New Marlborough Hazard Mitigation and Climate Adaptation Plan

Draft December 2020

PLACEHOLDER FOR FINAL SIGNED ADOPTION LETTER

<NEW MARLBOROUGH TOWN LETTERHEAD>

CERTIFICATE OF ADOPTION, NEW MARLBOROUGH, MASSACHUSETTS

A RESOLUTION ADOPTING THE

TOWN OF NEW MARLBOROUGH
HAZARD MITIGATION AND CLIMATE CHANGE ADAPTATION PLAN 2020

WHEREAS, the Town of New Marlborough established a Committee to prepare the *Town of New Marlborough Hazard Mitigation and Climate Change Adaptation Plan* 2020; and

WHEREAS, the *Town of New Marlborough Hazard Mitigation and Climate Change Adaptation Plan 2020*, together with the *Town of New Marlborough Municipal Vulnerability Preparedness Plan*, contains several potential future policies and projects to mitigate potential impacts from natural hazards and climate change in the Town of New Marlborough; and

WHEREAS, the *Town of New Marlborough Hazard Mitigation and Climate Change Adaptation Plan 2020* was formally posted and offered for public comment December 21, 2020 through January 8, 2021; and

WHEREAS, the Town of New Marlborough authorizes responsible departments and/or agencies to execute their responsibilities demonstrated in the plan; and

NOW, THEREFORE BE IT RESOLVED that the Town of New Marlborough Board of Selectmen adopts the *Town of New Marlborough Hazard Mitigation and Climate Change Adaptation Plan 2020*, in accordance with M.G.L. 40 §4 or the charter and bylaws of the Town of New Marlborough.

ADOPTED AND SIGNED this Date ____________________

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Tara White, Chair, Board of Selectmen

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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 *New Marlborough Hazard Mitigation and Climate Adaptation Plan* (the HMCAP) was prepared 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. Furthermore, 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. As the HMCAP will illustrate, New Marlborough's eligibility for FEMA's hazard mitigation grants is crucial. In addition to legal requirements, the Town of New Marlborough has laid out the following mission statement for their hazard mitigation planning process:

> To identify risks and sustainable cost-effective actions to mitigate the impacts of natural hazards in order to protect life, property and the environment.

In accordance with 44 CFR § 201.6 the local mitigation plan is the representation of New Marlborough'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.

Background

Mitigation Planning

The Town of New Marlborough was included in a regional hazard mitigation plan with 18 other Berkshire County municipalities approved by FEMA Region I in 2012. This HMCAP is an update of the *Berkshire County Hazard Mitigation Plan*, dated November 5, 2012 and is now a single jurisdictional plan.

Location

The town of New Marlborough is an area of 48 square miles, located along the southern border of Berkshire County in Western Massachusetts. It is bordered on the north by Monterey, to the west by Sheffield, to the northwest by Great Barrington to the east by Sandisfield and to the south by the Connecticut towns of North Canaan and Norfolk (see Fig. 1.1). New Marlborough is approximately 140 miles west of Boston and 125 miles north of New York City, taking it a favorite destination for second homeowners.

The town of New Marlborough, while one incorporated town, contains five distinct village areas. Hartsville is located southeast of Lake Buel at the intersection of Hartsville Road, Hartsville-New Marlborough Road, Hartsville-Mill River Road, and Hatchery Road in the northern portion of New Marlborough. New Marlborough is located in the north central portion of the Town at the intersection of Hartsville-New Marlborough Road, New Marlborough-Sandisfield Road, New Marlborough-Monterey Road, and New Marlborough-Southfield Road. Southfield is located in the central portion of the Town, stretching along Norfolk Road between Mill River Southfield Road and Canaan Southfield Road. Mill River is located in the west-central portion of Town at the intersection of Mill River-Great Barrington Road, Mill River-Southfield Road, and Norfolk Road. The village of Clayton is predominately an agricultural area knit together with three small hamlets: Konkapot, North Clayton, and Clayton. Refer to Figure 1.2 for locations of the villages.

Fig. 1.1. New Marlborough Regional Context

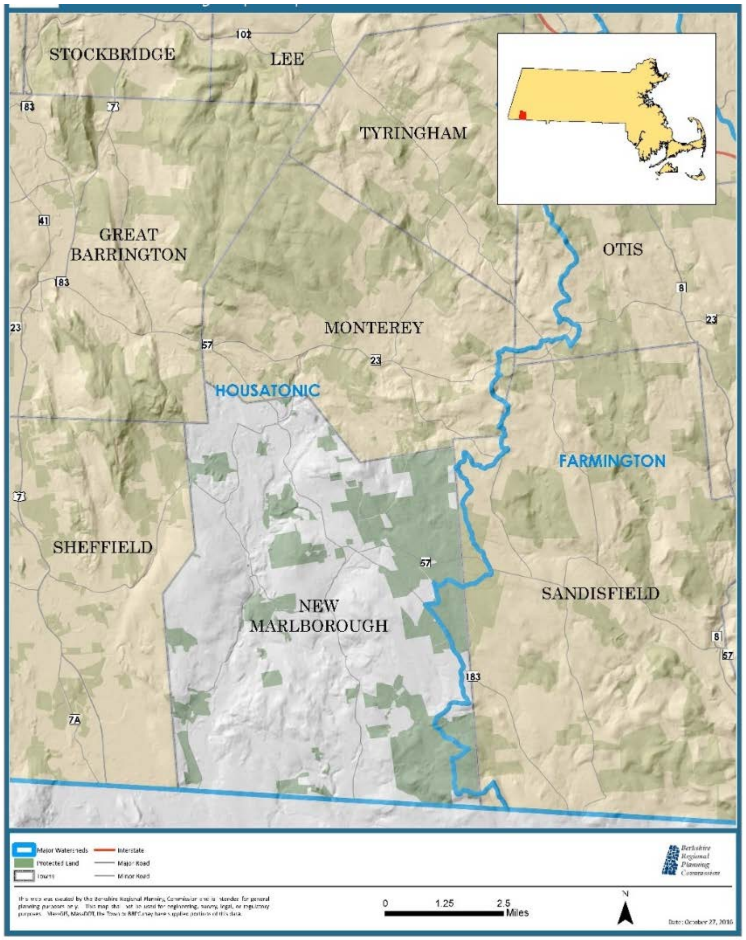
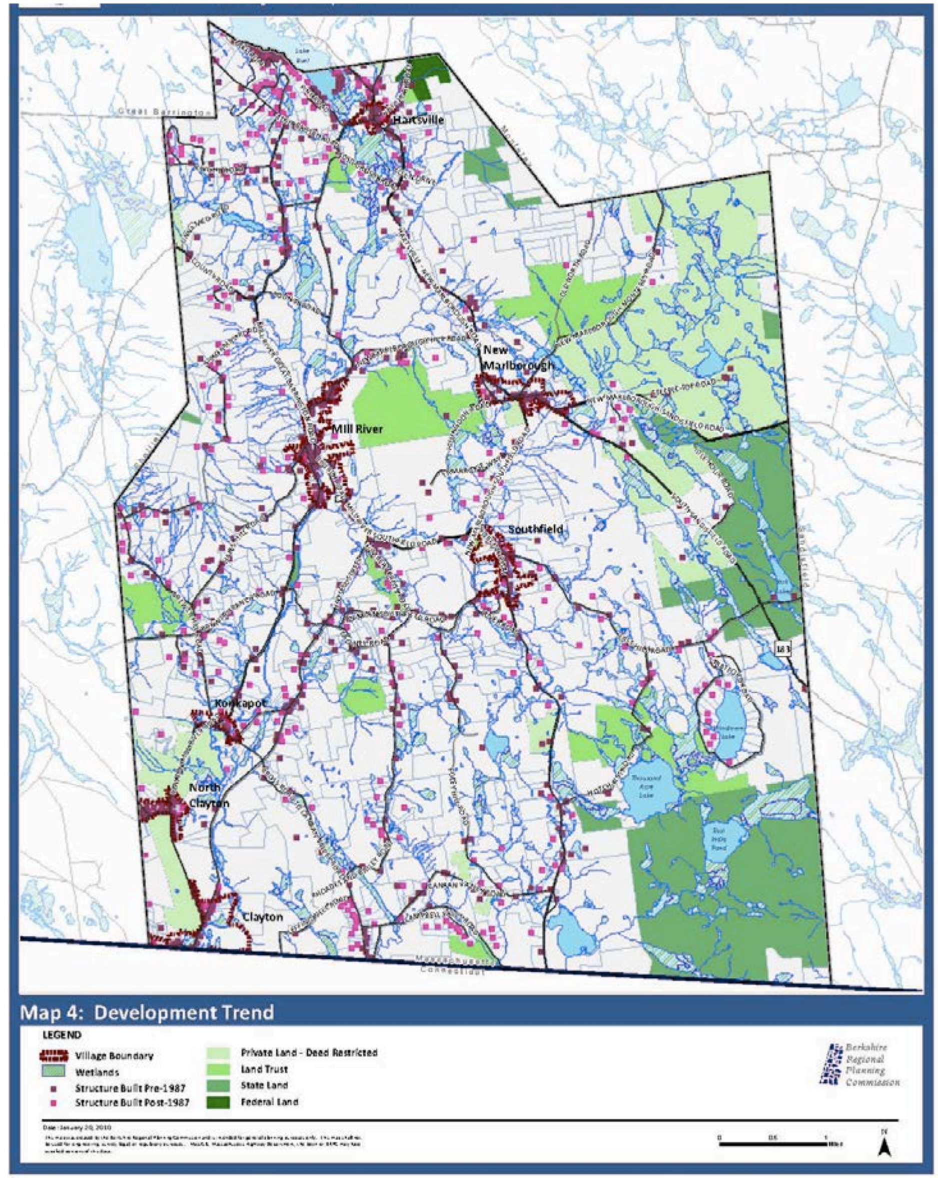


Fig. 1.2. New Marlborough Villages and Development Patterns



Source for both maps: New Marlborough Comprehensive Plan, 2010.

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 New Marlborough HMCAP. 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 Chapters 4-6.

Planning Meetings and Participation

44 CFR § 201.6(c)(1)

During 2019-2020 the Town of New Marlborough conducted two separate but complementary hazard mitigation and climate change adaptation planning processes: development of a state-approved *Municipal Vulnerability Preparedness Plan* (MVP) and development of a FEMA-approved *Hazard Mitigation and Climate Change Adaptation Plan* (HMCAP). In 2019 the Town of New Marlborough established a Hazard Mitigation Committee to guide the development of the updated HMCAP. Technical Assistance for the development of this plan were provided by the Berkshire Regional Planning Commission (BRPC), the planning agency that works with all local agencies to guide development in Berkshire County. The Hazard Mitigation Committee was comprised of core municipal staff who were familiar with emergency response and hazard mitigation concepts as they related specifically to New Marlborough and its neighboring towns. The Hazard Mitigation Committee focused on identifying and ranking natural hazard risks, reviewing for relevancy and accuracy the data and risk analyses developed by BRPC, reviewing the previous hazard mitigation plan and drafting a mitigation strategy that would address current and future hazards and climate change impacts. This group met in person October 18 and December 13 of 2019, providing information and identifying site-specific high-risk areas to BRPC staff to aid them in developing a draft HMCAP that would meet FEMA requirements. Because meeting in person was difficult due to COVID 19, BRPC held several phone interviews with Committee members to ensure that information and details were accurate.

Table 2.1. New Marlborough Hazard Mitigation Committee

Name	Position
Mari Enoch	Town Administrator
Graham Frank	Chief of Police
Edward Harvey	Emergency Management Director
Chuck Loring	Highway Superintendent, Fire Chief

The Hazard Mitigation Committee, armed with information from the draft HMCAP, participated a complementary and concurrent planning process to develop the Town's first *Municipal Vulnerability Preparedness Plan* (MVP). For this effort the Town retained the services of BSC

Group, Inc., a state-approved MVP Provider, to aid them in developing the MVP. This planning initiative followed the Community Resilience Building (CRB) framework developed by The Nature Conservancy to apply a community-driven workshop process to identify climate-related hazards, community strengths and vulnerabilities, and develop solutions to address these considerations. Completion of the CRB process enables the Town to achieve MVP community designation status from the Massachusetts Office of Energy and Environmental Affairs and receive preference for future state grants.

The CRB process began with the establishment of a Core Team that included community stakeholders comprised of Town Staff. The Core Team held a strategic planning session on May 20, 2020. This Core Team meeting involved developing a broad understanding of the Hazards, Vulnerabilities, and Strengths that characterize the Town of New Marlborough, and to identify a list of Preliminary Resilience Actions that the community could consider at the CRB Workshop. Due to the global COVID- 19 pandemic and the Massachusetts Non-Essential Business Order and Stay-at-Home Advisory that went into effect on March 24, 2020, BSC Group, Inc., hosted meetings, the CRB Workshop, and the Listening Session via the Zoom platform. To increase community engagement, a project website was developed and used to house project information in a central location. Resources made available on the website included project maps, an interactive GIS community data viewer, recorded video presentations, surveys, and links to useful climate data information provided on the Massachusetts Climate Change Clearinghouse Website, resilientma.org. Municipal stakeholders that were unable to attend the Core Team planning meeting were encouraged to provide information through the data collection tools provided on the project website.

The CRB Workshop was held on June 23 and June 24, 2020. Twenty-five attendees participated in the workshop, which included a diverse set of community stakeholders from municipal departments, local businesses, non-government entities, and local interest groups. The CRB workshop involved a refinement of preliminary planning efforts and concepts held during Core Team meetings. Workshop participants were asked to vote on the top actions through an online survey provided on the project website, and Top Priority Action Items were integrated into final report. Virtual participants were encouraged to visit the project website prior to, during, and following the workshop to become familiar with scientific concepts. Information gathered during these various methods of engagement were compiled and integrated into a MVP Plan entitled the *Town of New Marlborough Community Resilience Building Summary of Findings*. A list of workshop attendees is provided in Appendix A of this Plan.

Fig. 2.1. Public Participation held via Zoom Technology 2020.

Source: Malloy & Tozer, 2020.

A Public Listening Session about the MVP was held on October 5, 2020. A recorded presentation and an online survey was provided on the project website and the Town of New Marlborough solicited information from the community through this survey for two weeks. Feedback collected through this public process was integrated into the final version of the MVP.

After the conclusion of the MVP planning process, and armed with the findings garnered from that initiative, the Hazard Mitigation Committee returned to editing and finalizing the HMCAP. The Draft HMCAP was forwarded to MEMA/FEMA on December 18, 2020. Concurrently with MEMA/FEMA review, the Draft Plan was offered for public comment for three weeks, December 21, 2020 to January 8, 2021. The Draft Plan was posted on the Town's website and a paper copy was placed in the Town Library. The posting of the Draft HMCAP for public review was advertised in the New Marlborough Five Village News, a town-wide monthly newsletter and an invitation to review was sent to the Town's email distribution list. The New Marlborough Planning Board and Board of Selectman announced the Draft Plan's posting at their meetings on December 15 and 21, 2020 respectively. Additionally, a formal invitation to review and comment on the Draft Plan was sent to all neighboring Towns and to the Southern Berkshire Regional Emergency Planning Committee. This review process meets requirements of 44 CFR § 201.6(b)(1 and 44 CFR § 201.6(b)(2), pertaining to involvement of regional partners in the planning process. Public participation documents are found in Appendix A.

The HMCAP reflects comments provided by participants and the public through the MVP planning process, the Hazard Mitigation Committee, local officials and citizens, neighboring towns, and ultimately MEMA and FEMA.

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 New Marlborough reviewed and incorporated existing plans, studies, reports and technical information into their hazard mitigation plan with the assistance of BRPC. Specific local plans referenced include:

- *Town of New Marlborough Comprehensive Plan*, 2010.
- *Berkshire County Hazard Mitigation Plan*, 2012.
- *Town of New Marlborough Open Space and Recreation Plan,* 2017.
- *Mass. State Hazard Mitigation and Climate Adaptation Plan* (MA SHMCAP), 2018.
- *Town of Sheffield Hazard Mitigation Plan,* 2019.
- *Town of New Marlborough Community Resilience Building Summary of Findings,* 2020.
- *Monterey Hazard Mitigation and Climate Change Adaptation Plan*, 2020.
- *Town of Monterey Community Resilience Building Summary of Findings,* 2020

These documents provided important insight into the value of natural resources in New Marlborough, as well as a long-term vision for the Town, including a path forward for protecting the community's assets. This plan should be used in conjunction with other local and regional plans.

The next chapter of this plan will involve the risk assessment section of the plan, profiling each hazard with potential to affect the Town of New Marlborough. Table 2.2 illustrates part of the process of prioritizing hazard mitigation actions in addition to the profiling of local impacts during the risk assessment. The rankings found in Table 2.2 were developed during a working meeting of the New Marlborough Hazard Mitigation Committee and BRPC staff. The method of prioritization meets requirements of 44 CFR § 201.6(c)(3)(iii).

Table 2.2: Hazard Prioritization for the Town of New Marlborough

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	
Dam Failure	2	0	3	**5**
Flooding (include Ice Jam, Beaver Activity)	3	3	3	**9**
Severe Winter Event (Ice Storm, Blizzard, Nor'easter)	3	3	2	**8**
Severe Storms (High Wind, Thunderstorm)	3	3	2	**8**
Hurricane & Tropical Storms	3	2	3	**8**
Wildfire	1	3	1	**5**
Drought	2	2	1	**5**
Tornado	1	1	1	**3**
Earthquake	1	0	1	**2**
Landslide	2	1	2	**5**
Change in Average Temperatures/Extreme Temperatures	3	3	3	**9**
Invasive Species	3	3	3	**9**
Pests/Vector-borne Diseases	3	3	3	**9**
Cybersecurity	2	2	3	**7**

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% and > 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% and > 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 New Marlborough. After a general profile of the Town of New Marlborough, 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 New Marlborough 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 New Marlborough.
2. Develop and implement sustainable, cost-effective, and environmentally sound mitigation projects.
3. Protect lives, health, safety, and property of fulltime residents and seasonal visitors from the impacts of natural hazards.
4. Protect critical facilities and essential public services from disruption during or after hazardous conditions.
5. Promote the hazard mitigation plan and involve stakeholders to enhance the local capacity to mitigate, prepare for, and response to the impacts of natural hazards.
6. Integrate the risks and mitigation actions identified through this planning process into all plans for the town, region, and state and ensure its consideration in all land use decisions.

CHAPTER 3: RISK ASSESSMENT

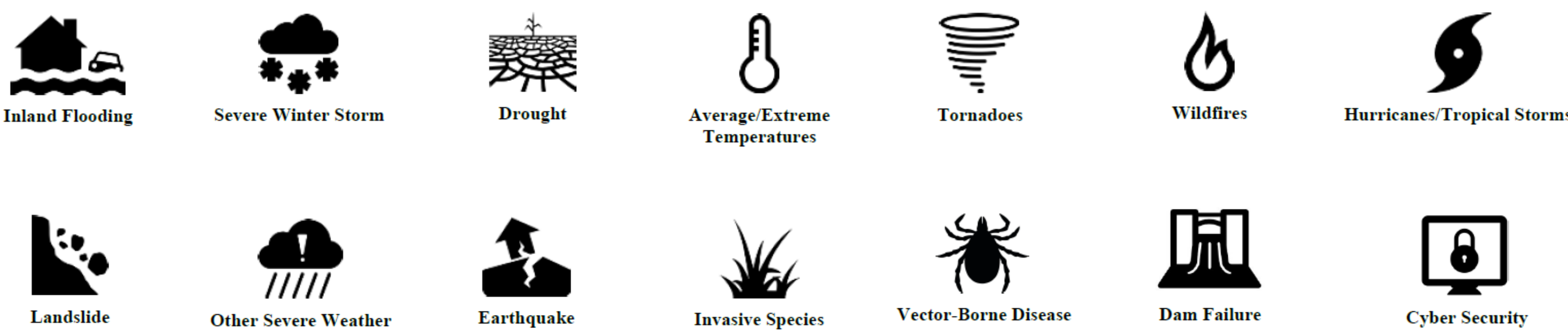
44 CFR § 201.6(c)(2)

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 New Marlborough 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 New Marlborough 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 was consulted. Accounting for the location, natural and built environments, history, and scientific studies of the area, it was determined that New Marlborough must plan for the following hazardous conditions:



New Marlborough did not consider coastal flooding, coastal erosion, or tsunami hazards because the Town is not located near the coast or large body of water.

People

New Marlborough is an overwhelmingly residential community, with residents typically commuting to jobs in southern/central Berkshire County or neighboring towns in Connecticut. The 2017 American Community Survey (ACS) estimates the year-round New Marlborough population to be 1,370 persons, which is slightly less than the 2010 US Census data and is in line with Berkshire County's overall declining population. New Marlborough, with a median age of 53, is older than Berkshire County (median age 45) and significantly older than the median age in Massachusetts (age 39). The population of the Town increases substantially during the warmer months, with approximately 40% of the homes being seasonal or second homes. Where in the past many of these homeowners were primarily summer visitors, the trend now is for these homes to be used much more extensively or even to become primary residences. The aging of the town's population, combined with the trend for seasonal residents to occupy their homes for longer periods, will have implications for demand for future town services.

Natural Environment

The predominant land uses in New Marlborough are forests (77% of total), water/wetlands (10%), and open lands such as pasture, grasslands, lawn areas and shrub/scrub (11%). All residential, business and other impervious acreage account for less than 2% of the land (MassGIS, 2016). These percentages should not be compared to data given in the 2010 Hazard Mitigation Plan because the 2016 data methodology gives greater specificity for developed areas.

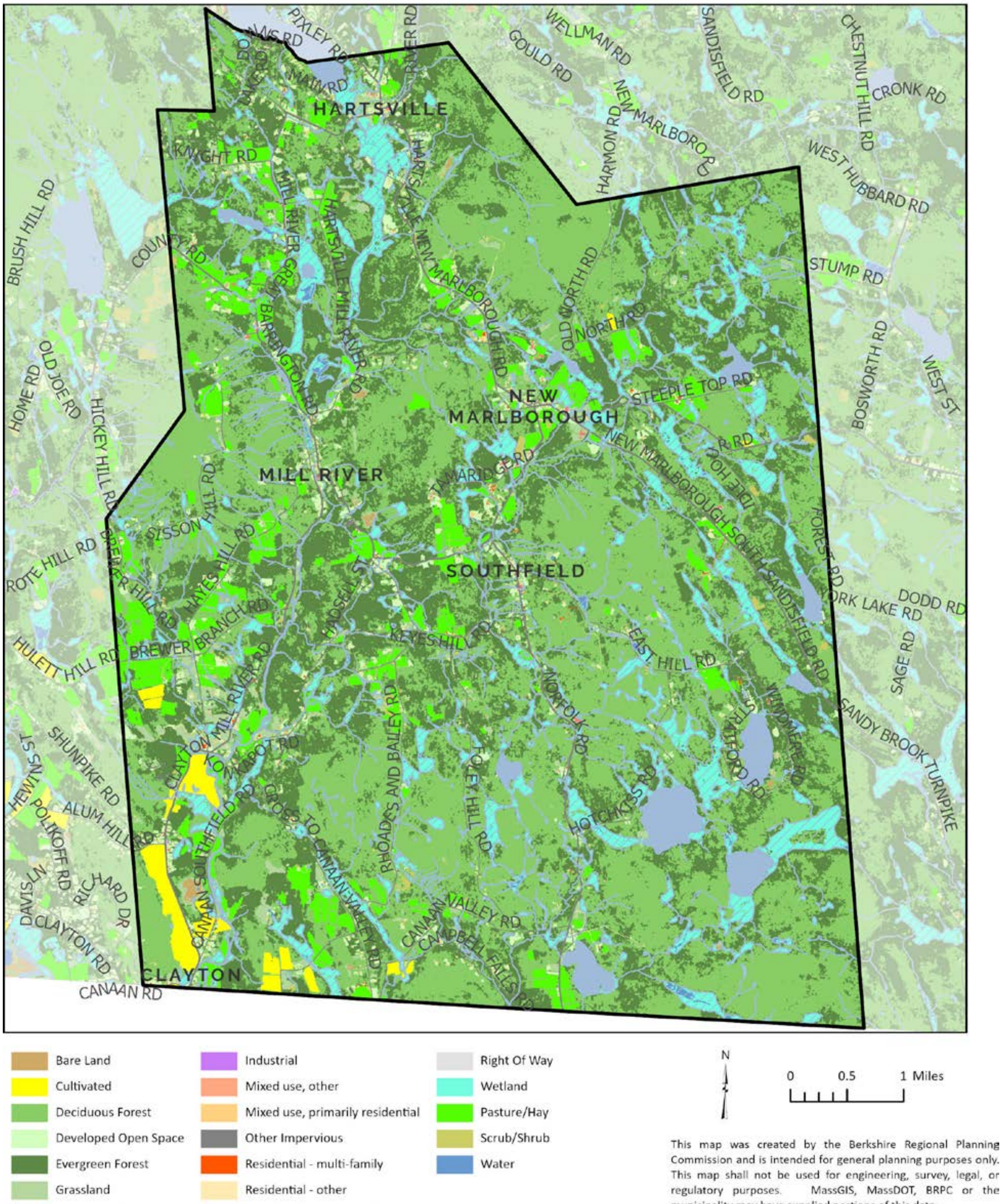
The topography of the town is a combination of rolling hills covered with dense, mature forests; meandering valleys with productive agricultural soil; and fast flowing, clean rivers. The two main rivers in New Marlborough, the Konkapot and the Umpachene, with their short, steep hillsides bisect the town from the north to the south. Wetlands and marshes between hills cover significant areas of the southeastern section of town. All of the headwater streams of the Umpachene River are located within the borders of the town; also within the town's borders are many of the headwater streams of the Konkapot River, which drains much of the town of Monterey to the north. The Whitting River drains Thousand Acre Swamp and Wolf Swamp and joins with Ginger Creek (from Connecticut) at Campbell Falls and moves west out of the plateau into Connecticut and to the broader valleys of the Blackberry and Housatonic Rivers. Except for York Lake (located in the easternmost section of town) that drains into the Farmington River, all of the water in New Marlborough drains into sub-basins and the Housatonic River.

Twenty percent of the total acreage of land in New Marlborough is open space permanently protected from development. As can be seen in Fig. 3.1, several of these lands (darker green polygons) extend into neighboring towns, providing large blocks of land for permanent natural habitat and wildlife movement. The Commonwealth, New Marlborough Land Trust, The Trustees of the Reservation and Berkshire Natural Resources Council are very active in pursuing the protection of open space through Conservation Restrictions and outright purchases.

New Marlborough is a relatively large town in physical size, with large tracts of unfragmented forest interspersed with streams, ponds and wetlands that open the forest canopy to different habitats. These forests can provide cover and travel corridors not only for rare species but also for a great variety of wildlife, including wide-ranging animals such as bear and moose. New Marlborough is in the midst of an area referred to by state and regional conservation organizations as the Berkshire Wildlife Linkage, an area between the Green Mountains in VT and the Hudson Highlands in NY that contains large intact areas of forest and river travel corridors between them. The linkage is a pathway for animals moving through the Appalachians to our south and the forests of Canada. Individual large animals may move through the linkage in a lifetime, while smaller animals may move over several generations. Ensuring that wildlife can safely move between habitats, including across the roads and through the priority areas shown below, will allow them to find food and habitat and to adapt their ranges to climate change.

The natural environment provides benefits to a community that are not always quantifiable. 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 small openings in the forest canopy can be beneficial to in areas where forest cover is particularly dense, particularly for some grassland bird species.

Fig. 3.1. New Marlborough Land Use 2016



Source: MassGIS 2016.

Built Environment

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.

Fig. 3.2. Historic homes are clustered in Villages

Source: New Marlborough Comprehensive Plan, 2010.

Historically the five villages retained their traditional New England development pattern of a cluster of homes and a few shops surrounded by farmland. However, in recent decades this New England village pattern has begun to blur, as scattered residential development replaced farm field and forest. Refer to Fig. 1.2 for development patterns.

According to the *New Marlborough Comprehensive Plan* (2010), all new housing since 1996 has been single-family residences [1]. Although zoning allows residential development on one-acre lots with 150 feet of frontage, newer development during the past 30 years tends to have larger lot sizes and deeper front setbacks than the traditional village centers. Commercial businesses are located within the villages and long rural connector roads, with many of these home-based operations within residential buildings. Development in New Marlborough is projected to continue to occur as scattered large lot residential homes, dispersed along existing country roads and within new subdivisions. This type of development will continue to fragment forest and open field habitats and threaten the rural character of the town.

Most residents in New Marlborough get their drinking water supply through private individual wells. Two private community water systems serve approximately 60 households, one in Mill River and the other in Southfield. The Berkshire Mountain Spring Water company is a private business that draws and bottles groundwater in the village of Southfield. Similarly, all waste is handles by individual septic systems. Improperly functioning septic systems can contaminate groundwater and surface waters by leaching untreated nutrients and pathogens. Septic systems around Lake Buel have in the past been suspected of negatively impacting water quality, and an outreach program was established several years ago to educate property owners of the importance of proper maintenance of their systems

Critical facilities are the buildings and infrastructure hubs that are necessary for continued operation during a hazardous event. Table 3.1 shows New Marlborough's Critical Facilities and Figure 3.4 provides a map of the critical facilities and areas of concern.

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[1] *2010, New Marlborough Comprehensive Plan.*

Table 3.1: New Marlborough Critical Facilities

Type	*Name*	*Address*
Fire	Fire Station	205 Norfolk Road
Police	Police Department	807 Mill River - Southfield Road
Health Services	Fire Station	205 Norfolk Road
Town Offices	Town Hall	807 Mill River-Southfield Road
Emergency Operations Center	Fire Station	205 Norfolk Road
Alternate Emergency Operations Center	Town Hall	807 Mill River Southfield Road
Public Works	Town Garage	603 Mill River Southfield Road
Schools/Special Needs	New Marlborough Central Elementary School	44 Hartsville-Mill River Road
Shelters	New Marlborough Central Elementary School	44 Hartsville-Mill River Road
	Fire Station	205 Norfolk Road
	New Marlborough Town Library	1 Mill River-Great Barrington Road

Economy

New Marlborough's tax base is large derived from residential property taxes. However, the Town supports a surprising number of businesses, as according to the 2010 *New Marlborough Comprehensive Plan*, there were 95 businesses located within the town. The commercial/industrial component of the economy is comprised of small local businesses and specialized farming operations. Independent contracting businesses, retailers and home-based professional services are found here, while other businesses tend to revolve around the hospitality and tourism sectors. There are a number of farms in the town with over 1,000 acres of land in active agricultural use. These farms tend to follow the regional trend of smaller, independent farms to focus more on specialized farm products such as wine, alpaca wool, and grass-fed beef.

New Marlborough's natural resources are inextricably linked to the Town's economy. Tourism, second home residents and vacationers are important economic drivers for the Town, and maintaining the health and resilience of its natural resources is key to maintaining New Marlborough as a destination.

Inland Flooding

Hazard Profile

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 urban drainage, though the latter is not an issue for the rural Town of New Marlborough. 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." (FEMA, 2011b as cited in MEMA & EOEEA, 2018[2]). 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. (MEMA, 2013) 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 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

[2] 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

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.

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

Flooding of properties and roadways occurs across New Marlborough, due to historic development within the floodplain, from floodwaters overtopping and eroding streambanks, and where bridges and culverts are undersized and restrict flow. Development is scatted across the

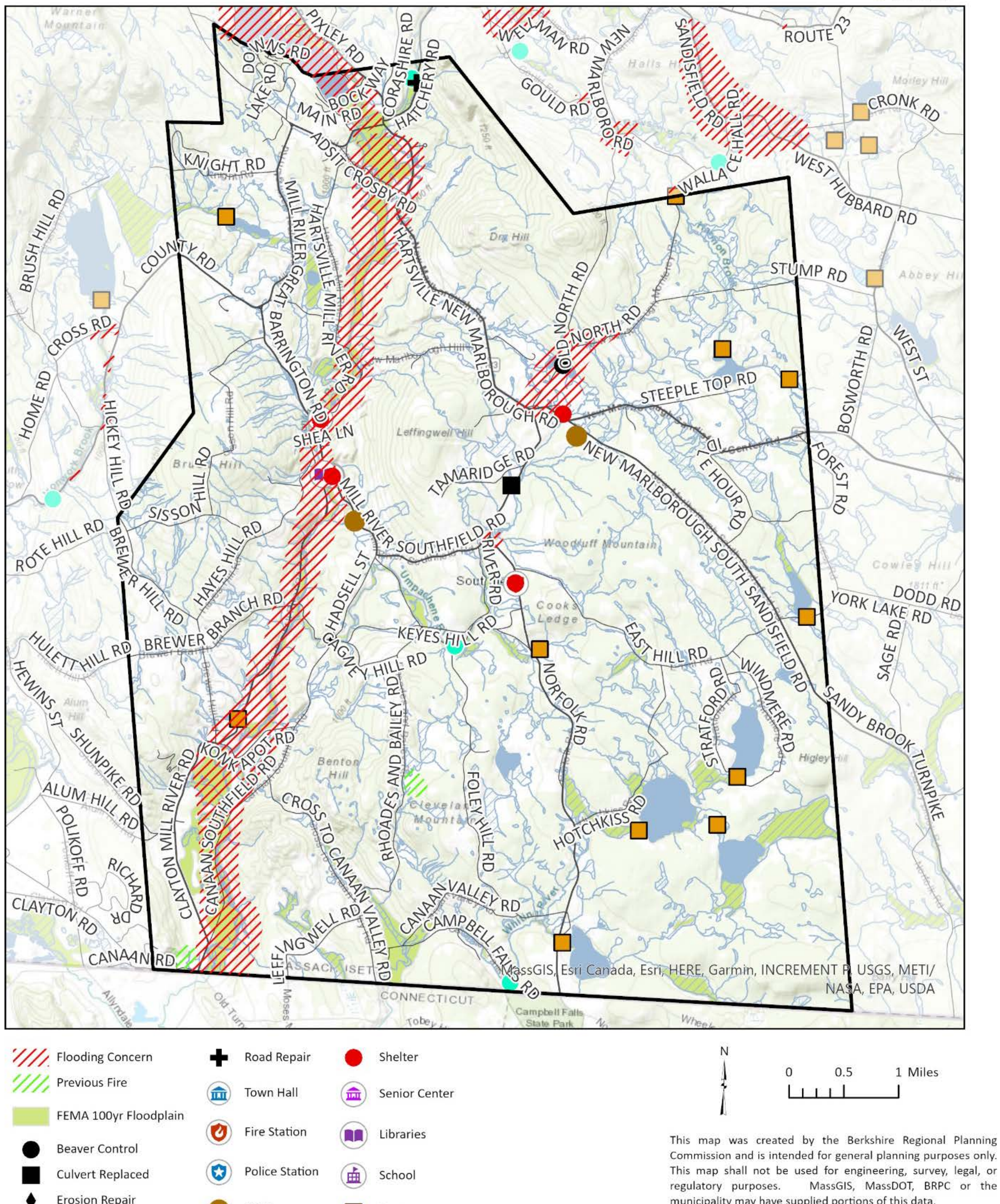
Town, near the many lakes, ponds, wetlands, and a network of rivers and streams. Much of the Town's terrain is steeply sloped, with streams flowing through incised ravines. As such, the streams and rivers in New Marlborough has a flashy flow regime where peak flows built up quickly and bank erosion is common. There are relatively few acres of wetlands or floodplain to absorb storm flows during severe storm events. 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 New Marlborough follow streams and rivers, having been laid in the floodplain or carved along the slopes above the bank. Fluvial erosion can also scour and downcut 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).

The major river system in the town is the Konkapot River, which flows southward through the central/western part of the town and has 100-year floodplain associated with it much of its length. The river is formed at the outlet from Lake Garfield, located in neighboring Monterey, meandering downstream almost a mile before it joins another brook formed by the outlet of Lake Buel. Just below the confluence of these two brooks, silt builds up and will cause water to backflow into Lake Buel. This causes extensive flooding and severe riverbank erosion, which threatens the bridge at Hartsville Mill River Road, just below the confluence. The severe bank erosion is washing away 4-5 feet of bank per year, moving the bank's edge close to the road. Downstream of the confluence with the Lake Buel outlet, the Konkapot River flows through the villages of Hartsville, Mill River and Clayton. The river causes repeated flooding along its entire length to the Connecticut state line, threatening Mill River Great Barrington Road and Clayton Mill River Road where bank erosion threatens road stability. The drainage system along the length of the Mill River Great Barrington Road needs an improved drainage system because there is only one catch basin at the lower portion of the road and runoff in certain areas cross private residential properties before discharging into the waterway. Some landowners are losing land due to bank erosion, with one owner having lost almost 50 feet of property over the decades.

Stabilizing the bank of Konkapot River to protect Hartsville Mill River Road is a high priority. The Town partnered with Trout Unlimited to apply for grant funds to National Fish and Wildlife Foundation's Long Island Sound Futures Fund for engineering design to stabilize the bank, but the application was not successful (notice of denial was received December 14, 2020). The Town will continue to investigate alternate grant funding and other financial opportunities to undertake the bank stabilization project.

Flooding of residences on Lake Buel flood often, due to water backing up in the outlet and sedimentation deposits at the site. Most of the flooding is to homes on the Monterey side of the lake where homes were built in low-lying land near the edge of the water; homes on the New Marlborough side of the lake tend to be on higher ground. However, one homeowner in New Marlborough suffered flooding during T.S. Irene in 2011. Several years ago the Towns of New Marlborough and Monterey jointly appropriated funds to study the issue, but the recommended engineering solutions were found to be too difficult to permit and implement, so the recommendations were not pursued. Still, residents and officials in both New Marlborough and Monterey have cited the ongoing flooding issues at Lake Buel and its outlet as a major concern, having voiced these concerns during the extensive community participation processes involved with the development of the 2012 Berkshire Regional Hazard Mitigation Plan (2012), the New Marlborough and Monterey Municipal Vulnerability Preparedness Plans (2020 and 2019 respectively), and this updated New Marlborough Hazard Mitigation and Climate Action Plan (2020).

Fig. 3.4. Location of Flood-prone Areas in New Marlborough and Critical Facilities



Roads that run along or over the rivers and streams in New Marlborough are at risk of flooding, being washed out, or collapsing into streams due to severe bank erosion. The Town of New Marlborough maintains approximately 90 miles of roadway, of which 38 miles are gravel/unpaved roads. Approximately seven miles of roadway are located within the 100-year floodplain, of which 2.3 miles are unpaved.

New Marlborough's gravel/unpaved roads are becoming more difficult to maintain. These roads have always been more prone to washing out, often repeatedly in one year during severe storm events. As greater numbers of severe storm events are occurring, repairs have increased in number and costs due to added staff labor, materials and equipment required at the sites. One example is an event last year when the Town experienced a 3-4" rain event one night. The road washed out and was repaired with new gravel. The new gravel was washed out a second time when another heavy rain of 3" returned the next night. Many of these roads are entrenched, with high banks on both sides which hinder drainage out of the road corridor.

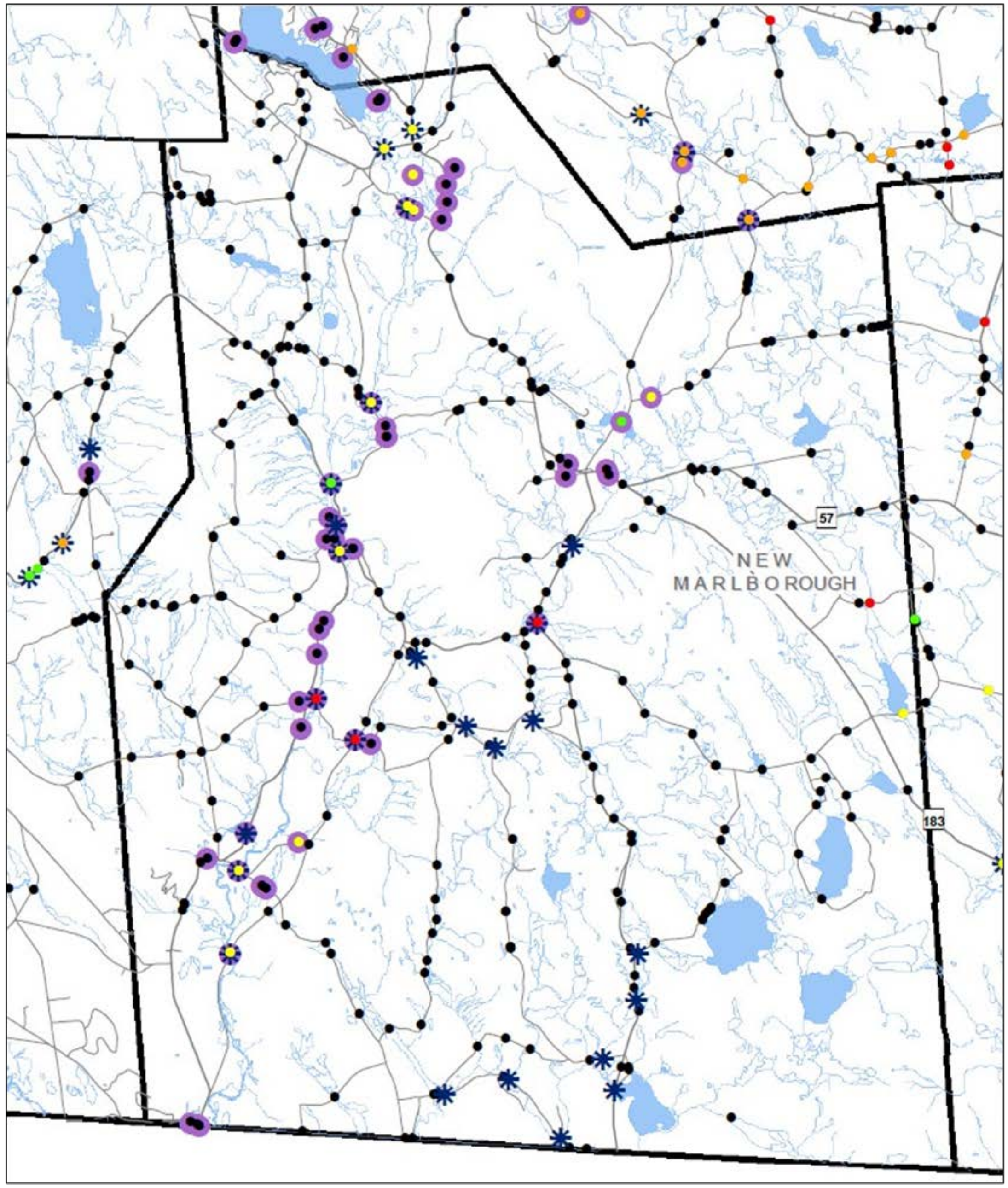
Maintaining gravel roads is also becoming more difficult during the winter because the road bed no longer remains consistently frozen during the winter months. The roads suffer from repeated cycles of freeze/thaw and become impassible due to ruts and wash outs during period of thawing. Whereas the muddy condition of the roads would typically only happen as the roads thaw during spring mud season, the Public Works Superintendent voiced his frustration with the 2019-20 winter season, calling it the year "with five mud seasons." Impassible roads restrict emergency response to homes along these roads, where fire trucks and possibly ambulances cannot access.

As a first step in addressing gravel road issues, the Town of New Marlborough joined its neighbors Sheffield and Sandisfield in receiving a Massachusetts Municipal Vulnerability Preparedness Action Grant to conduct an assessment of its gravel roads. The engineering firm of BSC Group began the work in the spring of 2020. Next steps will be to prioritize for implementation the recommendations put forth by the engineers.

Many of the road crossing bridges and culverts are undersized and need upsizing or replacement. New Marlborough has approximately 10 that need repair/replacement due to age and deterioration, but to meet the state Stream Crossing Standards they will need to be enlarged, with some probably needing to be doubled in size. This is a financial hardship for the Town, as the cost for enlarged crossings is significantly greater, but the crossings do not fit the criteria for funding under the state Small Bridges Program. Some culverts have had initial assessment. The North Atlantic Aquatic Connectivity Collaborative (NAACC) is a network of individuals from universities, conservation organizations, and state and federal natural resource and transportation departments focused on improving aquatic connectivity across the Northeast. The NAACC provides protocols for road-stream crossings (culverts and bridges) to assess and score crossings for fish and wildlife passability, as well as culvert condition and other data useful for evaluating risk of failure. Trained staff and volunteers from the Berkshire Environmental Action Team (BEAT) have assessed stream crossings throughout Berkshire County, including some in New Marlborough. Working with the Berkshire Regional Planning Commission, maps have been created that reflect the NAACC data collected alongside information gathered from local town officials. Figure 3.5 shows the culverts and bridges that have been determined to be at greatest risk for failure during severe storm events (shown in purple on map). Of these, the Town has identified Foley Hill Road (near number 1526 Canaan Southfield Road, Hartsville New Marlborough Road) and near 1191 Canaan Southfield Road and North Road to be of highest priority for repair/upsizing to mitigate risk.

The Town of New Marlborough has worked hard to upgrade, repair and replace aging and undersized bridges, including completion of work on Hadsell Road, Clayton Mill River Road and Umpachene Falls Road (which was closed for 6 years). Construction is scheduled to start on Campbell Falls Road in March 2021, and three bridges are bundled together into one bid project to begin in summer 2021 (Lumbert Cross Rd., Norfolk/New Marlborough Southfield Rd., and Canaan Southfield Rd.). Keyes Hill Road will be entering 25% design in spring of 2021.

Figure 3.5. Bridge and Culvert Crossing Evaluation



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.[3]
1938	Large rain storm 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.
Dec. 31, 1948 – Jan. 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.
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.

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

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 as a result 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 lead 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 or not 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. Residents on dead-end roads are at greater risk of isolation if their only evacuation route out has been washed out or if debris from flooding has blocked the route.

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 or not 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. Vulnerable populations may also be less likely to have adequate resources to recover from the loss of their homes and jobs.

The total number of injuries and casualties resulting from typical riverine flooding is generally limited due to advance weather forecasting, blockades, and warnings. 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 power lines, 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.

Floodwaters can become health hazards. 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. Floodwaters often contain a wide range of infectious organisms from inundated septic systems and from naturally occurring sources such as floodwaters where concentrated animal populations, such as beavers or geese, are present. Areas where floodwaters do not drain properly can become breeding grounds for mosquitos, which can transmit vector-borne diseases.

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). Berkshire County’s emergency room visits due to asthma related illness is already higher than the state average without the added factor of flooding. 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

Flood waters can cause injury and damage the built environment due to several factors. Wood framing can rot if not properly dried, compromising building structure and strength. Repeated inundation brings increased risks of both structural damage and mold. 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. While most flooding in the Berkshire region is localized and has resulted in few wide-spread outages, utility companies first restore power to areas with higher population densities, which leaves sparsely populated areas like New Marlborough lagging.

An analysis of the FIRM flood hazard area maps indicates that there is a total of 2,230 acres of 100- year floodplain within New Marlborough, which amounts to 7.3% of the total acreage in town. Based on additional analysis, approximately seven acres (0.3%) of the floodplain are developed, not include maintained property or open space. This leaves 2,223 acres of floodplain that could potentially be developable under current zoning. Although the Town does not currently have a floodplain zoning bylaw, any development that would be proposed would be subject to permitting under the state's Wetlands Protection Act and strict Building Code. The Town should adopt a floodplain bylaw to clearly state what types of development would be prohibited and what types would be allowed with conditions.

According to floodplain data obtained by the Berkshire Regional Planning Commission, there are currently 84 residential buildings located within the 100-year floodplain in New Marlborough (see Table 3.4 and Fig. 3.6). Of these, 80% of these are residential buildings, most located along the Konkapot River corridor. Within this corridor many homes are clustered in Hartsville, where the Lake Buel outlet discharges into the upper Konkapot River. A few older homes in Mill River Village back up against the river, some where banks are eroding and flooding threatens the structures. The locations of the buildings within the floodplain can be seen in Fig. 3.6. The percentage of buildings is then multiplied by the total property value, as determined from the Department of Revenue, to come up with a potential loss. In addition to this, an additional percentage of the value was added to represent the contents of the properties. This can be found in Table3.4.

Table 3.4 Buildings in 100-Year Floodplain in New Marlborough

Residential		Commercial		Mixed Use		Industrial	
Number Bldgs.	Percent Res. Bldgs.	Number Bldgs.	Percent Comm. Bldgs.	Number Bldgs.	Percent Mixed Use Bldgs.	Number Bldgs.	Percent Ind. Bldgs.
80	8.2%	1	3.2%	2	8%	1	50%

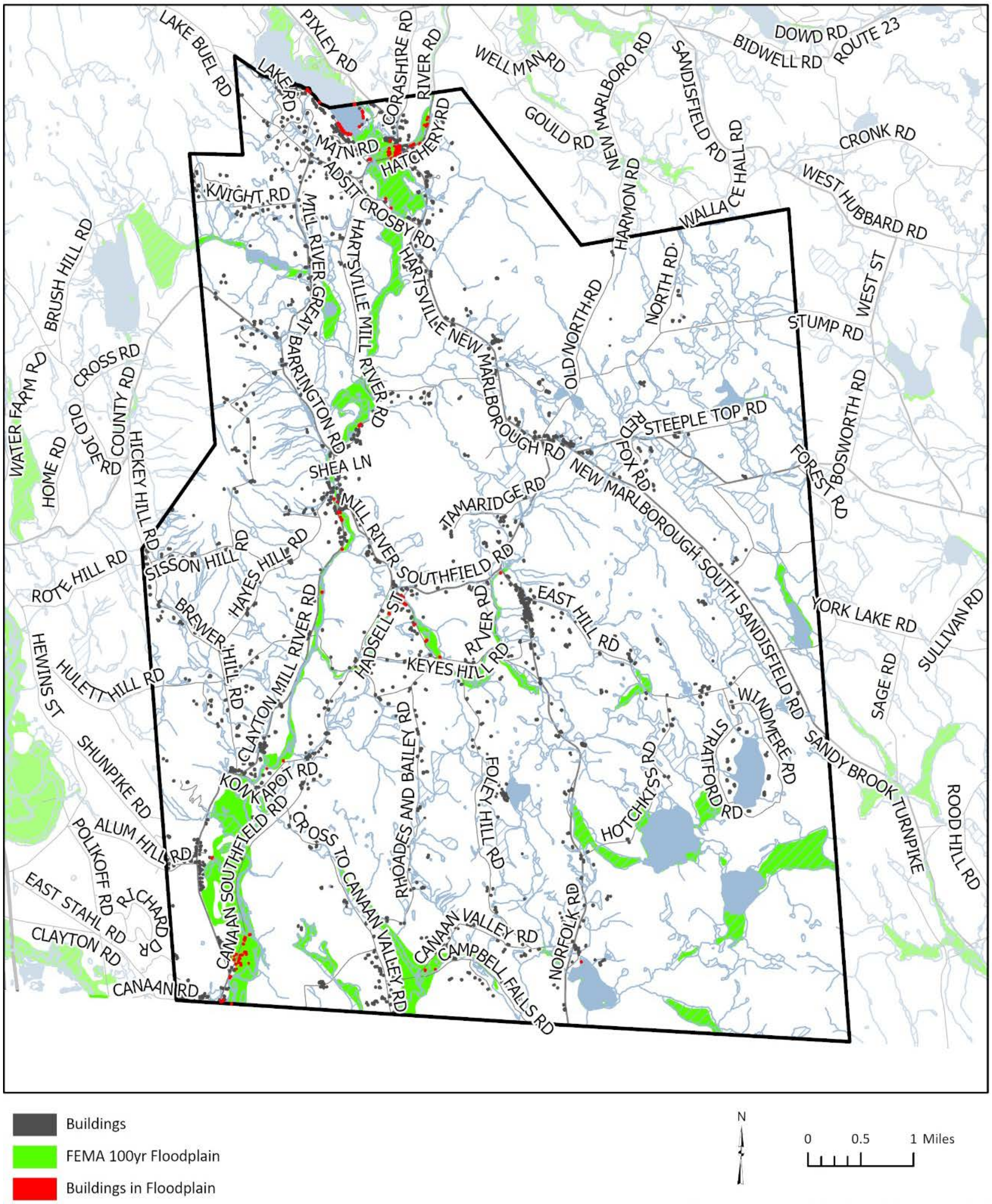
Source: BRPC, 2019.

Table 3.5 New Marlborough Loss Estimate for Properties within the 100-year Floodplain

Residential Property	Residential Contents (50% of property value)	Commercial Property	Commercial Contents (100% of property value)	Mixed Use Property	Mixed Use Contents (75% of property value)	Industrial Property	Industrial Contents (125% of property value)	Total Loss Estimate
$ 20,253,000	$ 10,126,500	$ 17,800	$ 17,800	$ 431,200	$ 323,400	$ 81,000	$ 101,250	$ 31,351,950

Source: BRPC, 2019.

Figure 3.6. Development in New Marlborough in the 100-Year Floodplain



This map was created by the Berkshire Regional Planning Commission and is intended for general planning purposes only. This map shall not be used for engineering, survey, legal, or regulatory purposes. MassGIS, MassDOT, BRPC or the municipality may have supplied portions of this data.

The Town of New Marlborough is enrolled in the National Flood Insurance Program (NFIP). Federal 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. According to data obtained from MEMA from BRPC, there have been a total of 13 flood insurance claims in New Marlborough since 1978, totaling $52,818.16, with 7 of the claims being closed without payment (MEMA, 2017). There are 21 National Flood Insurance Program policy holders (as of 2017).

According to MEMA files, there is one repetitive loss property in New Marlborough, which is a single family home located on Lake Buel. The home is located in the Zone A floodplain. The flood loss on file occurred on August 29, 2011, which was during T.S. Irene, one of the most severe precipitation events to impact Berkshire County in recent history. The totally FIRM payment to the homeowner was for $23, 979 on a home with a building value of $124,892. The property has not been mitigated.

Natural Environment

Flooding has the potential to affect the natural environment in several ways. Flooding can remove trees, other vegetation, rocks and soil causing erosion, high turbidity and the loss of community assets. Severe bank erosion is damaging the land and use of Umpachene Falls Park and possibly impairing the quality of the water in the Umpachene River, which is a cold-water fishery. The Park is losing park land due to severe erosion of the bank. This six-acre, Town-owned park is highly valued by residents for its scenic beauty as well as its recreational opportunities such as swimming, fishing, picnicking, and hiking. During a 2016 public survey, Umpachene Falls was listed most often by respondents as the one single most important scenic or natural resource area in the town.[4] Engineering designs to stabilize the banks have been developed, with a focus on “soft” engineering solutions that include stabilizing the bank, installing coir logs with live stakes, and planting native shrub vegetation to anchor soils. Planting of shrubs will discourage human intrusion on the bank and will encourage park users to access the water using one specific area where native stone steps will be placed. A Notice of Intent, the first step in permitting the project under the state Wetlands Protection Act, has been drafted. Funding to implement the project is needed to implement this action.

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.

Flooding can spread contamination potentially harmful to people, the environment, and wildlife. Hazardous materials containers can be dislodged and damaged, potentially spilling contents into native soils or waterways. In New Marlborough the most likely contaminants to be released during sever flood events would be heating oil, propane and generator fuels, in addition to fuels from vehicles.

Economy

[4] *Town of New Marlborough, 2017. New Marlborough Open Space and Recreation Plan.*

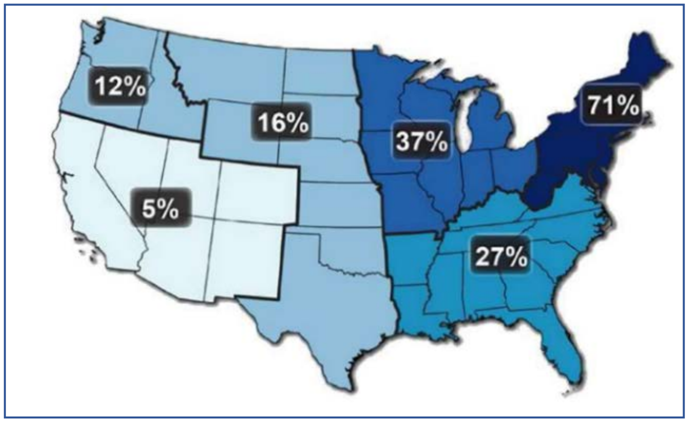
New Marlborough's small business community is particularly vulnerable to the effects of natural hazards and climate change. Farmers' livestock is vulnerable during flooding events, where they may become trapped or isolated during extreme floods or eroded stream channels. Loss of electricity or the road system can lead to disruptions in operations and distribution, particularly for home-based businesses.

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, as well as forest products that provide revenue for local businesses.

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

Figure 3.7 Increase in Precipitation Falling in Top 1% Extreme Precipitation Events 1958-2012 Engineering



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

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.[5] 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.

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. 3.8)[6].

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.

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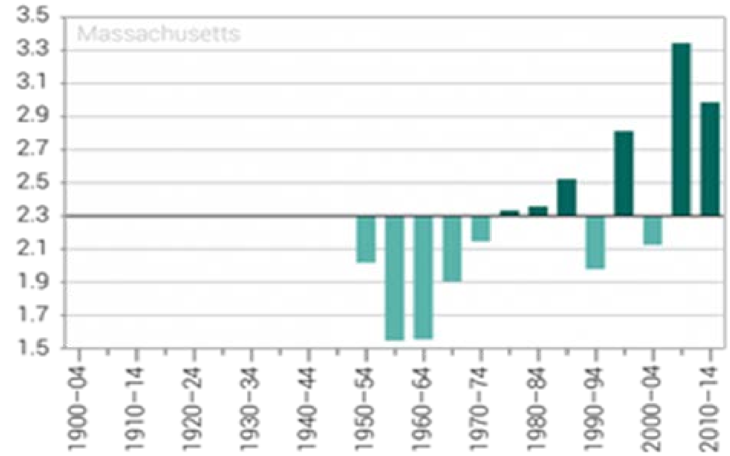
[5] *NOAA - https://toolkit.climate.gov/image/762, adapted from Karl et al.*

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

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.

Figure 3.8: Number of Extreme Precipitation Events of 2" or more in 1 Day



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

Hazard Profile

Severe winter storms in New Marlborough 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 counter-clockwise 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 3.6 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 New Marlborough'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.

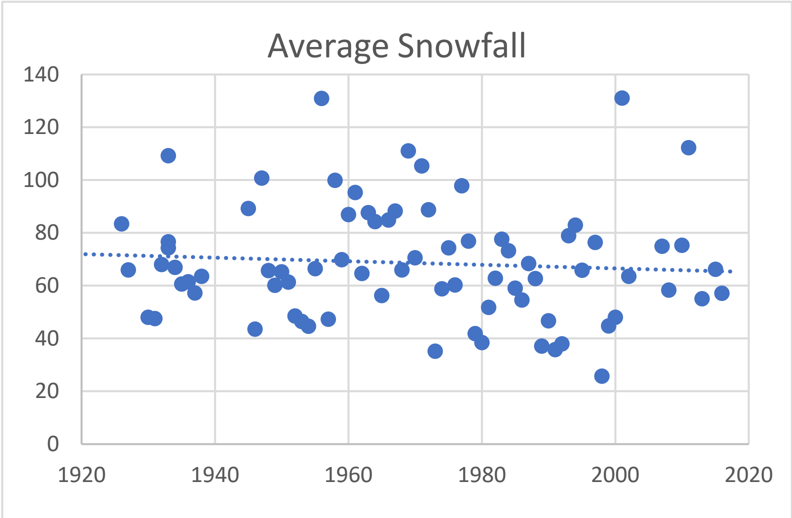
Geographic Areas Likely Impacted

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

Historic Data

Figure 3.9 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 varies each winter,

Figure 3.9: Average Snowfall in Berkshire County



Source: BRPC, 2020.

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 3.7).

Table 3.7: 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 3.8: 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 New Marlborough, 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 with Infrastructure and Systems

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

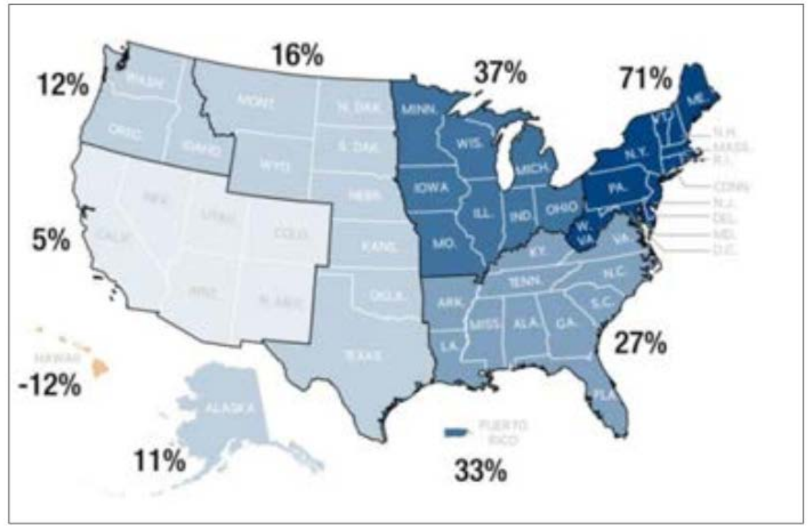
The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain municipal and state financial resources due to the cost of staff overtime, snow removal and wear on equipment. Rescheduling of schools and other municipal programs and meetings can also be costly. The potential 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 3.10, 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 3.10: Observed Changes in Heavy Precipitation



Source: NCA, 2014 as cited in MEMA & EOEEA 2018.

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 New Marlborough. 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 New Marlborough 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 3.9). (MEMA, 2013). The most severe drought occurred during the 1960s, due to both severity and extended duration.

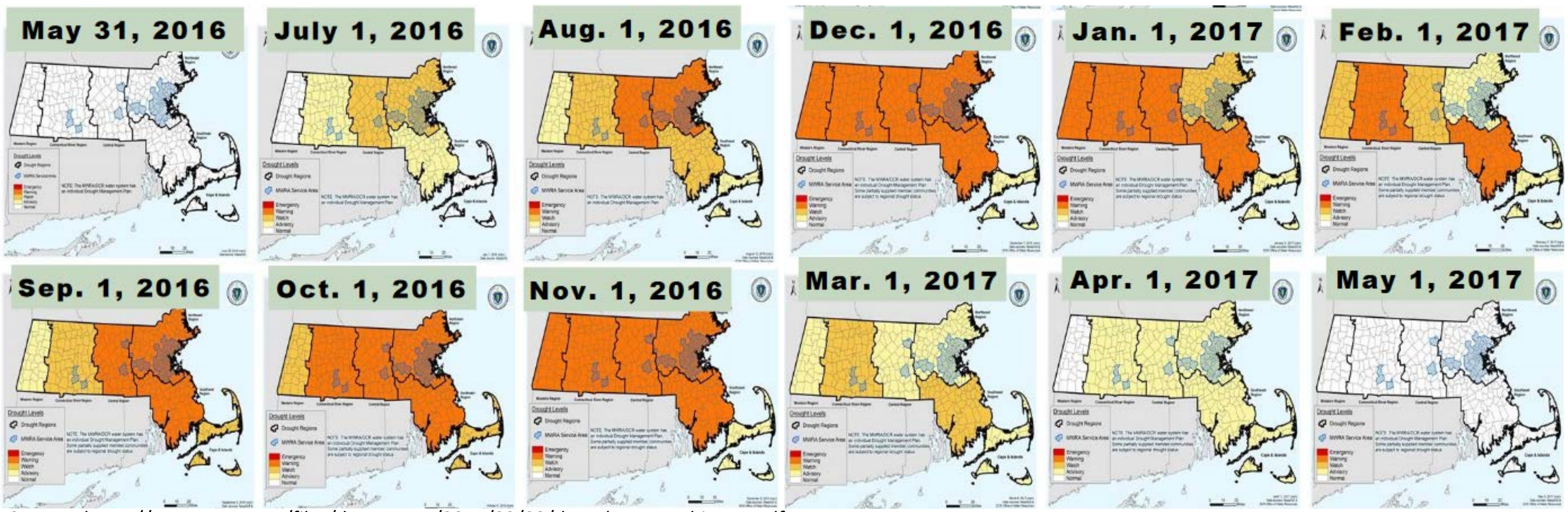
Table 3.9: Estimated Droughts Based on the Mass. Standardized Precipitation Index

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.[7]

Figure 3.11: 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.

[7] *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 New Marlborough is exposed and vulnerable to drought. Most residents in New Marlborough get their drinking water supply through private individual wells. There are two villages that are served by private community water systems, one in Mill River and the other in Southfield. Although the region has experiences dry periods, conditions did not cause wells to go dry on a large scale. Some owners of older or shallow wells have drilled a second, deeper well to alleviate this issue. In general, the Berkshire region has not suffered a severe, Emergency level drought since the 1960s and it is unclear how well the groundwater could meet the demands of residents and businesses during a prolonged drought. given an increased population and changes in precipitation patterns.

Built Environment

Drought does not threaten the physical stability of buildings and critical facilities in the same manner as other hazards such as wind-based or flood-related events. However, if local wells were to go dry on a large, regional wide scale, it would impact the Town's residents to be able to remain in their homes unless large quantities of water were imported. The large influx of seasonal homeowners would increase summer demand on the groundwater supply. Additionally, if drought increased the risk of wildfire then 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.

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
- 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

For drought conditions to occur it is likely that soil moisture will be limited or lacking, forest duff will dried out and standing vegetation will be dry and possibly dead, providing the fuel needed for a wildfire. Given that the Town of New Marlborough if 77% forested, the risk of wildfire during drought conditions is a concern. A more detailed discussion of wildfire and the Town's vulnerability is found in that section of the report.

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 Berkshire Mountain Spring Water company is a private business that draws and bottles groundwater in the village of Southfield. An extended drought could impact the company's ability to continue to operate. In more general terms 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. Although the impacts can be numerous and significant, dollar damage estimates are not tracked or available at this time (MEMA & EOEEA, 2018).

Future Conditions

Changes in winter temperatures will lead to less snow pack 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. A continued increase in seasonal residents will continue to create a heavier demand for groundwater, especially during the peak spring-fall months of the year.

Hazard Profile

Likely severity

Considering the higher elevation and cooling effects of forest cover, New Marlborough does have an average colder climate when compared to the central and eastern part of Massachusetts. The environment and local residents have adapted to these conditions, but extreme temperatures still pose a risk. The lack of many extreme heat events has left most residents unprepared. Air conditioning is becoming more common for most homes, but some low income or older residents may still rely on portable fans for cooling.

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.

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.

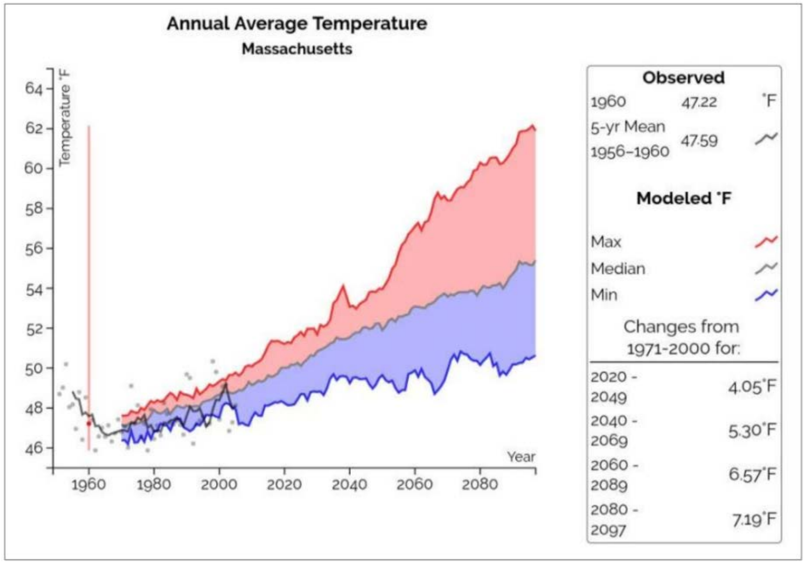
A heat wave is defined as 3 or more days of temperatures of 90°F or above. A basic definition of a heat wave implies that it is an extended period of unusually high atmosphere-related heat stress, which causes temporary modifications in lifestyle and which may have adverse health consequences for the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

Probability

Massachusetts has averaged 2.4 declared cold weather events and 0.8 extreme cold weather events annually between January 2013 and October 2017. The year 2015 was a particularly notable one, with seven cold weather events, including three extreme cold/wind chill events, as compared to no cold weather events in 2012 and one in 2013.

The change in average temperatures has already affected the Town of New Marlborough. Figure 3.12 shows the projected annual average temperature, increasing through the next century.

Figure 3.12: Projected Annual Average Temperature



Source: Resilient MA, 2018.

Geographic Areas Likely Impacted

For the purposes of this Plan, the entire population of the New Marlborough is considered to be exposed to extreme temperatures. Extreme temperature events occur more frequently and vary more in the inland regions where temperatures are not moderated by the Atlantic Ocean. According to NOAA, the annual average temperatures in the Western Division of Massachusetts, encompassing the Town of New Marlborough, are around 46°F.

Historic Data

The following are some of the lowest temperatures recorded in the Berkshire region for the period from 1895 to present. (National Climatic Data Center, 2017)

- Lanesborough, MA –28°F
- Great Barrington, MA –27°F
- Stockbridge, MA –24°F
- Pittsfield, MA -19°F

Extreme heat temperatures are those that are 10°F or more above the average high temperature for the region and last for several hours. The following are some of the highest temperatures recorded for the period from 1895 to present, showing Boston and three Berkshire County locations. (National Climatic Data Center, 2017)

- Boston, MA 102°F
- Great Barrington, MA 99°F
- Adams, MA 95°F
- Pittsfield, MA 95°F

It should be noted that 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°-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.

Vulnerability Assessment

People

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.). Berkshire County has some of the highest rates of emergency room visits due to asthma-related illness in the state, due to several environmental and social factors. Particulate and fossil fuel emissions may also accompany hot weather, as the prevailing western winds that bring heat waves to the region may carry pollution from other areas of the more industrialized mid-west. Poor air quality can negatively affect respiratory and cardiovascular systems and can exacerbate the region's already high asthma and trigger heart attack rates.

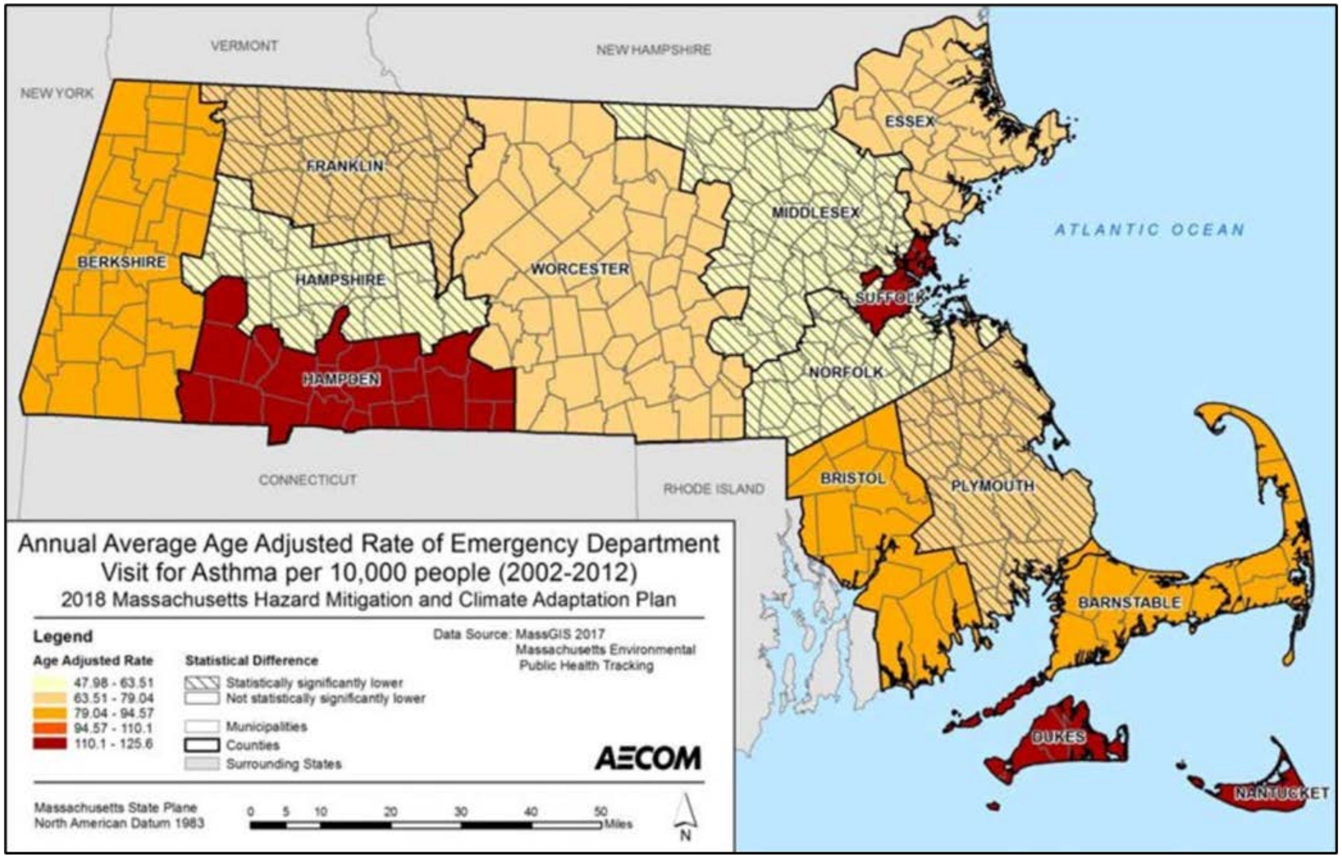


Figure 3.13: Rates of Emergency Department Visits Due to Asthma by County

Built Environment

All elements of the built environment are exposed to the extreme temperature hazard, including state-owned critical facilities. The regional electric grid system will be strained during heat waves, as residents and businesses increase the use of air conditioning. Brown-outs or spotty power outages can injure or kill vulnerable populations who cannot withstand extreme heat. 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 (Resilient MA, 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).

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, streams and ponds drying up with associated fish kills, and wetlands drying out (MCCS and DFW, 2010). 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 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). Additional impacts of warming temperatures include the increased survival and grazing damage of white-tailed deer, while it will decrease or eliminate presence of moose. Increased invasion rates of invasive plants, and increased survival and productivity of insect pests, which cause damage to forests is expected (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

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 new or more widespread invasive species.

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. Historically, Berkshire homeowners have relied on opening their windows in the evening to let the cooler overnight air clear out the heat of the day. The fresh night air brought interior temperatures down to more comfortable level before the heat of the next day began. However, as overnight temperatures have risen, homeowners without air conditioning are finding it more difficult to bring down interior temperatures overnight, and homes become increasingly hotter each day as heat waves progress. For this segment of the population, cooling centers will become vital, especially for vulnerable populations such the elderly. Cooling centers with backup power generation will be critical if a prolonged power outage occurs during a heat wave.

Fortunately, 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

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

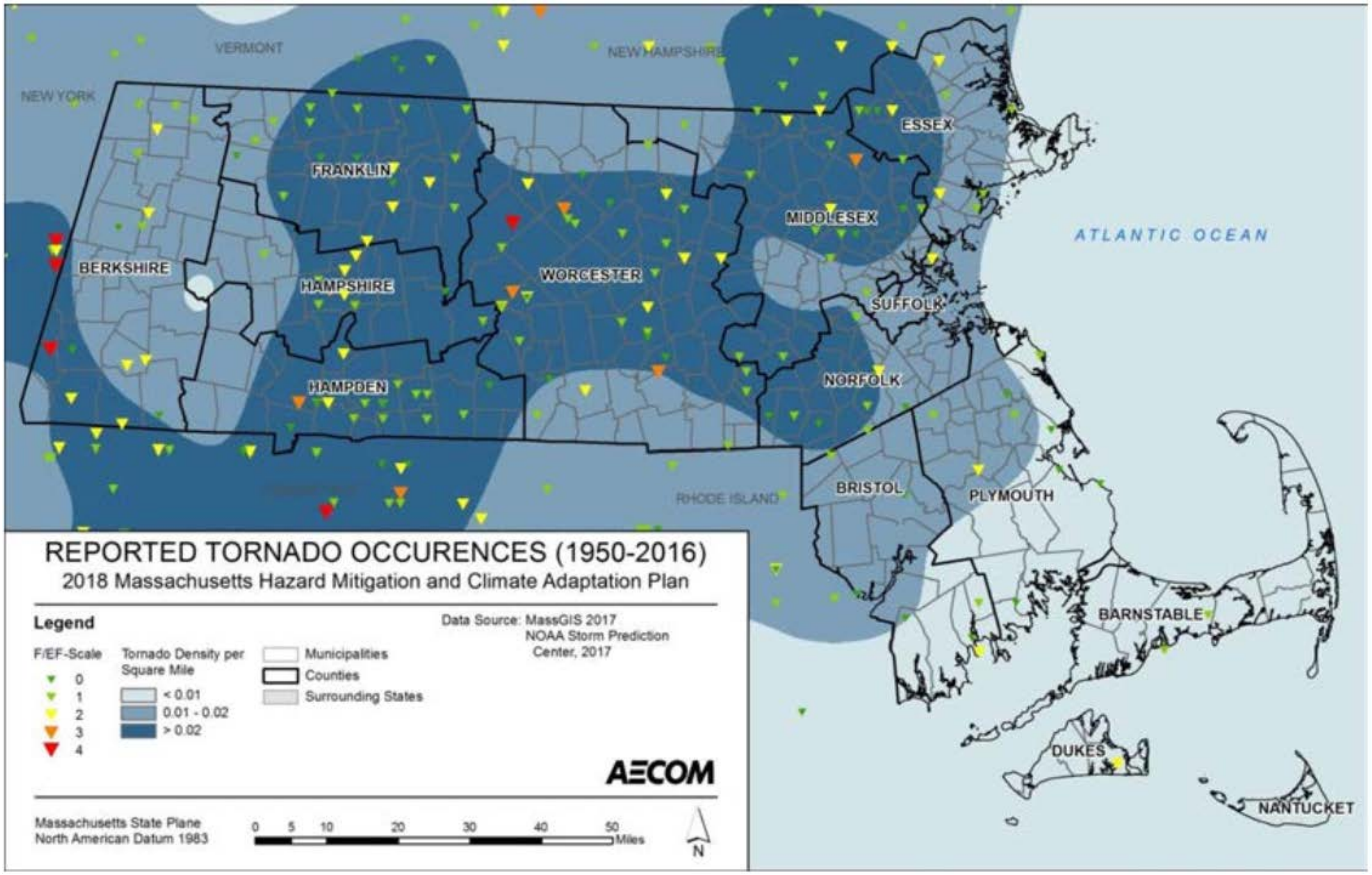
The location of tornado impact is totally unpredictable. Tornadoes are fierce phenomena which generate wind funnels of up to 200 MPH or more, and occur in Massachusetts usually during June, July, and August. Worcester County, and areas just to its west have been dubbed the "tornado alley" of the state, 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 New Marlborough is susceptible. Figure 3.14 shows tornadoes reported in Massachusetts.

Fig. 3.14: 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. Most tornados occur in the late afternoon and evening hours, when the heating is the greatest. In Berkshire County the majority of tornados occur in the month of July and to a lesser degree in August, but tornadoes have it the county as early as March (in Adams in 1966) and as late as October (in Cheshire in 1963). (MEMA, 2013).

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. 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 – they lie scattered on the hillside like matchsticks. Although New Marlborough itself has not experienced a tornado, it has experienced small spotty microbursts that felled groups of 10 trees at a time, most recently in August 2020. The neighboring Town of Monterey has experienced several small tornado touch downs, blocking roadways and bringing down power lines. One of these blocked Route 57 into New Marlborough for a time.

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 (MEMA & EOEEA, 2018). 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 (EPA, 2015). 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 two 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). Mutual aid will increasingly be important to aid local first responders and public works crews to open and maintain emergency routes for transporting injured people, restoring downed power and moving heavy equipment.

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 New Marlborough 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

For the purposes of this HMCAP, 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.

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). The results of this study are shown in Figure 3.15.

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. However, 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 3.15 shows the area in New Marlborough that are at risk of landslide. The legend explaining the categories of risk are on the following page.

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 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).

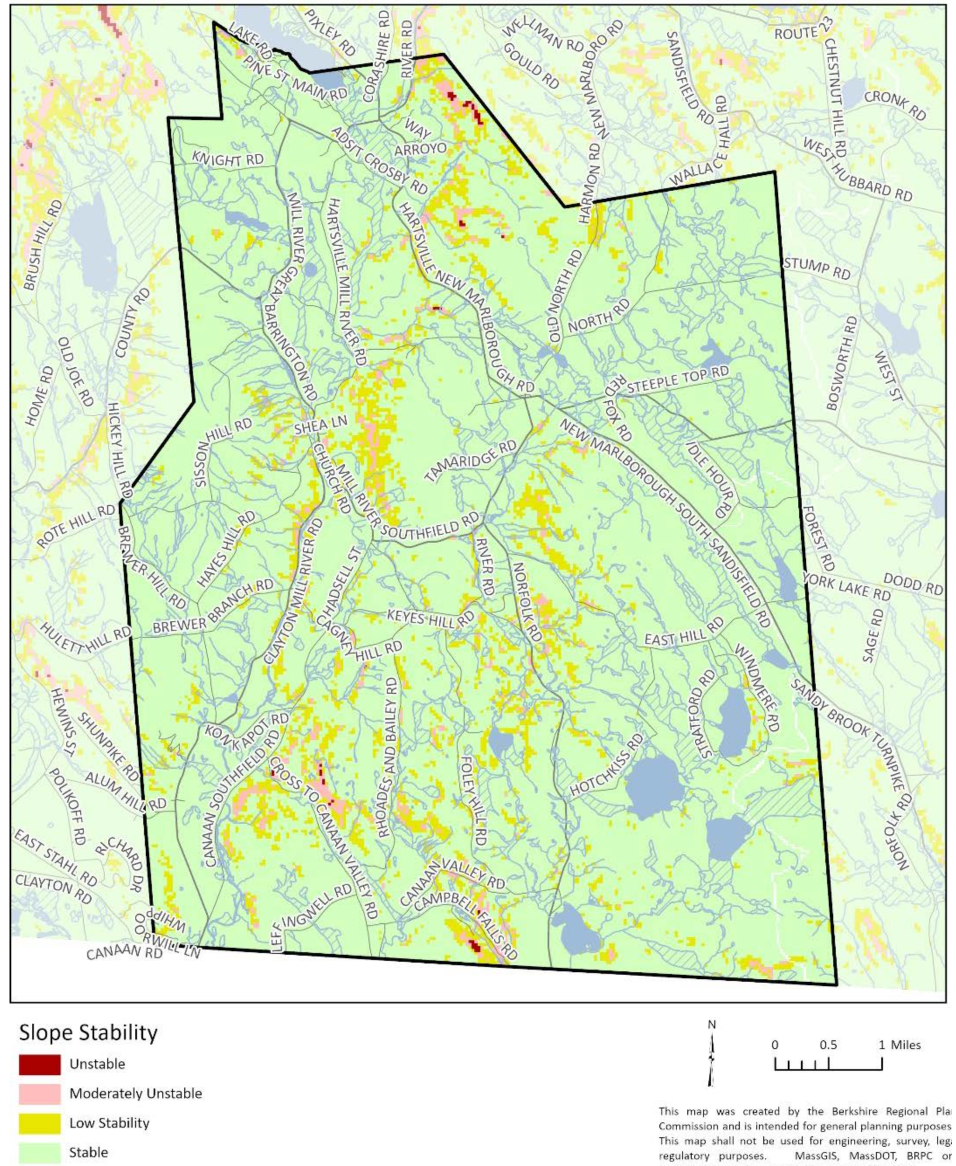
Despite New Marlborough's rolling and sometimes mountainous terrain, few areas in the Town are categorized as Unstable or Moderately Unstable. Those areas determined by computer model to be at greatest risk are shown on the map as red pixels. Comparing the current landslide map against the Land Development Trends map from the 2010 New Marlborough Comprehensive Plan, which shows the locations of individual structures, it appears that only one structure is located within an area of Unstable sloped land.

Table 3.10. New Marlborough Slope Stability Category and Acres

Slope Stability Category	Acres	Percent of Total
Unstable	24	0%
Moderately Unstable	512	2%
Low Stability	2,426	8%
Stable	27,609	90%

Source: MassGIS, BRPC 2020.

Figure 3.15: Slope Stability Map (explanation of terms on following page)



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

[1]**Relative Slide Ranking—**This column designates the relative hazard ranking for the initiation of shallow slides on unmodified slopes.

[2]**Stability Index Range—**The stability index is a numerical representation of the relative hazard for shallow translational slope movement initiation based on the factors of safety computed at each point on a 9-meter (~30-foot) digital elevation model grid derived from the National Elevation Dataset. The stability index is a dimensionless number based on factors of safety generated by SINMAP that indicates the probability that a location is stable, considering the most and least favorable parameters for stability input into the model. The breaks in the ranges of values for the stability index categories are the default values recommended by the program developers.

[3]**Factors of Safety—**The factor of safety is a dimensionless number computed by SINMAP using a modified version of the infinite slope equation that represents the ratio of the stabilizing forces that resist slope movement to destabilizing forces that drive slope movement (Pack et al., 2001 as cited in MEMA & EOEEA, 2018). A FS>1 indicates a stable slope, a FS<1 indicates an unstable slope, and a FS=1 indicates the marginally stable situation where the resisting forces and driving forces are in balance.

[4]**Probability of Instability—**This column shows the likelihood that the factor of safety computed within this map unit is less than one (FS<1, i.e., unstable) given the range of parameters used in the analysis. For example, a <50% probability of instability means that a location is more likely to be stable than unstable given the range of parameters used in the analysis.

[5]**Possible Influence of Stabilizing and Destabilizing Factors—**Stabilizing factors include increased soil strength, root strength, or improved drainage. Destabilizing factors include increased wetness or loading, or loss of root strength (Massachusetts Geologic Survey and UMass Amherst, 2013; Pack et al., 2001 as cited in 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

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 New Marlborough may lead to a higher likelihood for landslides as soil and vegetative cover are impacted. Overall New Marlborough is at low risk of landslide, however further development of unstable slopes could prove to be detrimental.

Wildfires

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

The Town of New Marlborough has an all-volunteer fire department, with Mutual Aid Agreements with neighboring communities. In the event of a significant forest fire, DCR's Bureau of Forest Fire Control and Forestry would also become involved. The travel time to remote areas of New Marlborough could allow the fire to grow in severity if local and state fire fighting equipment cannot readily access the site. If the fire occurs at a time that gravel/unpaved roads are impassible to fire fighting and other emergency vehicles, it would hinder response.

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.

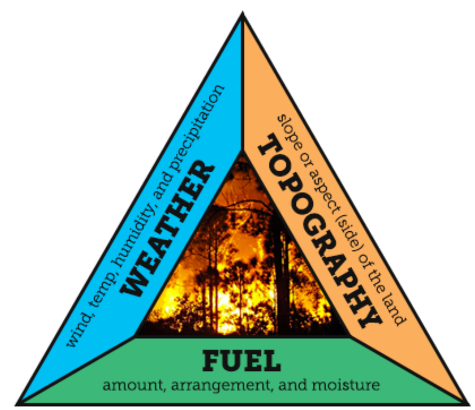
Fuel:

−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.

Fig. 3.16. Fire Behavior Triangle



Source: https://learn.weatherstem.com/modules/learn/lessons/121/12.html

−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.
−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, interested parties should anticipate at least one notable wildfire in the Commonwealth each year, narrowing down the probably of New Marlborough being affected even lower.

Geographic Areas Likely Impacted

Most of the land in New Marlborough is vulnerable to wildfire. Fire risk and associated damages increases where there is a mix of development and forested land. The heavily forested landscape of the Town and the scattered pattern of development increase the risk. Also, there are no fire hydrant systems in the town. Given increasing temperature and evaporation, drought and forest fire concerns are growing. Human visitation such as hiking and camping, increase risk of fire, especially if campfires are built. One of the largest brush fires to have burned in Berkshire County, in Clarksburg State Forest in 2015, is suspected to have started with an Appalachian Trail hiker's campfire[8].

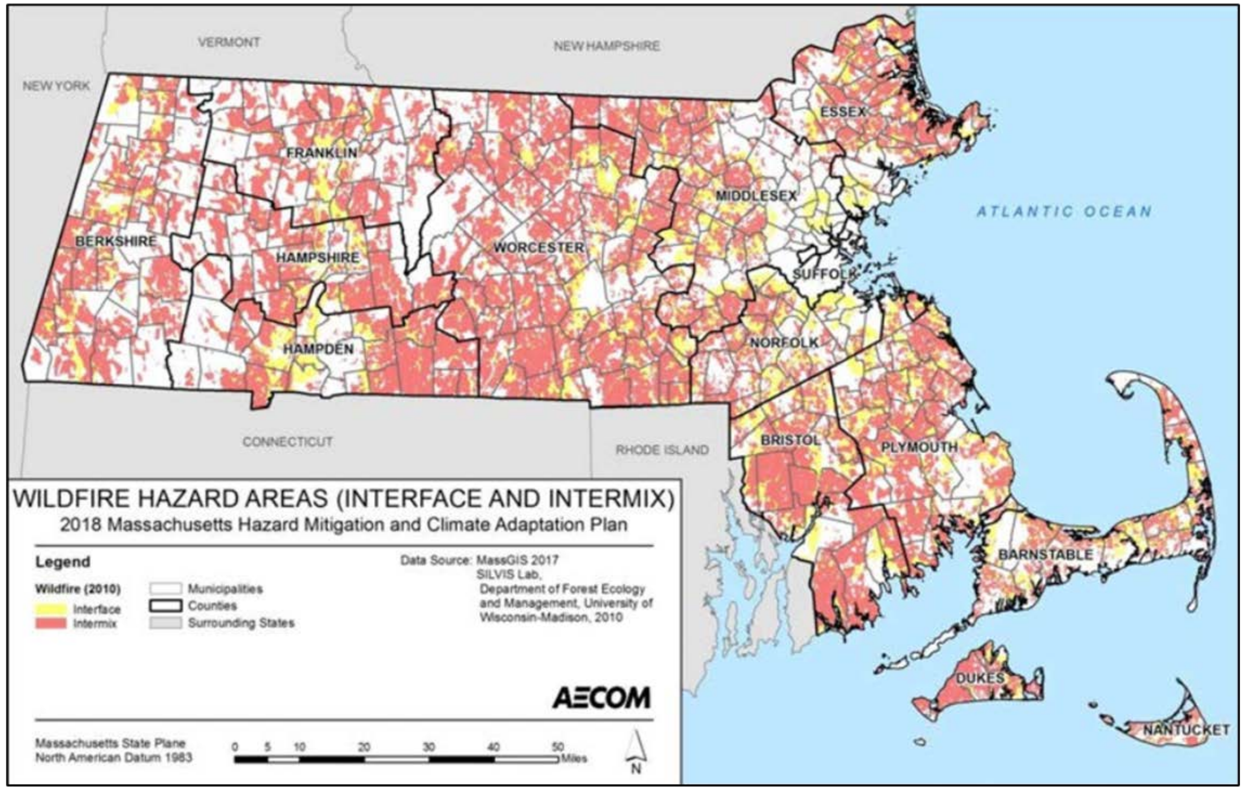
The ecosystems in Massachusetts that are most susceptible to the wildfire hazard are pitch pine, scrub oak, and oak forests, as these areas contain the most flammable vegetative fuels. New Marlborough does not host pitch pine or scrub oak plant communities. The town's evergreen forest canopy consists primarily of white pine, hemlock, balsam fir, and above 1,200-foot elevation, red spruce. The deciduous components are mainly sugar maple, yellow and black birch, red oak, black cherry, hickory, beech, and white ash. However, local officials have noted and been told by local woodlot owners that the ash trees are on the decline and dying. As a result, many woodlot owners are harvesting ash. Aspens and paper birches are also common, primarily along roads and field edges. Relatively pure stands of hemlock dominate the north-facing slopes and higher elevations. Mixed evergreen/deciduous forest increase as one moves into lower elevations. The distributions of forest types can be reviewed by referring to the Land Use Map, Fig. 3.1 of this Plan. The understory is generally sparse and consists primarily of striped maple, witch hazel, ironwood, and mountain laurel. The herbaceous layer, too, is rather sparse, especially when hemlock, spruce, and pine are abundant. There are post-agricultural fields in New Marlborough currently undergoing the process of secondary succession. This land has not been tilled for

[8] *https://www.berkshireeagle.com/stories/clarksburg-state-forest-brush-fire-successfully-knocked-down,326542#top-carousel*

many years or may have been mowed occasionally, but more typically woody perennial species like birches, aspens, dogwood, elderberry, and multiflora rose and larger herbaceous vegetation such as thistle, goldenrod and ragweed have taken over.

Wildfire risk is greater where development meets the forest edge. 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 a housing density greater than one house per 6.5 acres with more than 50 percent vegetation. 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 202 acres that is more than 75 percent vegetated.

Figure 3.17: Wildland-Urban Interface and Intermix for the Commonwealth of Massachusetts



Source: MA SHMACP, 2018.

The Northeast Wildfire Risk Assessment Geospatial Work Group completed a geospatial analysis of fire risk in the 20-state U.S. Forest Service Northeastern Area. The assessment is comprised of three components—fuels, wildland-urban interface, and topography (slope and aspect)—that are combined using a weighted overlay to identify wildfire-prone areas where hazard mitigation practices would be most effective. Figure 3.17 illustrates the areas identified for the Commonwealth.[9] As seen in Fig. 3.18, the western portion of the Town and the adjacent southern portion of Monterey and eastern portion of Sheffield is categorized as Intermix Wildfire Hazard Areas.

[9] MA SHMCAP, 2018.

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

Potential losses from wildfire include human health and the lives of residents and responders. It should be assumed that the entire population of New Marlborough is vulnerable to wildfire due to the fact that most homes are surrounded by forest and there are no fire hydrant systems in the Town. Residents who live on dead-end roads could be at greater risk during wildfire if fire or fallen debris blocked the only evacuation/fire response route.

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. 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 Berkshire County, 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, with first responders 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 New Marlborough 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, an unnatural, accelerated build-up of branches and other dry materials on the forest floor from whole stands of trees being damaged or killed by ice storms or die-offs due to pest infestations (e.g. Emerald Ash Borer, Hemlock Woolly Adelgid, etc.) can increase the risk of fire, particularly in dry seasons or periods of drought.

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). Wildfires cause both short-term and long-term economic 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). Timber harvesting is important to farming and woodlot landowners, while loss of aesthetic value could impact the Town’s appeal to seasonal homeowners, an important tax base.

Future Conditions

While climate change is unlikely to change topography, it can 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. Rainstorms in the Berkshires often falls 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).

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).

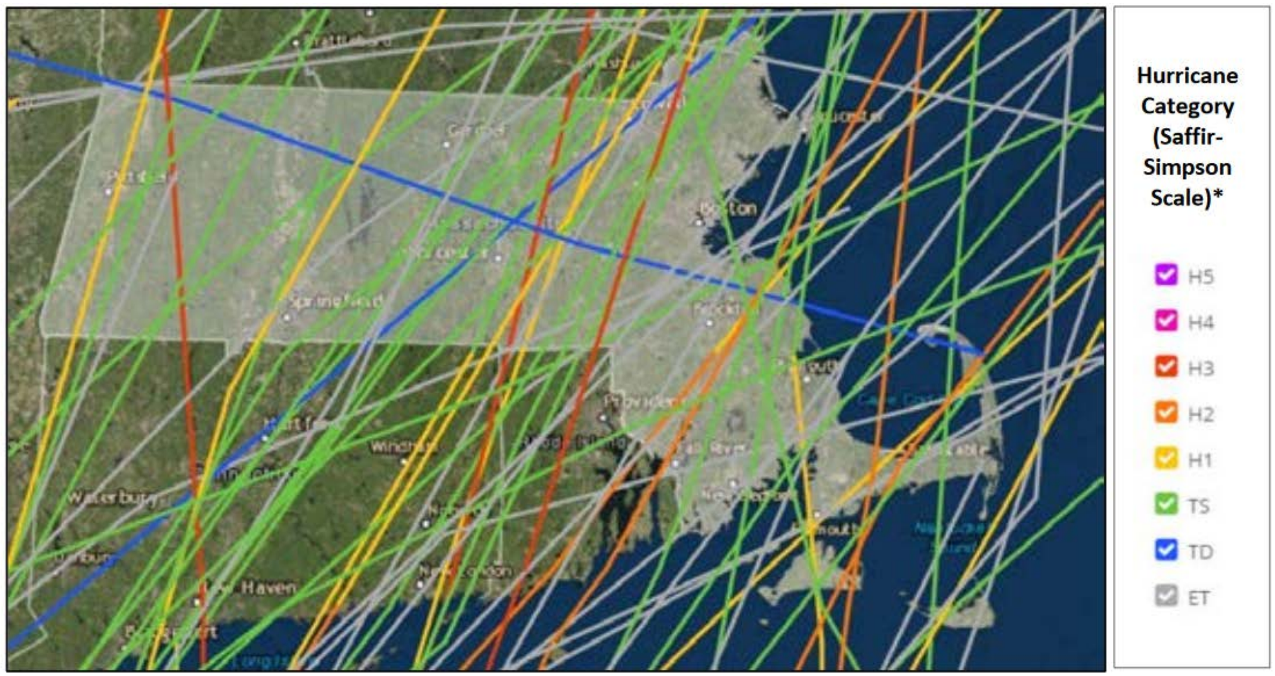
The severity of a hurricane is categorized by the Saffir-Simpson Hurricane Scale. This scale categorizes or rates hurricanes from 1 (Minimal) to 5 (Catastrophic) based on their intensity. This is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane 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 3.18: 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, as depicted on the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) maps. 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 3.18. The graphic shoes tracks that have cut through New Marlborough.

Historic Data

The National Oceanic and Atmospheric Administration (NOAA) has been keeping records of hurricanes since 1842 (Table 3.11). 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 3.11: 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

Source: NOAA, 2018.

The Great Hurricane of 1938 remains one of the most memorable historic storms, with almost seven inches of rain falling over a three-day period. The flooding from the Hoosic River caused severe damages in the northern Berkshire communities of Adams and North Adams. According to an *iBerkshires* news article highlighting the damages, two deaths occurred, many other people were injured, and 300 people were left homeless. The West Shaft Road bridge in North Adams was lost, as was the Wally Bridge in Williamstown. The damages from this storm, following devastating flooding and damages from events in 1901, 1922, 1927 and 1936, and combined with that from a severe rain event in 1948, led to the construction of the flood control chutes on the Hoosic River in Adams and North Adams.

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)

Locally, TS Irene (DR-4028-MA) is the most memorable storm event in recent history due to the flooding that occurred in northern Berkshire and Franklin Counties in Massachusetts, and in southern Vermont. In Williamstown 225 mobile home households, many elderly and low income, permanently lost their homes in the Spruces Mobile Home Park. Extensive flooding in the Deerfield River watershed caused, among other damages, the closing of Route 2 in Florida/Charlemont (due to collapse of the road and a landslide) and damages to structures in Shelburne Falls.

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.

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. Due to wind-related damages from downed tree 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. For the purposes of New Marlborough's HMCAP, these events include high winds and thunderstorms. The Town of New Marlborough 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 3.12.

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 3.12: 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

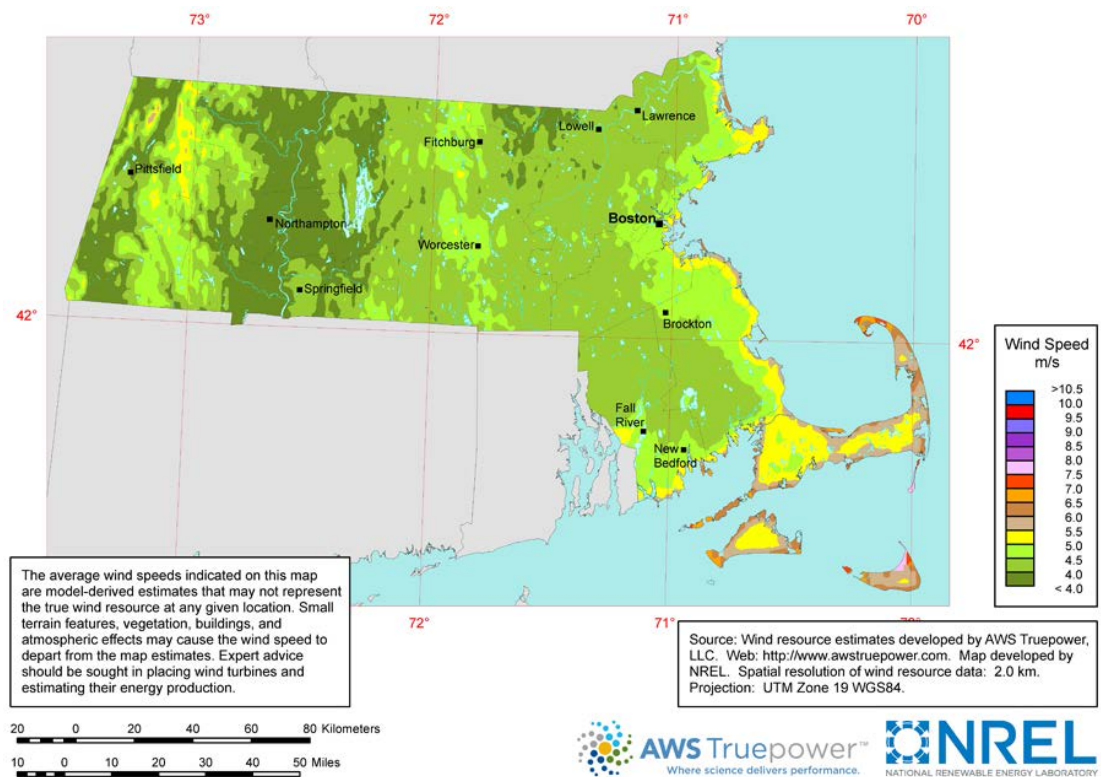
High Winds

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 3.19: Massachusetts Average Annual Wind Speed at 30 m



Geographic Areas Likely Impacted

High Winds

The entire Town of New Marlborough is vulnerable to high winds that can cause extensive damage. While Fig. 3.20 indicates that average wind speeds in New Marlborough near 100 feet above ground level tend to be less than 10 miles per hour (4.5 m/s), wind gusts of much greater than this are common during storm events.

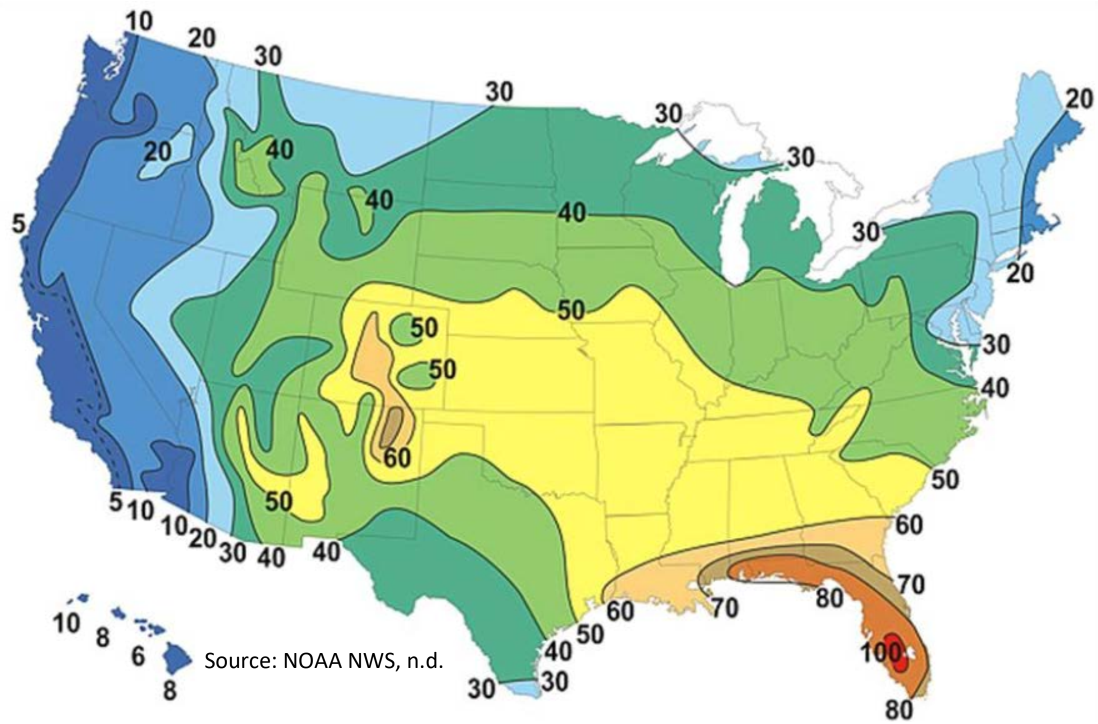
Thunderstorms

Even more so than high wind, thunderstorms have the potential of impacting all of New Marlborough. The low mountainous/valley terrain can capture warm air pockets from prevailing westward winds, causing the Berkshires to experience more thunderstorms that its neighbors in the Hudson or Connecticut Valleys. Microbursts associated with thunderstorms can and do also occur in spots across the county.

Historic Data

It is difficult to define the number of other severe weather events experienced by New Marlborough each year. Figure 3.20 shows number of annual thunderstorm days across the United States. Massachusetts experiences 20 to 30 thunderstorm days each year.

Fig. 3.20: 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 (SHMCAP, 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 are discussed in depth in Section 4.1.1 and 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

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.

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).

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 New Marlborough in the future.

Hazard Profile

Likely Severity

The Town of New Marlborough chose to examine the hazard of both plant and animal invasive species. 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).

The damage rendered by invasive species can be 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. The continued propagation and selling of invasive plant species remains a concern, despite the Commonwealth's efforts to regulate the nursery trade and outlaw several species of trees, shrubs, forbs and flowers. Additionally, invasive species continue to be dispersed by movement of native bird and animals, and by people who hike, bike and drive through natural areas. Aquatic invasive species are spread by watercraft that move from one infected waterway to another. The increased visitation by tourists to the Berkshire's natural resources areas, particularly southern Berkshire communities like New Marlborough, increases the risk of spreading existing invasive species populations and possibly importing more invasive species.

Geographic Areas Likely Impacted

All the lakes and ponds in New Marlborough are at risk of infestation from several species of invasive aquatic plant species. Fragments of invasive plants can easily be transported from one waterbody to other waterbodies if fragments of plants are attached boats, paddles, trailers or other equipment that come into contact with the water. The waterbodies in the Berkshire regional are popular with boaters and anglers from throughout the Northeast and beyond, making New Marlborough's waterbodies vulnerable to invasive species. According to the Department of Conservation and Recreation Lakes and Ponds Program, the aquatic plant species most prevalent in the Berkshire County region are:

- Eurasian Milfoil
- Fanwort
- Curly-leaved Pondweed
- Water Chestnut
- European Naiad
- Purple Loosestrife
- Common Reed

Because of their ability to produce large volumes of plant material, they can deplete dissolved oxygen levels when they die off in huge masses, impairing or killing fish and other aquatic animal species. Dense mats of plants can clog culverts and other drainage infrastructure. Invasive species can also have significant and lasting impacts on aquatic habitat, property values and recreational use, including:

- Degradation of water quality.
- Degradation of wildlife habitat, reducing diversity of native plants and animals and possibly causing local and complete extinction of rare and endangered species.
- Declines in fin and shellfish populations.
- Impairment of recreational uses such as swimming, boating, and fishing.
- Increased threats to public health and safety.
- Diminished property values.

Freshwater Zebra mussels, already found in Laurel Lake and in the Housatonic River in Lee, are a species of upmost concern. They can proliferate at an alarming rate and due to their small size can readily be transported undetected by attaching to boating and equipment. The young free swimming microscopic larvae can easily be transported unintentionally in cooling water, bait buckets, live well water and on other equipment that may have come in contact with infested water.

Lake Buel is heavily infested with Eurasian watermilfoil, and Thousand Acre Pond is also infested. The ongoing proliferation of this species damages the ecosystems of these waterbodies, impairs their use for recreational purposes and reduces property values. The environmental degradation, loss of recreational use have been cited as important issues from residents of both New Marlborough and Monterey throughout the MVP and Hazard Mitigation planning processes of both Towns.

The forest communities all across New Marlborough are at risk of invasive pests that could damage or eliminate whole stands of forest tree species. 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.

The Emerald Ash Borer was first discovered in Massachusetts in the Berkshire County town of Dalton. The Emerald Ash Borer can kill ash trees quickly by drilling holes through the trunks. Although the Asian Longhorn Beetle has not yet been detected in the Berkshires, efforts to monitor and eradicate pioneering individuals must be undertaken to avoid the damage and loss of trees. This pest is particularly a threat because it is known to attach several tree species. Insect species can be easily transported into or out of the infested areas through movement of firewood or logs.

Table 3.13: Invasive and Nuisance Insects with Potential Threat to New Marlborough 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 being monitored across the state. Needlecast has been identified to be caused by multiple fungal pathogens; the most prevalent agent in Mass. is Lecanosticta acicola.

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

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. Several terrestrial and aquatic invasive species have been introduced throughout the Berkshires, including New Marlborough.

Fig. 3.21. 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 CO_2 levels could increase some organisms' photosynthetic rates, improving their competitive advantage.
- 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).

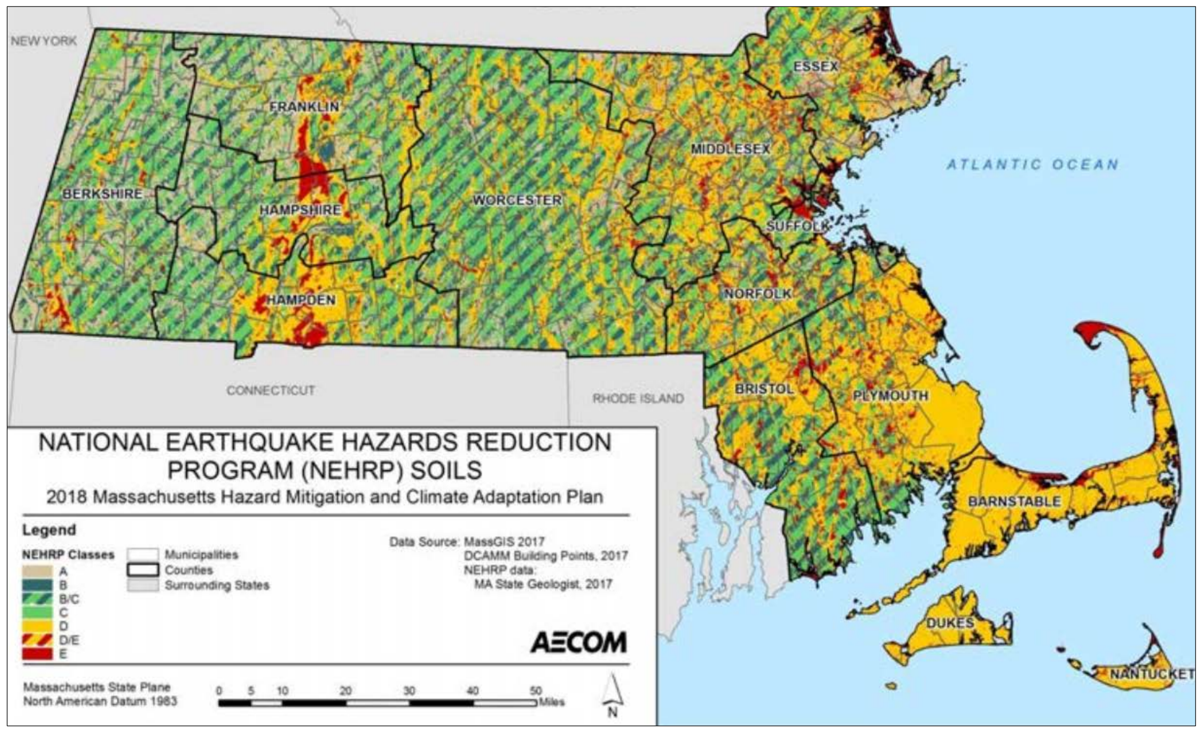
Invasive species can trigger a wide-ranging cascade of lost ecosystem services. Additionally, they can reduce the resilience of ecosystems to future hazards by placing a constant stress on the system (MEMA & EOEEA, 2018).

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 New Marlborough (MEMA & EOEEA, 2018).

Likely severity

Figure 3.22: NEHRP Soil Types in Massachusetts



Sources: Mabee and Duncan, 2017; Preliminary NEHRP Soil Classification Map of Massachusetts

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 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). New Marlborough does not have the higher risk E soils.

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 New Marlborough 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).

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 3.14 shows the number of injuries and casualties expected for events of varying severity, occurring at various times of the day.

Table 3.14: 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 in the New Marlborough Hazard Mitigation and Climate Adaptation Plan, 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 3.15.

Table 3.15: 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 3.16: 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 3.16. The hazards pertain to potential loss of human life or property damage in the event of failure or improper operation of the dam or appurtenant works. 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 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

The Massachusetts Office of Dam Safety lists ten dams in the New Marlborough. The only dam that that has a Significant classification for hazard is that of York Pond Lake, the outlet of which flows not into New Marlborough but into neighboring Sandisfield and into Connecticut. There are two dams that are in poor condition, Gleason Pond Dam and Trout Pond Dam, but both are classified as a low hazard (Office of Dam Safety, 2004). Given these dams, the town considers itself to be of low risk for dam failure.

Table 3.17: Dam Hazard Status for New Marlborough

Name	Location	Hazard Code	Size Class	Inspection Condition	Other Info.
Cookson Pond (Hay Meadow)	Hay Meadow Pond off Norfolk Road	Low	Intermediate	Good	
Gleason Pond Dam	Between Knight Road and County Road	Low	Unknown	Poor	Non-Jurisdictional
Harnett Pond Dam	Harnett Pond off Steepletop Road	Low	Intermediate	Fair	
Poulson Pond Dam	Off Norfolk Road by River Road	Low		Good	Non-Jurisdictional
Rosenstein Pond Dam	Rosenstein Pond off Clayton Mill River Road	Low	Small	Fair	
Thousand Acre Site #1 Dam	Thousand Acre Lake off Hotchkiss Road	Low	Intermediate	Good	
Trout Pond Dam	Harmon Brook off North Road (formerly New Marlborough Monterey Road)	Low	Small	Poor	
Trout Pond Dam	Harmon Brook off New Marlborough Sandisfield Road	Low			Non-Jurisdictional
Windemere Lake Dam	Windmere Lake off East Hill Road	Low	Intermediate	Good	
York Lake Dam	York Pond off East Hill Road	Significant	Intermediate	Good	

Source: MA Office of Dam Safety, 2004.

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. Only one dam in the county is known to have failed and caused damages, that being the Plunkett Lake dam in Hinsdale (BRPC, 2012)

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.

CHAPTER 4: MITIGATION STRATEGY

44 CFR § 201.6(c)(3)

The Mitigation Strategy lays out how the Town of New Marlborough intends to reduce losses identified in the Risk Assessment section of this Plan. The goals and objectives of New Marlborough guide the selection of actions to mitigate and reduce potential losses. A prioritized list of cost-effective, environmentally sound, and technically feasible mitigation actions are the product of reviewing benefits and costs of each proposed project.

Existing Protections

The Town of New Marlborough is fortunate in having natural mitigative infrastructure in the contiguous forests and wetland resources that dominate the landscape. New Marlborough'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. 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[10]. As such, partnering with state and local conservation organizations to protect and maintain the hazard mitigation functions of the Town's natural landscape is a key component in overall efforts to reduce the impacts of natural hazards and disasters on the Town's people, property and wildlife habitats.

New Marlborough is a member of the National Flood Insurance Program (NFIP). The Town's FIRM map dates from 1981, which is the same year that the Town joined the NFIP. However, the Town has not adopted a zoning bylaw that would prohibit or limit with conditions development in the 100-year floodplain. Most other towns in Berkshire County have adopted floodplain bylaws, usually as overlay districts. The Town could look to one of its neighbors for bylaw examples that could be adapted to meet the needs of New Marlborough. Neighboring Sheffield has a floodplain zoning bylaw that requires that anyone who proposes new construction "*involving or requiring the erection of new structures and/or alteration or moving of existing structures or dumping, filling, transfer, relocation or excavation of earth materials or storage of materials or equipment shall submit an application for a special permit to the Planning Board, who shall serve as the SPGA for this section, in accordance with the provisions of Section 9.4. Such application shall describe in detail the proposed use of the property and the work to be performed and shall be accompanied by plans as specified therein. In addition to the information required thereby, such plans shall also include boundaries and dimensions of the lot, existing and proposed drainage easements, all existing and proposed fill, existing and proposed sewage disposal facilities, means of access and mean sea level elevation, with contour separation of two feet or less, of the existing and proposed land surface, cellar floor and first floor*." Additionally, subdivisions located partially or wholly within the Zone A of the Flood Insurance Rate Map shall take steps to avoid flood hazards. [11]

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

[11] *2012, Town of Sheffield Zoning Bylaws.*

Absent a zoning bylaw, floodplains in New Marlborough are partially protected from adverse development impacts through the Massachusetts Wetlands Protection Act, which is locally administered by the New Marlborough Conservation Commission. The Act prohibits or restricts development that would negatively impact the natural functions of wetland resources, including protecting natural flow regimes and flood storage capacity. Additionally, the Massachusetts Building Code (780 CMR 1.00-36.22) has some of the most stringent building code standards in the country, including construction within flood zone or floodplains, and this code has been adopted by the Town of New Marlborough as its minimum building standards. Local municipal building inspectors must be certified by the state to be eligible for the position.

The New Marlborough Highway Department is a small but dedicated crew of six full-time staff, working under challenging financial constraints to maintain the road system throughout the town. Staff frequently inspect culverts and bridges to ensure that they are clear of debris, and beaver deceivers have been successfully used on North Road and East Hill Road. The Department is available for emergency calls 24 hours a day throughout the year.

The Department actively pursues state funding for road, bridge and culvert upgrades and replacements, despite the fact that the odds are stacked against small towns such as New Marlborough in receiving priority state highway funding. Demands for state and federal highway funding has for decades far outpaced the annual allocations given to the Berkshire County region. As a result, worthy road improvement projects languish on the regional Transportation Improvements Project (TIP) list for years, sometimes decades. Because of the high cost of full reconstruction of roads and stream crossings, many local roads and bridges may have to restrict vehicle usage for safety while awaiting repairs/replacements. For example, the Town has had to restrict traffic flow to one lane or to reduce the tonnage rating of bridges. Fortunately, the Highway Department's hard work has paid off, with the Town recently securing key funding for road improvements, including the recent completion projects on stream crossings on Umpachene Falls Road, Hadsell Road and on Clayton Mill River Road. Upcoming 2021-2025 MassDOT bridge repair/replacements are as follows:

- Campbell Falls Road
- Canaan Southfield Road
- Lumbert Cross Road
- Norfolk Road
- Keyes Hill Road

New Marlborough, in partnership with Sheffield and Sandisfield, has also successfully pursued grant funding for a gravel road assessment, with the project having begun by the BSC Group, Inc. in the spring 2020. The Town partnered with Trout Unlimited in applying for grant funds to procure engineering designs to address severe bank erosion along the Konkopot River, but this application was not successful. The Town will continue to search for a solution to this high priority area.

The New Marlborough Fire and Rescue Department is an all-volunteer department that answers emergency fire and medical calls. The Department volunteers attend trainings, including proper chainsaw use, wildfire response and water rescues. As noted in the *New Marlborough Comprehensive Plan*, almost half of responses are for local and mutual aid medical calls, 20% are false alarm calls and 5% are structural and other fire calls. In general, New Marlborough and its neighboring towns have observed an upward trend in medical calls for fire/EMT, attributed to the aging population of the Southern Berkshire Region.

If there is an emergency, the Town of New Marlborough utilizes a reserves 911 systems to alert residents of the hazardous conditions and shelter operations. A broadband communication system, which has not been available to residents, is set to become established in 2021. This will afford Town Government and first responders to better communicate with residents and businesses about emergency preparedness, hazard mitigation and other important issues.

New Marlborough is an active member of the Southern Berkshire Regional Planning Committee (REPC), an all-hazards planning committee that focuses on emergency and incident planning and response. The REPC's strength is the coordinated efforts and expertise shared by the 12 South Berkshire member communities, in which New Marlborough is in the midst of. All member towns of the REPC are small rural communities which benefit from the coordinated efforts undertaken by the REPC, which includes formal mutual aid agreements, coordinated communications and public outreach programs, trainings and drill exercises. The REPC meets once a month, hosted by Fairview Hospital in Great Barrington, the region's small hospital.

During the public participation planning processes conducted as part of the Municipal Vulnerability Preparedness Plan and the Hazard Mitigation Plan, more than 70 action items were developed. Some actions were duplicative, being voiced in both planning processes. While any of these individual items are important actions that could lead directly or indirectly to improved community-wide resilience, not all reach to the specific level of being included in a FEMA hazard mitigation document. In practicality, including all 70 actions seemed to dilute the importance of key actions that should be prioritized and pursued to meet the requirements set forth in 44 CFR § 201.6(c)(3-5). As a result, the Mitigation Action Plan outlined in Table 4.1 lists the actions that are most relevant to addressing natural hazards and disasters that could impact the City of North Adams and its residents and meets the requirements set forth by FEMA.

This does not diminish the importance of the actions not listed herein. For example, several key priority actions were identified that involve increasing the capacity of local public health officials, first responders and the Southern Berkshire REPC to develop emergency preparedness plans and improve the emergency response infrastructure. These include wider public outreach, improving and expanding emergency communications, and acquiring equipment and supplies. The REPCs of Berkshire County are the region's first response teams and are invaluable resources that should be wholeheartedly supported through local, regional, state and federal efforts. This plan refers to and supports the actions proposed by the REPCs, including efforts to obtain grants and other financial means to meet their goals and responsibilities. It also supports complementary but herein unlisted actions developed as part of the Municipal Vulnerability Plan.

The Town of New Marlborough prioritized hazard mitigation projects based on the most pressing issues, or those with the greatest benefit. Cost was also a factor, though subordinate to protection of life and property. Since actual project costs were unknown for the majority of New Marlborough's proposed mitigation actions, the costs were estimated and categorized as follows:

The mitigation projects listed in table 4.1 fall within the primary *Categories of Actions*:

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

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.

Benefit explains what the action mitigates or how it to increase resilience.

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

Time / Priority is listed at Short (1-3 years), Long (4+ years), 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.

Project Cost was estimated and categorized as follows:

High: Over $100,000
Medium: Between $50,000 - $100,000
Low: Less than $50,000
N/A: For some projects, cost is not applicable.

Resources and Funding listed for each action are known potential technical assistance, materials and funding for the type of project identified. *Notes/Updates* provides an additional explanation of the action or, if the action was included in the previous 2012 plan, the status of that action.

Notes/Updates from 2012 describes the status of the action item. Some actions have been successfully completed since the previous Hazard Mitigation Plan of 2012; others have not been completed and a short narrative explains whether the action should be pursued in the future. Some actions are new to this updated plans, not being listed in 2012.

NOTE: Actions shown in green text on the Action Plan Table are from 2012 Hazard Mitigation Plan, with an update on the status of the action item listed in the right-hand column. Actions shown in blue text are new items that have emerged during the development of the updated 2020 Hazard Mitigation and Climate Action Plan.

Table 4.1: Mitigation Action Plan Table - New Marlborough

Category of Action	Description of Action	Benefit	Implementation Responsibility	Timeframe / Priority	Cost	Resources / Funding	Notes/Updates from 2012
Local Plans & Regulations; Natural Systems Protection	Create a stormwater control bylaw to prevent large increases in stormwater runoff	Reduce flooding by reducing surface/stormwater runoff into streams and roads from new development or forest cover removal	Planning Board (PB)	Short / High	Low	Town	No action since 2012– maintain as action
Local Plans & Regulations; Natural Systems Protection	Amend subdivision regulations and zoning to maintain surface and groundwater onsite; restrict discharge of stormwater	Reduce surface/stormwater runoff into streams and roads from new development or forest cover removal	PB, Conservation Commission (CC)	Long/ High	Low	Town	No action since 2012– maintain as action
Structural Project	Replace bridge on Hadsell Road with a larger bridge to reduce flooding	Improving the bridges capacity for water flow will help reduce flooding	Town, MassDOT	NA	NA	MassDOT	Completed by MassDOT
Structural Project	Replace bridge on New Marlborough Southfield Road with a larger bridge	Reduce road and upstream flooding	Town, MassDOT	NA	NA	MassDOT	Completed – new culvert upsized

Category of Action	Description of Action	Benefit	Implementation Responsibility	Timeframe / Priority	Cost	Resources / Funding	Notes/Updates from 2012
Structural Project	Rebuild Hatchery Road with larger culverts	Reduce road and upstream flooding	Highway Dept. (Highway)	Long/ High	High	Town, Ch.90 Road Aid, FEMA	No action since 2012– maintain as action
Structural Project, Natural Systems Protection	Remove sediment in Lake Buel outlet and Konkapot River south of the lake	Increase flood storage capacity, reduce the risk of road and properties flooding; reduce erosion threatening road	Highway, Town of Monterey, Lake Buel Preservation District, CC	Long/ High	High	Towns, MEMA/FEMA, Municipal Vulnerability Program (MVP)	No action since 2012 - maintain as action
Preparedness and Response	Identify historic structures, businesses and critical facilities located in hazard-prone areas, including floodplains and dam failure inundation areas	Enable those facilities to be better prepared for the hazards and to prevent their loss	Planning Board, Highway, Emergency Management (EM), MA Hist. Commission	4-6 years/ Medium	Low	Town, MA Hist. Commission	Partially completed, but remains in the updated plan
Local Plans & Regulations; Natural Systems Protection	Work on controlling beaver activity throughout the entire town; focus New Marlborough – Monterey Rd. (now North Rd.), North Rd.(now Old North Rd.), Norfolk Road, Caulkins Cross Rd., Hotchkiss Rd	Reduce or in some places eliminate the risk of flooding	Highway, MA Div. of Fisheries & Wildlife (DFW), CC	Ongoing/ Medium	Low	Town, MA DFW, MSCPA	Some beaver deceivers have been installed to control water level
Natural Systems Protection; Structural Project	Strengthen stream banks all along Konkapot River where bank erosion along the road is a problem	Reduce damage to the road and possible loss if main transportation route	Highway, Trout Unlimited (TU)	Short/ Medium	Medium	Town, MEMA/FEMA, DFW, MVP	No action since 2012– maintain as action
Natural Systems Protection; Structural Project	Implement the findings of the Trout Unlimited findings regarding the Konkapot River; continue to pursue funding opportunities	Reduce damage to the road and possible loss if main transportation route	Highway, Trout Unlimited (TU)	Short/ High	Medium	Town, MEMA/FEMA, DFW, MVP, MassDOT	New site-specific Action

Category of Action	Description of Action	Benefit	Implementation Responsibility	Timeframe / Priority	Cost	Resources / Funding	Notes/Updates from 2012
Local Plans & Regulations	Develop a floodplain zoning bylaw	Ensure that development does not impede flood flow, reduce flood storage capacity or endanger people or property	PB, CC	Short/High	Low	Town	New Action
Local Plans & Regulations	Develop a local wetlands bylaw	Reduce flooding due to development that impacts or reduces the functions of wetland resources	CC, PB	Short/High	Low	Town	New Action
Natural Systems Protection/ Structural Projects	Permit and implement engineered bank erosion solution for Umpanchene Falls Park	Reduce bank erosion and sedimentation of cold water fishery; reduce loss of park land to erosion	Highway, Umpachene Falls Park Comm.	Short/Medium	Medium	Town, MA PARC grant, MVP	New Action
Structural Projects	Complete inventory and assessment of dirt road by BSC Group and pursue funding for implementation	Identify locations most at risk and prioritize them for future work; construction actions should reduce road washouts and other closures that put people at risk	Highway, Berk. Reg. Planning Comm., Capital Planning (Cap PL)	Short/High	Grant	MVP is funding assessment; Town and state grants for construction	New Action
Structural Projects	Implement nature-based solutions in areas of erosion, including steep sloped roads	Reduce road washout and ensure residents are not cut off from emergency services in the event of a disaster	Highway	Long/Medium	High	Town, MVP,	New Action
Structural Projects	Identify areas where trees are subject to wind and ice damage and implement tree maintenance plan	Protect people and property by reducing road closures and loss of power and communications for pr	Highway, Tree Warden, EM, Utility Company, Cap PL	Long/High	High	Town, Utility Companies	New Action

Category of Action	Description of Action	Benefit	Implementation Responsibility	Timeframe / Priority	Cost	Resources / Funding	Notes/Updates from 2012
Structural Projects	Assess culverts and stream crossings to determine which need upgrading/enlargement; partner with TU and Berkshire Environmental Action Team (BEAT) to conduct assessments; conduct pilot construction projects; consider Hartsville as priority	Reduce flooding of property and transportation systems; proactively identifying need for upgrades/enlargements may aid in getting FEMA funding in future post-disaster replacements; upgrade/enlargements improve aquatic connectivity	Highway, Cap PL, BEAT, TU	Long/Medium	Medium/ High	Town, Chapter 90, MVP, DFW	New Action
Structural Projects	Replace and expand the culverts on Brewer Hill Road, Mill River Gt Barrington Road, Canaan Southfield Road and Hartsville Mill River Road	Reduce the risk of flooding to people, properties and roads	Highway, Cap PL	Long/Medium	Medium/ High	Town, Chapter 90, MVP, DFW	New Action
Preparedness and Response	Establish a community outreach program to raise awareness of hazards, including flooding and vector borne disease	Protect the health and safety of residents and property	EM, COA, Bd. Health, Bd. Selectmen	Medium/High	Low	Town, Berk. Co. Bds. Of Health Assoc.	New Action
Preparedness and Response	Increase emergency response capacity, including shelter planning, improved redundancy in emergency communications, power outage planning	Ensure the safety of residents in the event of a disaster	EM, So. Berk. Regional Emergency Planning Committee (REPC), Utility & Phone Companies	Short/Medium	Low	Town, MEMA, REPC	New Action
Natural Systems Protection; Preparedness and Response	Assess and identify forested areas at high risk for fire, especially near critical infrastructure; seek funding for forest fire fighting equipment	Reduce risk of loss of property and possible loss of emergency response capacity	EM, Fire Dept., Tree Warden, DCR Bureau of Forest Fire Control & Forestry	Short/Medium	Medium	Town Fire Dept.	New Action

Category of Action	Description of Action	Benefit	Implementation Responsibility	Timeframe / Priority	Cost	Resources / Funding	Notes/Updates from 2012
All	Annually conduct joint and coordinated review of this Hazard Mitigation Plan and the Municipal Vulnerability Plan; update these plans and actions as needed to meet changing conditions	Increase resilience through pursuit of actions that address natural hazards and disasters, incorporating the shifting weather patterns of climate change	EM, Bd. of Selectmen, Highway, Fire Dept.	Ongoing	NA	Town, various partners	New Action

CHAPTER 5: PLAN ADOPTION

44 CFR § 201.6(c)(5)

This plan has been formally adopted by the Board of Selectmen of the Town of New Marlborough on DATE .

CHAPTER 6: PLAN MAINTENANCE

44 CFR § 201.6(c)(4)

44 CFR § 201.6(c)(4) asks for a section of the HMCAP to describe the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle, process by which New Marlborough 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 New Marlborough will review needed updates for the New Marlborough HMCAP on an annual basis. This will be done in coordination with review of the MVP. Under the leadership of the Select Board and Town Administrator, the Hazard Mitigation Committee will track changing problem areas and conduct updates based on completed mitigation actions and input from the public. Town staff sitting on the Hazard Mitigation Committee will maintain and update the mitigation action tables, complete site visits and produce reports of completed or initiated mitigation actions to incorporate into the next plan revision, and participate in resiliency- and mitigation-related initiatives available to the region. As needed on an annual basis, updates will be shared with BRPC, which maintains county-wide GIS data.

In reaching out to the residents and neighbors of New Marlborough, the Hazard Mitigation Committee began building a network of interested residents that can enhance the next update. While the Hazard Mitigation Plan must be updated every five years, New Marlborough will begin the process of organizing and identifying funding for the plan update every 3.5 years.

Integration in Future Planning

§201.6(c)(4)(ii)

This HMCAP and the MVP will be used and integrated into all future planning efforts in the Town of New Marlborough. The final adopted HMCAP will made publicly available on the Town of New Marlborough and BRPC websites for reference and comment. Any regional plans developed by BRPC or the Commonwealth should refer to the publicly available New Marlborough HMCAP to ensure consistency with the vision for community resilience to hazards.

MAJOR REFERENCE DOCUMENTS

Berkshire Regional Planning Commission (BRPC), 2012. *Berkshire County Hazard Mitigation Plan*, Pittsfield, MA.

BRPC, 2020. Monterey Hazard Mitigation and Climate Change Adaptation Plan, Pittsfield, MA.

Massachusetts Emergency Management Agency (MEMA), Executive Office of Energy and Environmental Affairs (EEOEA), 2018. *Mass. State Hazard Mitigation and Climate Adaptation Plan* (MA SHMCAP), Boston, MA.

Malloy, J.T.; Tozer, J., 2020. *Town of New Marlborough Community Resilience Building Summary of Findings* (MVP Plan), Boston, MA.

Town of New Marlborough, 2010. *Town of New Marlborough Comprehensive Plan*, New Marlborough MA.

Town of New Marlborough, 2017. *Town of New Marlborough Open Space and Recreation Plan*, New Marlborough, MA.

Other references are cited throughout the Plan and noted in footnotes.

APPENDICES:

APPENDIX A: PUBLIC PARTICIPATION DOCUMENTATION

New Marlborough Hazard Mitigation Program Meeting: 10/18/19

Meeting Attendees:

- Ed Harvey (EMD)
- Graham Frank (Chief of Police)
- Mari Enoch (Town Administrator)
- Chuck Loring (Highway Superintendent)
- Caroline Massa (BRPC)
- Justin Gilmore (BRPC)

Communication issues:

- There is no cell coverage in most areas of the town.
- When the town's power supply is knocked out by inclement weather, the landline phones go down as well. After power is knocked out, the landline phones run for a short period of time on batteries, but it is not a substantial amount of time.

Flooding/Stormwater issues:

- Many of the gravel/dirt roads in town are susceptible to being washed out during rain events.

Worksheet – General Hazards:

- Dam Failures: NMB has not had any dam failures.
    - Lake Garfield (not in town) – impacts Hartsville Village just below Lake Buel where the two outflows merge.
    - Konkapot River – along the riparian area is the most developed part of town, if the dam were to fail along this river, has the potential to impact a large swath of the town.

- Hurricanes: NMB suffered the loss of a few dirt roads and culverts during Hurricane Sandy (2011).

- Tornados: No tornados have occurred in NMB.
    - There was an instance of a tornado/high wind event that hit the surrounding area and did some damage to Route #23 – which prevented access to the town of NMB.

- High Wind Events: One of the roadways in town leading to the hospital was blocked by fallen debris caused by a high wind event in recent years.

- Earthquakes: NMB has not had any recent recorded earthquakes, however the town sits on top of a fault line.

- Wildfires: Brush fires have occurred in two (2) isolated areas in town over the past 5 years and the frequency and severity appear to be increasing.

- Landslides:
  - Umpachene Falls Road appears to be very vulnerable to landslide/erosion issues.
  - Campbell Falls Road would be significantly damaged if a landslide were to occur in the area.
  - Stone Bridge is another at risk area.

- Temperature Changes:
  - In NMB, those that would be affected by warmer temperatures include corn farmers and farmers more generally.
  - Colder temperatures pose real risks to most of the population in NMB (if power goes out for instance).

- Invasive Species:
  - Ash Tree removal
  - Purple Leaf Strife
  - Knot Weed (Konkapot Riverbanks have become overrun with Knot Weed – looks like bamboo).
  - Phragmites

- Cybersecurity: Something for the town to consider.
  - Chief of Police mentioned a recent potential risk of cyber breach.

Questions:

1. Zoning: The town does not have any zoning ordinances that restrict development in the floodplain area of town. The town would consider developing such an ordinance. The town has basic conservation zoning.
   a. There were erosion issues in recent years near the cemetery in town located near the school (Konkapot riparian bank erosion) – land being lost to the river.

2. DCR Data: Repetitive flood loss data still needed – request will be sent.

3. Second Home Ownership Data: The town does not have a good sense of second homeowner data, and they have no database or tax on rental properties.

4. Critical Facilities List:
   a. Town Hall should have a generator. They do have portable generators (may not be sufficient).
   b. Verizon map of service areas (utilities) is needed.
   c. The phone line infrastructure in town is poor, however, with fiber optic on the horizon, investments to replace existing infrastructure is unlikely.
   d. *Stormwater devices are to be removed from the list for now*.
   e. East Hill Road and North Road have beaver deceivers.
   f. Dam Inspection Data – BRPC is working to acquire this.

Other Ideas:

g. Hazardous Materials: The town has two (2) 30,000-gallon propane tanks that are filled on a scheduled basis. (Green dots were drawn on the map designated the location of these propane tanks).
h. The town has public water supplies that are privately owned.

Desired Projects:

1. Hartsville Area Project: That area has a ton of flooding/erosion issues, Lake Buel feeds into the Konkapot River – which then backs up the whole area after heavy rain events. Hartsville River Road – bridge could be washed out along with the road – which is a main road for NMB.
2. There are flooding/erosion issues along the Town's Park, on Umpachene Road. The park is being eroded away by the river. (Example: the house located in the southwestern portion of town along the Konkapot River has lost about 50 feet of land due to erosion issues).

Mission Statement:

- Mission statement was adopted.

Map of problem culverts in town is needed:

- There is one problem culvert near the bottom of Foley Hill Road.
- More to be identified

Next Meeting: Scheduled for Friday, December 13th @ 11:00 AM.

Note: BRPC staff needs to request an extension on the HMP planning process. Caroline has been designated to follow up on this task.

MVP Planning:

- New Marlborough is participating in the MVP process jointly with the towns of Sheffield and Sandisfield.

New Marlborough Hazard Mitigation Planning Committee Meeting

12/13/2019

Agenda

11am Review of Questions - Handout Worksheet for Completion

Addresses are needed for all repetitive flood loss structures and structures which have incurred substantial damage. Buildings must be analyzed by type (commercial/residential), number, and general location as it related to the known hazard areas.

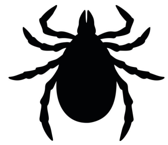
11:30am FEMA Worksheet 4.1

12:10pm Review Scope of Work

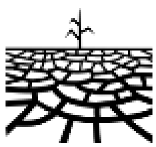
12:15pm Schedule Next Meeting,

Risk Assessment


Inland Flooding


Vector-Borne Disease


Severe Winter Storm


Drought


Average/Extreme Temperatures


Tornadoes


Landslide


Wildfires

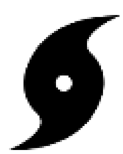

Other Severe Weather


Erosion


Invasive Species


Earthquake


Cyber Security


Hurricanes/Tropical Storms


Dam Failure

Adapted from the Massachusetts State Hazard Mitigation and Climate Adaptation Plan September 2018 pg. 3-3

Table _. Hazards that have the greatest potential to impact NHB

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	
Dam Failure	2	0	3	5
Flooding (include Ice Jam, Beaver Activity)	3	3	3	9
Severe Winter Event (Ice Storm, Blizzard, Nor'easter)	3	3	2	8
Severe Storms (High Wind, Thunderstorms, Hail)	3	3	2	8
Hurricane & Tropical Storms	3	2	3	8
Drought	2	2	1	5
Tornado	1	1	1	3
Earthquake	1	0	1	2
~~Urban~~ & Wildfire	1	3	1	5
Landslide	2	1	2	5
Change in Average/Extreme Temperature	3	3	3	9
Invasive Species	3	3	3	9
Pests/Vector-borne Diseases	3	3	3	9
cyber-security	2	2	3	7

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 (less than 0.1% per year0
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% and > 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% and > 25%
4=catastrophic	multiple deaths; complete shutdown of facilities for 30 days or more; property severely damaged> 50%

Source: Table developed by BRPC 2005.

----- Original Message -----

Hello Mari and Ed,
I have attached the worksheet we discussed at the meeting. Please answer the questions and send it back. Let Justin and me know if you need clarification.

For clarification on public participation you can refer to the following policy:
(b) Planning process. An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:

1. An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;
2. An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and 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; and

You can see the full text at this link: https://www.law.cornell.edu/cfr/text/44/201.6

I have also attached the hazard prioritization table we completed together, along with the declared hazards and emergencies in Berkshire County within the same word document for you to add onto.

That is all for now.

Kindest Regards,
Caroline

Caroline Massa
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Berkshire Regional Planning Commission
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<u>Questions for New Marlborough: Hazard Mitigation Planning</u>
Friday, December 13th, 2019:

<u>Task 6 – Vulnerability</u>:
Based on the previous information from Task 5, the Town will update the overview of each of the specific hazards and the community's vulnerability to those specific hazards.

- <u>Problem Statements</u>: These will summarize the biggest issues for the community in terms of; Types and numbers of buildings, infrastructure, and critical facilities located in the hazard areas.
- All existing multiple hazard protection measures within the community, including protective measures under the National Flood Insurance Program (NFIP).
- A description of each measures, the method of enforcements, and/or the point of contact responsible for implementation of each measure.
- Historical performance of each measure ad a description of improvements of changes needed.
- General description of land uses and development trends to incorporate future land use decisions.

<u>Other related Questions</u>:

- The primary town agency responsible for regulating development in town?
- How will the community continue compliance with the NFIP program over the next five years?
- Where are emergency vehicles stored when not in use?
- *<u>Clarification question on communication issues</u>*: Was it the landline phones that stop working (after back-up batteries die) when the power for the town goes out? Or, is it the Verizon cell and internet service box that go out (once backup batteries die) – and only those residents who have kept their landline phones are able to make calls? Who might be the right contact to get information related to communication issues the town experiences during storm events?

- Is there a zoning ordinance restricting development in the floodplain in New Marlborough?

- Please contact Joy Duperault to receive 2019 updated flood loss information. She is only allowed to share the information directly with a municipal contact.
  Joy Duperault, CFM
  Director, Flood Hazard Management Program
  State NFIP Coordinator & Deputy Hazard Mitigation Officer
  Dept. of Conservation & Recreation, Office of Water Resources
  251 Causeway Street, 8th floor, Boston, MA 02114
  617-626-1406 or joy.duperault@mass.gov

  - Do you have available data on occupied households for recent than census? Any information on number of second homeowners?

  - Do you want to include any other facilities in critical facilities list? Such as any public utilities?

  - Please identify what the "stormwater devices" are at Easthill Road and Hotchkiss Road.

  - I have contacted the Office of Dam Safety for updated dam inspection data and will update that when I receive a reply.

- Please identify culverts that need mitigation and are priority for assessment (review attached map).

- Generally confirm information is correct and complete in the edited document.

44 CFR § 201.6 Local Mitigation Plans
…
(c)Plan content.
…
(2) A risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards. The risk assessment shall include:
(i) A description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.
(ii) A description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. All plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods.

Citation

New Marlborough (2020) Community Resilience Building Workshop Summary of Findings, BSC Group, Inc. and Town of New Marlborough. New Marlborough, Massachusetts

MVP Core Team Working Group

Mari Enoch, Town Administrator (designated municipal liaison for the program)
Mark Carson, Planning Board
Robert Dvorchik, Assistant Fire Chief
Graham Frank, Police Chief
Freddy Friedman, Conservation Commission
Edward Harvey, Emergency Management Director
Richard Long, Board of Selectmen
Charles Loring III, Highway superintendent and Fire Chief

Workshop Facilitators

Jeffrey T. Malloy, BSC Group, Inc.
Ale Echandi, BSC Group, Inc.

Acknowledgements

This project was made possible through funding from the Massachusetts Executive Office of Energy and Environmental Affairs' Municipal Vulnerability Preparedness (MVP) Grant Program. Thank you for providing the leadership and funds to support this process. The Town of New Marlborough values your partnership.

Thank you to the community leaders within New Marlborough who attended the New Marlborough CRB Workshops. The institutional knowledge provided by Workshop participants was essential to the success of this process.

Thank you to Carrieanne Petrik, EEA Regional MVP Coordinator for continued procedural guidance through this planning process.

Workshop Participant List

Bryan, Martha - New Marlborough Land Trust
Carson, Mark - Planning Board
Conklin, Will - Greenagers
Dixon, Alison - Housatonic Valley Association
Enoch, Mari - Town Administrator
Fields, Kenzie - Housing Committee
Frank, Graham - Police Chief
Friedman, Freddy - Conservation Commission
Hagen, Peter - Lake Buel District
Hoy, Sari - Sheffield Resident, Sheffield Planning Board
Long, Richard - Board of Selectmen
Loring, Chuck - Fire Chief/Highway Superintendent
Marchione, Barbara - Resident
Petrik, Carrieanne - MVP Regional Coordinator/Resident
Rodgers, Erin - Trout Unlimited
Rosenberg, Elisabeth - Housing Committee
Ryan, Tom - MA Department of Conservation and Recreation
Schreiber, John - Conservation Commission
Smith, David - Fire Department
Stalker, Tom - Commission on Disabilities/Farmer's Market
Westrick, Brian - Trustees of Reservation
White, Tara - Board of Selectmen
Wright, Stephanie - Multicultural Bridge
Yohalem, Nat - Board of Selectmen

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Tara B. White, Chair
Richard E. Long, Vice Chair
Mark Carson
Board of Selectmen

PUBLIC LISTENING SESSION

Municipal Vulnerability Preparedness Plan

Monday, October 5th, 2020
6:00 pm
Via zoom

Board of Selectmen members Tara White, Chair, Richard Long, and Mark Carson were in attendance for the Public Listening Session of the Presentation of Public Findings for New Marlborough's Municipal Vulnerability Preparedness Plan. The presentation to the public was led by Jeff Malloy of BSC Group. No discussion or action was taken by the Board of Selectmen.

Submitted,

Mari Enoch
Town Administrator

THIS IS A PLACEHOLDER FOR ADDITIONAL DOCUMENTATION OF THE PUBLIC REVIEW PERIOD OF THE NEW MARLBOROUGH HAZARD MITIGATION AND CLIMATE CHANGE ACTION PLAN, INCLUDING INCORPORATION OF PUBLIC COMMENTS RECEIVED.

- Concurrently with MEMA/FEMA review, the Draft Plan is being offered for public comment for three weeks, December 21, 2020 to January 8, 2021.
- The Draft Plan is being posted on the Town's website and a paper copy is being placed in the Town Library on December 21st.
- The posting of the Draft HMCAP for public review is being advertised in the New Marlborough Five Village News, a town-wide monthly newsletter and an invitation to review was sent to the Town's email distribution list.
- The New Marlborough Planning Board and Board of Selectman are announcing the Draft Plan's posting at their meetings on December 15 and 21, 2020 respectively.
- Additionally, a formal invitation to review and comment on the Draft Plan was sent to all neighboring Towns and to the Southern Berkshire Regional Emergency Planning Committee.