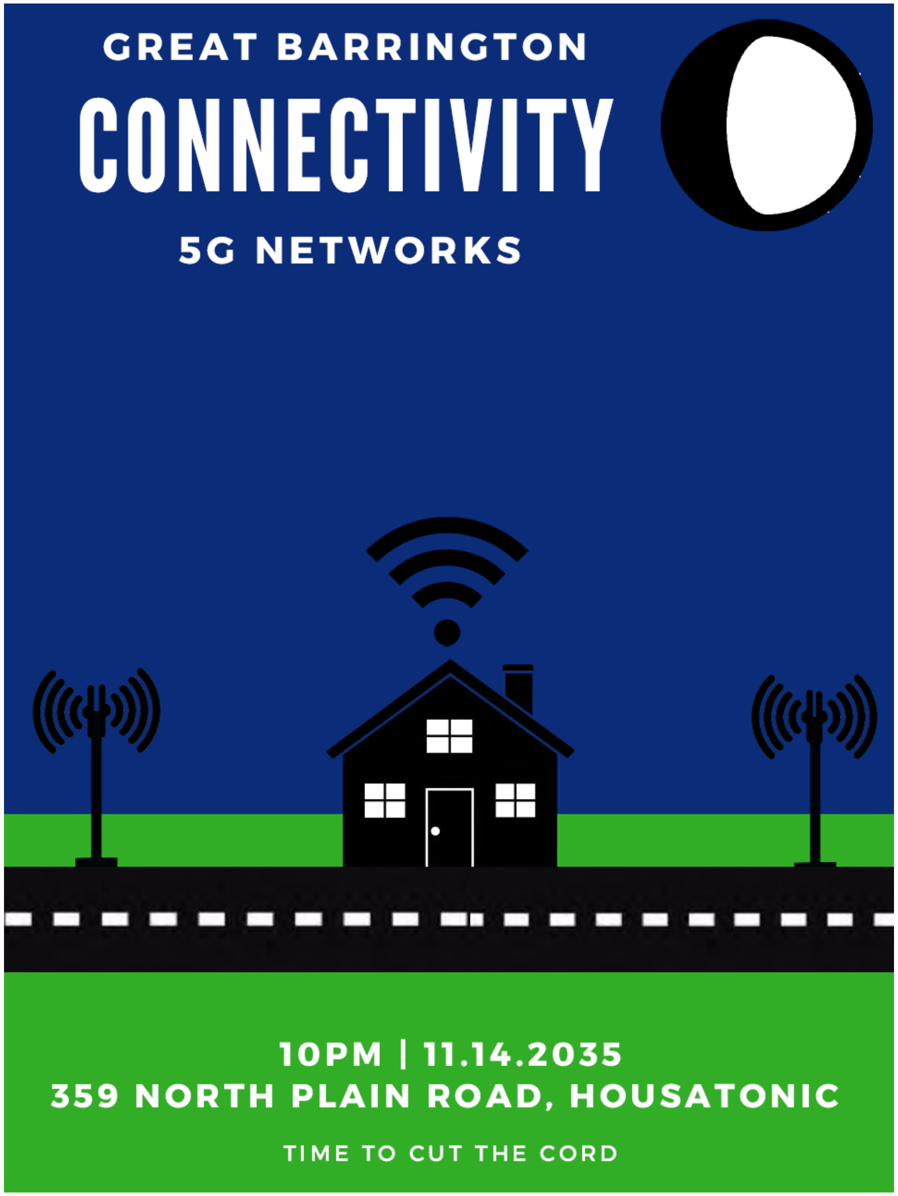
ECOLOGICAL HEALTH



AVERAGE TEMPERATURES EXPECTED TO INCREASE SIGNIFICANTLY



PRECIPITATION EXPECTED TO INCREASE SLIGHTLY


GREAT BARRINGTON
CONNECTIVITY
5G NETWORKS
10PM | 11.14.2035
359 NORTH PLAIN ROAD, HOUSATONIC
TIME TO CUT THE CORD


GREAT BARRINGTON
CONECTIVITY
6G NETWORKS
MASS
U S
7
11AM | 11.14.2050
ROUTE 7, GREAT BARRINGTON
A WORLD CONNECTED

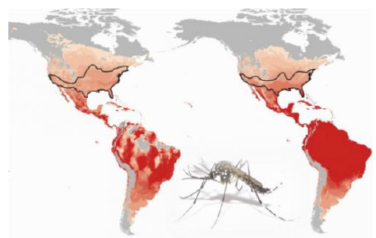
Climate Change and the Local Environment

Impacts

- Event Disturbances
  - Loss of trees and vegetation
  - Pollution of aquatic habitat
  - Loss of plants and animals, particularly birds
  - Introduction of invasive species downstream

Emerald Ash Borer

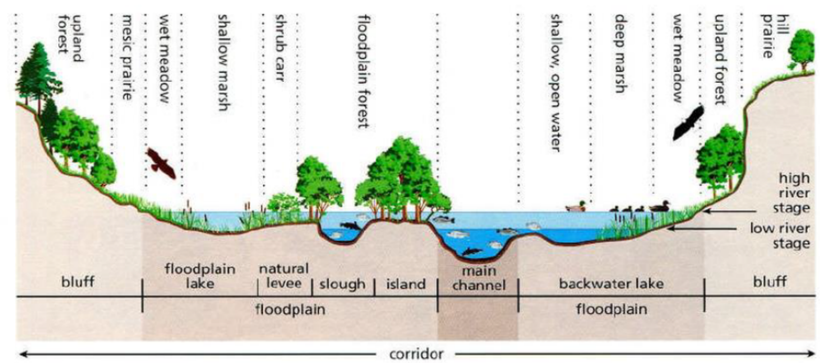
- Habitat Changes
  - Loss of snowpack to protect trees roots and other plants and animals
  - Decrease in food for birds because the timing is off
  - Expanding or contracting ranges depending on climate requirements – majority profoundly shrinking
  - Decrease in fish populations (seafood)
- Immediate & Long-term effects
  - Increase in cost of food
  - Loss of important native species
  - Changes in environmental composition
  - New pests and disease
  - Mass extinctions
  - Ecosystem failure



The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Report notes that since 1980 greenhouse gas emissions have doubled, raising average global temperatures – with climate change already impacting nature from the level of ecosystems to that of genetics – impacts expected to increase over the coming decades, in some cases surpassing the impact of land and sea use change and other drivers.

Solutions

- ✓ Forest and tree management
  - ✓ Incentivize healthy forest over development and remove invasive species
- ✓ Natural resource inventories
  - ✓ Know your species and habitats to enable post-disaster restoration
- ✓ Nature-based methods of resilience
  - ✓ Avoid using grey infrastructure such as riprap and cement and opt for methods that mitigate while adapting to increased extreme weather
- ✓ Restoration, Preservation & Conservation that protects habitat & people
  - ✓ River corridor development control
  - ✓ Prevent toxic material storage in floodplains
- ✓ Address invasive and problematic species
- ✓ Landscape with native species
- ✓ Education and public engagement
- ✓ Buy/consume ethically and less (build to last)



Invasive Species Impacts

Garlic mustard is one species that grows earlier in the spring than other native species. This is a problem because they dominant resources and are believed to release toxins into the soil that will kill the soil fungi other plants and hardwood tree saplings depend on. This doesn't only impact other plants, the West Virginia White Butterfly has been found to lay eggs on garlic mustard instead of native plants that have been outcompeted by the aggressive garlic mustard, greatly decreasing caterpillar survival rates because the plant is toxic. (Humans can eat garlic mustard however, so go collect some next spring after confirming it is the right plant!)

This butterfly also depends on moist woodlands for habitat, increasingly rare with higher temperatures.

Changing Seasons

- Early indicator: **Maple Syrup**
- According to the Maple Research Center at the University of Vermont, maple sugaring season on average starts earlier and ends earlier than it did 50 years ago, with an overall shorter season.
- Maple syrup is produced in a very short season in late winter during the alternating freezing and thawing cycles that control the flow of maple sap.
- Fewer freezing and thawing cycles mean the maple trees produce less sap.
- In addition, maple trees rely on snowpack during this time to protect their roots from freezing. Less snow can potentially affect the health of sugar maple trees.

Public Listening Session Posters

Community Resilience Building for Hazard Mitigation & Municipal Vulnerability Preparedness

- **What is Hazard Mitigation?**

IDENTIFY VULNERABILITIES TO HAZARDS	EXAMINE THE POTENTIAL IMPACTS ON PEOPLE, ENVIRONMENT, AND BUILT INFRASTRUCTURE	DEVELOP & PRIORITZE STRATEGIES TO PREVENT OR MINIMIZE THOSE IMPACTS

- **What is Municipal Vulnerability Preparedness?**
  - A state and local partnership utilizing the Community Resilience Building (CRB) process to respond to climate effects at the local level and pilot innovative adaptation initiatives.

- **Cast Your Vote on Priority Adaptation Actions**
  - Each poster represents a theme area. Each theme area contains various categories that represent a culmination of individual actions generated through the planning process.
  - Place a small sticky note in the box next to your priority action categories.
  - These votes will be tallied and will better inform the Town's future initiatives to enhance climate resilience.
  - Larger sticky notes are available for you to add your adaptation and resilience actions.
  - For a deeper dive, participate in our survey to vote on individual priority actions developed through the CRB process to date.

https://www.surveymonkey.com/r/MVP_Planning

Vote!

Resiliency Hub

- Regional Linkages
  - Transportation and Resource Distribution
  - Social Cohesion

- Livability & Accessibility
  - Transportation Alternatives
  - Housing and Utility Affordability

- Centralized Emergency Infrastructure
  - Shelters
  - Sharing of Resources with neighboring municipalities through Mutual Aid
  - Resources for Medical Facility
  - Emergency Communication Hubs

Vote! Economic Viability

- Culturally Creative Economy
  - Hold job-fairs, networking and volunteerism events

- Business Sustainability
  - Workforce development and training
  - Diverse businesses and workforce
  - Continuity of operations for disaster resilience

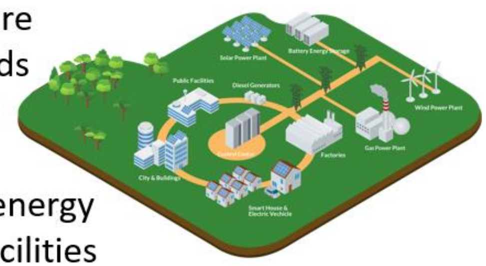
- Education and Youth Engagement in Addressing the Climate Crisis
  - Internet reliability
  - Farm-to-school programs
  - Climate change curriculum

Vote! Energy

- Back-Up Power
  - Generators and alternative sources of energy

- Assess Energy and Communication System Vulnerability to Extreme Weather Events

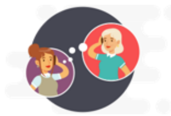
- Building Codes and Bylaws
  - Plan for future building needs



- Microgrids
  - Alternative energy for critical facilities
- Renewables
  - Energy independence

Marginalized Populations

- Looking Out for Elders and those Experiencing Hardship
  - Ensure there is a system of checking on isolated seniors during a disaster.
  - Build social resilience through strengthening community ties.



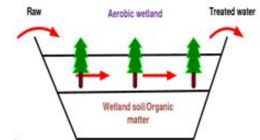
- Multilingual Emergency Preparedness Materials & Notifications

- Acknowledge and Address Barriers to Minority Populations
  - Facilitate meetings in spaces that encourage broad-based participation, particularly among historically disenfranchised.

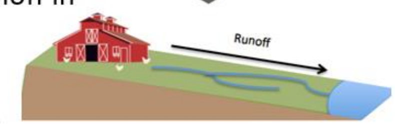
- Climate Refugee Planning
  - Study and prepare for population changes due to climate change.

Water Infrastructure

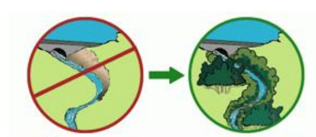
- Water Systems & Protection
  - Replace Aging Infrastructure



- Sewage, Wastewater, Stormwater Management
  - Improve flood resiliency of wastewater treatment plant
  - Decentralized wastewater treatment systems
  - Reduce nutrient runoff in stormwater



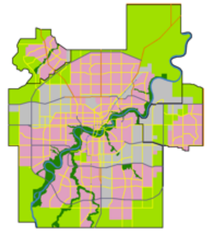
- Bridges and Culverts
  - Culvert inventory and replacement prioritization
  - Maintain and fix bridges



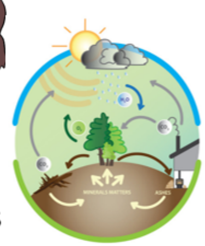
Vote!

Ecosystem Health

- Wildlife Corridors and Open Space
  - Align open space uses and wildlife corridors with the floodplain.
  - Utilize native species for private landscaping.



- Environmental Resource Inventory
  - Quantify ecosystem services of existing natural areas and assets (i.e. trees) to better inform cost-benefit analysis and maintain natural features.



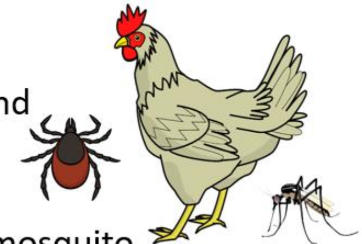
i-Tree

- Invasive Species
  - Native species seed banks for reestablishing after disturbances
  - Invasive management education

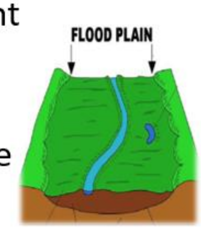
Vote!

Ecosystem Health

- Vector-Borne Disease
  - Education on tick and mosquito disease prevention
  - Non-toxic tick and mosquito mitigation



- Erosion Control and Development in the Floodplain
  - Riparian bank stabilization, including through use of native plantings along Housatonic, Lake Mansfield and Green River



- Food Systems Sustainability
  - Best management practices for soil health
  - Provide pathways for new, local farmers

APPENDIX B: COMPLETED OR WITHDRAWN MITIGATION ACTIONS

Table B.1: Completed Mitigation Actions since 2012

Category of Action	Description of Action	Benefit	Notes
Structural Project	Conduct engineering study on Round Hill Road to determine solution to flooding and implement findings.	Improving the drainage will reduce the risk of flooding and reduce the cost of maintaining the road.	Culvert replaced to address flooding.
Local plans and regulations/ Structural Project	Conduct engineering study of Lake Mansfield Dam and Road to determine solution to potential dam failure / road closure and implement findings.	Ensuring the condition of the dam will reduce the risk of failure and subsequent flooding.	Engineering and design of road embankment complete.

APPENDIX C: COMPLETED COMMUNITY RESILIENCE BUILDING WORKSHOP MATRICES

Yellow Table:

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

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

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

Features	Location	Ownership	V or S	HIGH WIND or TORNADO	HEAVY PRECIP FLOODING	EXTREME TEMPS	DROUGHT	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
ROADS, CULVERTS, BRIDGES Washouts, clogging, undersized	Seekonk Cross Rd. & Rte 7 @ Sheffield border	Town/State	V	Erosion Controls - using vegetated swales, & traditional	CULVERT LIST - Update Capital budget	Regular Maintenance & Cleanouts		M	O
Utilities - including Water Sewer Systems, Power & phone lines	All over	Public/Pvt	V	Backup Power, Redundancy; Energy Independence		Use alternative energy sources	capacities - Connect Public & Pvt. Company systems	H	L
In Town Medical - Fairview, East Mtn. CHP, Veterinary, VIM	Various	Pvt	S/V	Coordinate Preparedness	Limited Capacities - will each survive financially			L	L
Schools - Full Regional Shelter	Simons Rock, HS, BCC South	Pvt	S/V		Publicize shelter locations and capabilities			L	O
Homes -- Group quarters including apts., nursing, lodging	Various	Pvt	V	Tornado Alley locations	Shelter in place prepared	Engage with owners; ID vulnerable residents		L	O
Kolodza Airport	70 Egremont Plains Rd.	Pvt	S	Include in Emergency Ops Plan				L	O
Societal									
Faith Communities	Various	NGO	S	Formal Outreach around Preparedness for members & Supports during emergencies				H	S
Community Orgs	Various	NGO/Business	S	Food pantries or meal sites				H	S
Claire Teague Sr. Center & Sr. Housing Adjacent	Rte 7 - S.Main	Town	S/V	In Floodplain & Tornado Alley		Warming/Cooling shelter		H	S
Immigrants, Migrants, Non-English speakers	Various	Town	V	Targeted bi-lingual outreach via VIM, CHP, Multi-Cultural Bridge; ADA Translation Svces at Town Hall?				H	S
Vulnerable: Chronically ill, Recovering Addicts, Disabled,et	Various	Town/NGO's	V	Targeted bi-lingual outreach via VIM, CHP, Multi-Cultural Bridge; ADA Translation Svces at Town Hall?				H	S
Homeless or those in temporary quarters	Various	Town/NGO's	V	Who to call for help, where to go for help				H	S
Environmental									
Invasive Species - insects and plants	Various	Town/Pvt	V	ID & PROTECTION - ACTION PLAN; Public Education for Homeowners and new constr. on green topics				H	O
Farming and Food production impacts	Various	Pvt	V	Support small farms and build farm markets; Land for food not feed; Avoid monocultures; Bulk Food Storage				H	L
Deteriorated surface water quality/watershed and aquifer protection	Various	Town/Pvt	V	Protect drinking water sources (zoning overlay?); Connect 2 water systems				H	O
Forest - limbs down	Various	Town/Pvt	V	Update Forest Mgmt Plan; State Forest - DCR engagement on mgt/logging; Public Info campaign;				H	O
Wildlife threats -- bees, butterflies; animal habitats	Various	Town/Pvt	V	Encourage native habitat - plantings 4 pollinators, H.O. Education; Wildlife Corridor ID/Map; curb pesticide and herbicide					
Housatonic & Lake Mansfield	All over	Town	V	Bank Stabilization, invasive control, increase buffers w native plantings,	Rehab lake shore re: stormwater runoff	Implement watershed base plan & Lake Mansfield Improvement Plan	Increase size of buffers on all waterbodies	H	S

Red table:

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

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

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

Features	Location	Ownership	V or S	Flooding	Heat	Wind	Ice Storms/Freeze Thaw	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Fire Station	Downtown	Town	S	Education and tours of facility to gain tust, material in multi-language				M	S
Senior Center	Downtown	Town	S/V	Investigate flood prone concerns, get a generator and commercial kitchen				M H/L	O S
Bridges - connections between two sides of town	Division Street, Cottage Street, State Road, Bridge Street,	Town/State	V	Proactively maintain bridges Fix bridges that need repair				H H	O O
Route 23 power outages	Route 23	National Grid	V	Work with National Grid to reduce power outages on Route 23 Bury power lines for new construction				M L	L L
Power station in floodplain	Division Street	National Grid	V	Check power station vulnerability				H	S
Power	Town wide	Town	V	Develop energy efficient bylaws and codes for cooling				H	O/S
Societal									
Shelters	Town wide	Town	S	Consider Berkshire South and BCC South as shelters Have enough food for 4 days				H M	S L
Communications - Radio, Reverse 911	Town wide	Town	S	Educate the public on Code Red				H	O
Hospital / Airport coordination	Town wide	Fairview	S	Make sure the hospital is prepared for Higher Heat / Climate Change Continue airport coordination with hospital				H L	O O
Senior housing - Brookside	Brookside /Rout	Private	V	Ensure the buildings are not in the floodplain and improve their resilience				M	O
Butternut - seasonal jobs	Route 23	Private	V	Build a diverse economy - Destination Management Plan				H	S
Philanthropy / Grants / State Funding	Town wide	Foundations / T	S	Educate and utilize donors for improvements				H	O
Environmental									
Floodplains	Floodplains	Private	V	Work with land owners to be resilient Address zoning to reduce development				H M	L S
Monument Mountain	Route 7	TTOR	V	Limit usage improve hiker education on alternative locations				L M	L S
Ag fields - bare soil	Green River	Private Farmers	V	Keep soil covered and utilize less tilling				H	O
Ag Fields - manure	Green River	Private Farmers	V	Stop spread of manure in the winter				H	O
Invasives - Ash, Knotweed, diseases	Town wide	All	V	1) Targeted removal of invasives 2) education on invasives 3) Allow backyard chickes				M M M/L	L S S
Ckunate change	Town wide	All	V	Prepare for the worst					
SBREPC	Town wide	Town	S	Educate public on emergency response				H	S/O

Green Table:

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org

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

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

Flooding; High Winds; Snow/Ice Storms; Fire; Extreme Temperatures

Features	Location	Ownership	V or S	Floding	Extreme Heat	Invasive Species	Storms (Mircobursts)	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Sewage Plant is located in Town Floodplain	Bentley Road	Town Owned	V	The Town's sewage plant is located in the floodplain. The Town should consider undertaking earthwork and other measures to strengthen flood resilient capacities.			The facility should undergo a climate change audit to better understand hazards and potential solutions to strengthen the resilience of the sewage plant (which will not feasibly be relocatted by the Town).	M	L
Bridges/Culverts	Townwide	State and Town Owned	V	The Town should get a better handle on its existing bridge and, specifically, culvert inventory. Review existing management plan and prioritize repairs/replacements based on community values.				H	O
Water Supply		Public & Private	V/S	The Town should engage in better stormwater management techniques, such as providing education to residents on how best to mitigate nutrient use and other chemical use that contributes to non-point source pollution. The Town should explore regulations to prevent nutrient runoff/use.	The Town should consider finding an additional, suitable water source for drinking that is publicly owned. The Town should consider encouraging private water companies to merge and collaborate rather than compete - which undermine residents' interests. The Town should conduct a feasibility study to ensure equitable access among residents to bottless water refill stations. The Town should look at dveloping drought regulations to ensure efficient use of water resources during times of drought.			H	O
Electricity / Utilities		Public & Private	V	The Town should consider installing a micro-grid system to ensure that power can continue to flow to critical facilities during emergency situations.			The Town should considered engaging in a cost-benefit analysis to determine financial viability/payback of buring power lines underground.	M	L
Communications Infrastructure		Public & Private	V	The Town should explore alternative ways to disseminate important information to residents. The Town should provide venues for more face to face networking - either themed gatherings or 'meet your neighbor' gatherings, to increase social cohesion and develop stronger community ties.				M	O
Housing Stock		Public & Private	V	Identify housing stock and track demographic trends to adequately plan and construct housing stock that will be utilized. Encourage Town to develop more affordable housing stock.				H	O
Impacts of Climate Change on Energy Performance/Efficiency		Public & Private	V	Continue to seek out new technologies, renewabel energy sources. The Town should continue to adopt progressive codes and standards. The Town should continue to stay up-to-date with technological upgrades that improve energy use/efficiency.				L	L
Recyling / Composting			V	The Town should explor developing a robust recycling and composting program to sustainably dispose of materials.				H	O
Transportation	Lake Mansfield Road & General Townwide	Public & Private	V	The Town should consider funding to remove Lake Mansfield Road - as the road is plagued with erosion and flooding issues.	The Town should consider allocating more funding to construct additional pedestrian connections to make the Town more walkable/bikeable.		The Town should develop and ensure that are alternative emergency routes for EMS services to get into and out of neighborhoods that might need assistance during emergency situations.	H	L
Societal									
Potential for Climate Refugees			V/S	The Town should consider developing a Climate Refugee Plan that includes the establishment of a climate refugee program that would adequately prepare the town for an influx of potential climate refugees if that were to happen in the future. The Town should develop a 'Trust Policy' to incorporate the potential for climate refugees coming to the Town in the future. The Town should update their emergency preparedness plan to incorporate/identify shelters and capacity.				L	O
Demographics (Aging, populaiton loss)			V/S	The Town should consider developing a plan that seeks to ensure the Town's vulnerable populations are adequately protected from the key hazards outlined above. The Town should explore ways to capitalize on its elderly population which has resources such as financial capital and time to volunteer to assist with the needs of vulnerable populations.				H	O
Competition for Resources			V/S	The Town shoud consider engaging in more programs similar to the group purchasing program to share resources and reduce costs among municipal neighbors. The Town should encourage surrounding municipalities commit to sharing critical resources such as road salt or other products necessary to reduce vulnerabilities to various hazards.				M	O
Workforce Development			V	The Town should look for ways to transition away from an economy heavily dependent on tourism for economic generation. How can the Town create a more resilient workforce? The Town should encourage the establishment of more trade programs to diversify workforce. The Town should update municipal job descriptions to ensure implementation of best-management-practices that inform environmental stewarship. The Town should look for ways to encourage municipal staff to participate more in workforce development skills training and passing along their knowledge/expertise.				H	O
Fractured Communities	Cottage Street Bridge (good area to pilot program)		V	The Town needs to create stronger neighbor to neighbor programs - this could include a face-to-face check in among neighbors who are vulnerable (i.e. neighbor to neighbor program where vulnerable people sign-up to be checked-on during emergency situations and possibly on a day-to-day basis. The Town should establish emergency hotlines for vulnerable populations to utilize in emergency situations. Again, the Town should look for ways to diversify its communications and ensure a variety of mediums are used to disseminate important information.				L	L
CHP		Private	S	Continue subsidizing CHP's intitiatives so it can contiune to offer the services it currently provides. The Town shold explore ways to leverage CHP's existing outreach to include information about hazards / emergency situations. CHP, in coordination with the Town, should engage in a publicity campaign so that residents know about resources and work to attract more people to move to the Berkshires and GB.				M	L
VIM		Private	S	The organization should be encouraged by the Town to locate an alternative location for VIM (Volunteers in Medicine). VIM has an excellent link to the Spanish-sepaking community and VIM network should be leveraged to solicit feedback and wider participation among groups that have historically been disenfranchised. VIM's model should be explored and replicated among other organizations hoping to provide assistance to vulnerable populations.				M	L/O
Ideological Cohesion			S	The Town should continue to encourage greater community cohesion and understanding among diverse groups. The Town should encourage underscoring the non-partisan nature of environmentalism - this is something that all of us should care about regardless of our political interests or affiliations.				L	O
Non-Profit Networking (People helping people)			V/S	The Town should facilitate additional networking events - can be themed or just a venue to mingle to increase networking and propsective opportunities within the community/region for those looking for employment or ways to get more invovled in the community. The Town should encourage greater coordination and collaboration among non-profit organizations that provide similar services to maximize reach and effectiveness.				L	O
Second Homeowners			S	The Town should encourage second home owners to continue to buy property in GB as this helps local property tax revenues. The Town should explore ways to capitalize on the knowledge/skill set/intellectual capital that is typically associated with second homeowners (those who are well-off and presumbly have occupational skills that, if directed toward GB, could help solve some of the Town's problems.				L	O
Culture (creative arts & performances)			S	The Town should continue to promote GB/the Berkshires as a hub of cultural creativity and arts/performing arts. The Town should find ways to incentivize artists and creative performers to move to GB. Faciliating programs that incentive new a creative minds to move to the Town may help the Town devise creative new solutions to combat hazards created/exacerbated by climate change.				L	O
Increase Cost of Living			V	The Town should consider establishing programs such as a 'Wood Bank' - which is an area where wood is donated so families in need can come and take donated wood for heating purposes. The Town should make more of these programs available and accessable. The Town should consider inreasing its housing stock - particularly affordable housing - increase residential developments. Town should create more programs that provide financial alleviation to those recovering from emergency/disaster.				M	L
Environmental									
Ecological Diversity			V/S	The Town should conduct an ecological inventory - to see what ecological assets the Town has, to formulate differnet strategies to preserve/protect it, and to quantify the value of ecosystem services afforded by the Town's natural areas. The Town should develop an invasive species management plan. The Town should identify and allocate species vectors with high ecological diversity / critical species. Town should develop a forest management plan to capitalize on carbon sequestration of natural areas - encourage participation in carbon market - cap and trade/invet programs.				H	O
Open Space / Conservation Land			V/S	The Town should update its development plan and consider designation/protection of wildlife corridors. The Town's Open Space Plan should be updated to reflect updated floodplain management techniques. Explore ways for existing tourist industries, such as ski resorts, which rely on particular conditions that might be altered with climate change, town should consider how these businesses can adapt to new conditions and capitalize on changes.				M	O
Farming / Agriculture			V	The Town should consider developing reliable food distribution networks and food storage. Town should increase use of seed banks / seed storage to prepare for changes. The Town should establish more 'buy local' initiatives and provide more educational resources for increasing sustainable farming practices. Town should create more youth farming programs to encourage younger generation to continue farming locally (providing technology and assiting with labor needs).				M	O
Pest / Ticks / Mosquitoes			V	The Town should develop more educational resources including information on symptoms, prevention, and healthcare options. The Town should create a tick alert in which a mass message is sent to cell phone of people who have signed-up for notification system to alert them to the prevelance of ticks in certain areas during specific times of the year. The Town should continue to monitor the outbreak/spread of illnesses as they move across the state.				H	S

Blue table:

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

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

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

Features	Location	Ownership	V or S	Changes in Precipitation / Wind / Changes in Temperature (extremes) / Pests & Invasive Species	Priority H - M - L	Time Short Long Ongoing
Infrastructural						
Roads	Town wide	State & Town	V & S	Assessment of vulnerability and project prioritization for essential transportation routes.	H	S & O
Bridges and Culverts	Town wide	State & Town	V & S	(1) Further assessment utilizing the NAACC standardized process to determine connectivity and condition. (2) Seek subject matter expertise in resilient trees along waterways to prevent downed trees clogging culverts and washing out bridges. (3) Forest management to address tree health and invasive species along waterways. (4) Legislation or bylaws to control private land management coupled with education of best management practices.	H	S & O
Utility Lines and Systems	Town wide	Utility & Town	V	(1) Assess the potential for microgrids and scales including a town wide microgrid that can be connected to alternative energy sources or a microgrid for critical facilities including the shelters, EMS, and resiliency hubs or gathering points. (2) Research and analyze solutions to ice that damages power and communication lines.	H	S
Sewer and Wastewater Treatment	Town wide	Town	V	(1) Identify a new location and move the wastewater treatment plant out of the floodplain of the Housatonic and utilizing new technology that integrates engineered wetlands. (2) Allow primary composting toilets in town through local bylaws. (3) Asses feasibility and determine site suitability for decentralized neighborhood scale wastewater treatment systems as advised by the EPA.	H	L
Water Distribution	Town wide	Town & Privat	V	(1) Replace aging infrastructure including pipe replacement (2) Add backup water sources to Long Pond and the Green River. (3) Pursue public ownership of the water supply. (4) Prepare an emergency plan for the water supply. (4) Ensure there is backup energy supply for water distribution.	H	L
Resource Distribution (Food and Medicine)	Town wide	Various	V	(1) Evaluate risk posed to local food and import routes to determine a plan for providing food to the Town in the case of long-term hazardous conditions. (2) Determine medical supply reserves. (3) Determine food reserves and reference the Glenwood Institute study. (4) Encourage and support food grown locally.	H	O
Buildings				Ensure resiliency and energy efficiency in upgrades and new construction.	M	O
Financial Systems and Resources				Plan for financial and resource resiliency. Identify vulnerabilities and need for continuity.	M	O
Internet Access				(1) Improve service in Berkshire County. (2) Ensure dependable internet access for students because they depend on internet to stay competitive in school.	H	O
Housing Access	Town wide	Various	V	Address housing affordability issues in Great Barrington.	H	O
Societal						
Shelters	See map	Town & Simon's Rock	V & S	(1) Establish additional shelters throughout Town. (2) Prepare shelters to take in residents from the "social region" because Great Barrington can serve as a "resiliency hub."	M	S
Education	Monument High & Community Nodes	Various	V & S	(1) Address the discrepancy and disparity in snow day designation across the regional school district - some towns will cancel school while others will not, therefore some students, potentially those with better road maintenance have more days in school. (2) Construct a new school in order to move passed deferred maintenance and new programming. (3) Establish an on campus agricultural program and farm to school programs. (4) Develop a climate change curriculum. (5) Analyze alternatives to centralized education that can still support social connectivity. (6) Upgrade educational facilities and transportation modes to alternative fuels. (7) Provide a "real" and functional kitchen at the schools.	H	S
Language Access (focus: public health)			V & S	(1) Establish universal accessibility to public health information and centers including the translation of materials to multiple languages, or availability of on-demand translation services.	H	O
Marginalized Populations (including disabled)			V & S	(1) Acknowledge and prioritize. (2) Identify places and spaces to connect face to face with marginalized populations and going to the spaces that the targeted populations feels comfortable. (3) Provide the opportunity for the marginalized populations to organize and hold their own workshop to encourage candid conversation. (4) Reparations to native populations.	H	O
Public Transit			V & S	(1) Initiate research on if there are rural communities that successfully have public transit and how do they do it? (2) Initiate public campaign to promote public transit in Berkshire County.	M	S
Emergency Responders				Improve relationship between emergency responders (i.e.. Police) and the community protesting and taking action against climate change.	L	O
Climate Refugees				Develop a strategy to predict and plan for immigration and identify the role Great Barrington will play.	M	L
Community Health Program Inc (CHP) Great Barrington Health Center	444 Stockbridge Road	CHP	V & S	Address the proximity to the floodplain and likelihood that this area will flood.	H	S
Food Security			V & S	Promote and incentivize growing and producing local food to support the local population over importing food.	H	O
Environmental						
Water				Protect water sources including rivers and aquifers.	H	O
Green River				Address property erosion	H	O
Wetlands				(1) Provide education on benefits of and best management practices for wetlands. (2) Restore and protect wetlands, and engineer wetlands for ecosystem services, particularly water treatment.	H	O
Floodplains				Develop and educational strategy to inform people about the floodplain, where it is, its services, and the dangers of developing within the floodplain.	H	O
Soil Health				(1) Provide education on soil health and agricultural practices that maintain soil health. (2) Ban glyphosate. (3) Provide technical assistance programs for the transition to more sustainable agricultural practices. (3) Provide a composting program for the Town.	H	S
Wildlife				Plan for wildlife in conjunction with mitigation actions.	M	O
Conservation Lands		Public, Private, NGO, AT Corridor		Plan conservation lands so that they align with hazard prone areas, and protect threatened habitat.	M	O

APPENDIX D: REQUEST FOR COMMENT FROM REGIONAL PARTNERS AND JURISDICTIONS

Correspondence Sent:

TOWN OF GREAT BARRINGTON
MASSACHUSETTS

OFFICE OF PLANNING AND COMMUNITY DEVELOPMENT

Christopher Rembold, AICP

Ph: (413) 528-1619, ext. 7
crembold@townofgb.org

MEMORANDUM

TO:	Town of Alford Planning Board Town of Egremont Planning Board Town of Lee Planning Board Town of Monterey Planning Board Town of New Marlborough Planning Board Town of Sheffield Planning Board Town of Stockbridge Planning Board Town of Tyringham Planning Board Town of West Stockbridge Planning Board
FROM:	Christopher Rembold *Assistant Town Manager, Director of Planning & Community Development*
DATE:	November 20, 2020
SUBJECT:	Great Barrington Hazard Mitigation Plan

The Town of Great Barrington invites review and comments from abutting Towns on our recently completed Hazard Mitigation and Climate Adaptation Plan (HMCAP), which was prepared to meet the requirements of 44 CFR § 201.6 pertaining to local hazard mitigation plans, as well as the requirements of the Commonwealth's Municipal Vulnerability Preparedness (MVP) program.

The plan may be accessed on the Planning Department page of our Town website: https://www.townofgb.org/planning-department.

Please feel free to email your comments to me at crembold@townofgb.org.

Correspondence Received: (to be added)