DRAFT Town of Clarksburg Hazard Mitigation and Climate Adaptation Plan

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ACKNOWLEDGEMENTS

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The Town of Clarksburg would like to thank the members of the Clarksburg Hazard Mitigation Planning Committee, who served as the advisory committee for this planning effort. The Town would particularly like to thank the time and effort directed to this project by Town Administrator Rebecca Stone.

The Berkshire Regional Planning Commission provided technical assistance to the Town and the Planning Committee throughout the planning and approval processes.

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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 Clarksburg Hazard Mitigation and Climate Adaptation Plan (HMCAP) was prepared in order to meet the requirements of the Code of Federal Regulations, Title 44 CFR § 201.6 pertaining to local hazard mitigation plans. Title 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 hazard mitigation project grants. A local government must have a mitigation plan approved pursuant to this section in order to apply for and receive mitigation project grants under all other mitigation grant programs." As the HMCAP will illustrate, the Town's eligibility for FEMA's hazard mitigation grants is crucial.

The Town of Clarksburg established the following mission statement for their hazard mitigation and climate adaptation planning process:

> **It is the Town of Clarksburg's mission to protect the lives, health, safety, and property of residents and businesses of Clarksburg from the impacts of natural hazards and climate change**.

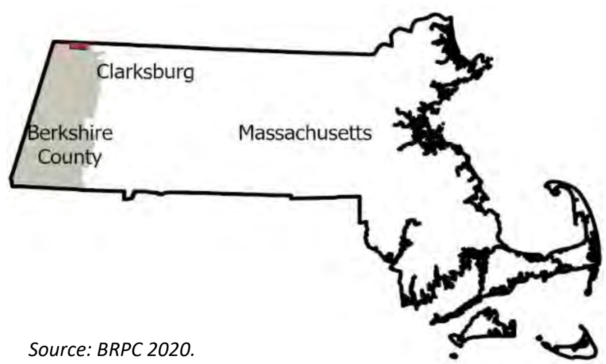
In accordance with Title 44 CFR § 201.6 the local mitigation plan is the representation of the Town's commitment to reduce risks from natural hazards, serving as a guide for decision makers as they commit resources to reducing the effects of natural hazards. Additionally, the HMP is meant to serve as the basis for the Commonwealth of Massachusetts to provide technical assistance and to prioritize project funding.

Background

Location

Massachusetts is located on the east coast, where coupled with its northerly latitude, exposes it to both the moderating and moistening influence of the Atlantic Ocean, and the effects of hot and cold air masses from the interior of the continent. The polar jet stream is often located near the state, giving it highly variable weather patterns, wide ranging daily and annual temperatures, and generally abundant precipitation throughout the year.[1] The Town of Clarksburg is located in northern Berkshire County, Massachusetts. It is nestled on the northern border of Berkshire County adjacent to Stamford, VT and between the Massachusetts communities of Florida to the east, the City of North Adams to the south, and Williamstown to the west.

Fig. 1.1. Location of Clarksburg within Massachusetts



Source: BRPC 2020.

Community Setting

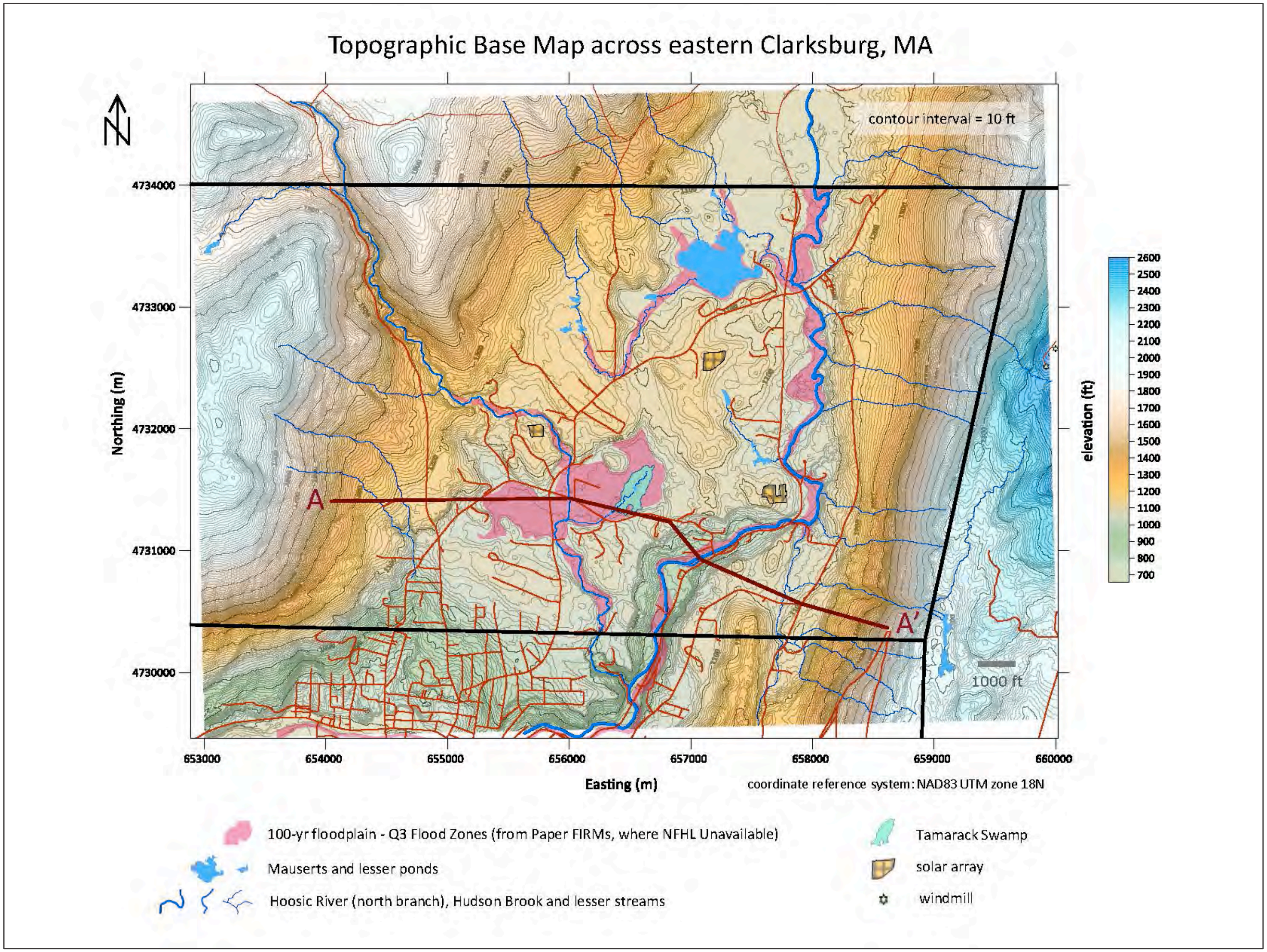
The Town of Clarksburg is relatively small in size, covering an area of 12.8 square miles (8,187 acres). The town is bordered on two sides by mountains, with East Mountain and Bald Mountain to the west, located within the Clarksburg State Forest, and the Hoosac Range to the east.

[1] *https://statesummaries.ncics.org/chapter/ma/*

Between the two ranges, Hudson Brook and the North Branch Hoosic River flow through a relatively broad valley, merging just south of the Town line in North Adams. Tamarack Swamp is a tributary that flows into Hudson Brook. The general lay of the land of the eastern portion of Clarksburg, in which development is centered, is found in the following Figures 1.2 and 1.3 (provided courtesy of Jim Brandon, Clarksburg Conservation Commissioner and proprietor of GeoPinva LLC).

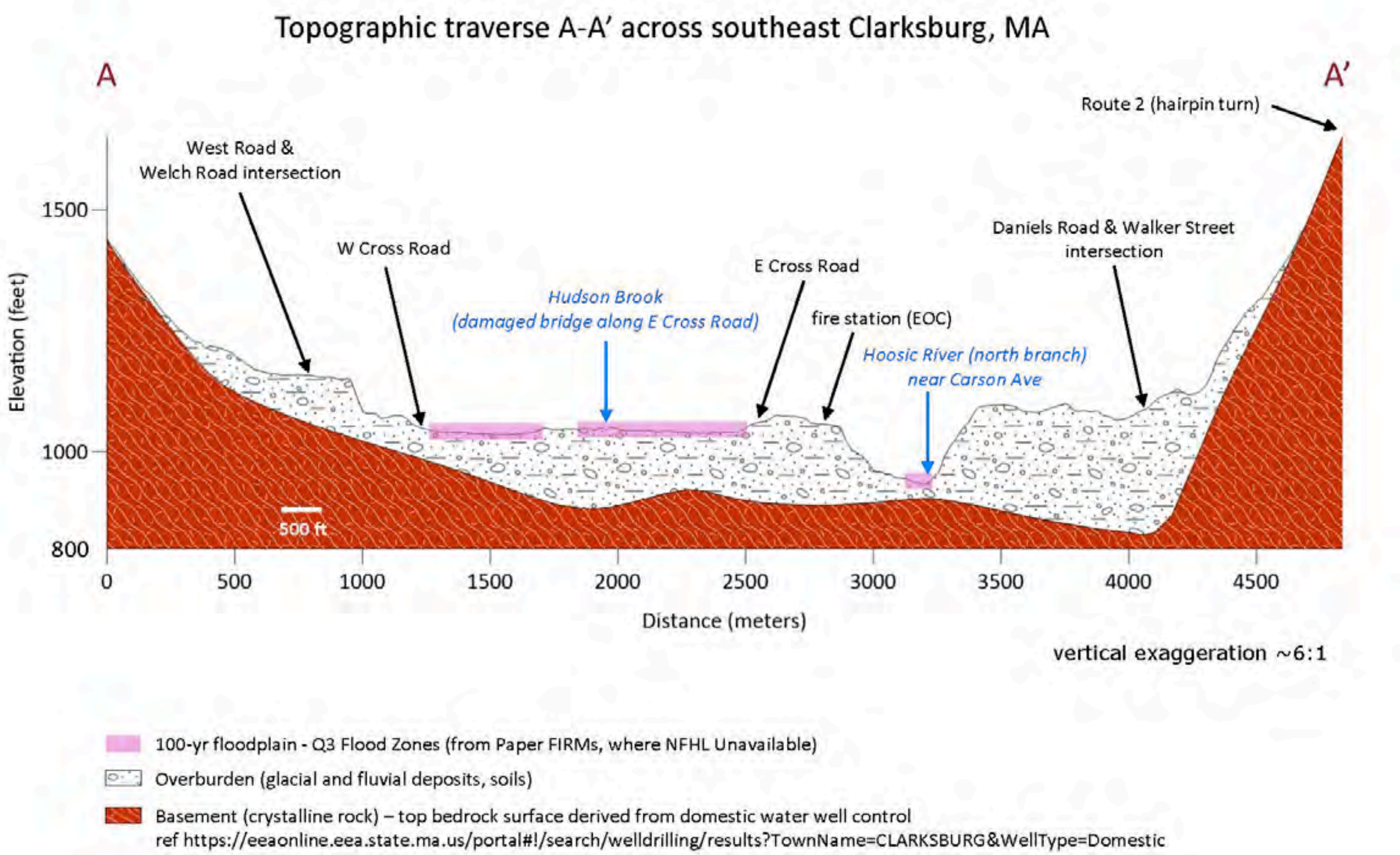
In the northern part of the valley is Clarksburg State Park, operated by the state's Department of Conservation and Recreation (DCR). The park is home to Mauserts Pond and offers picnicking, hiking, and camping, as well as other recreational activities. On the Vermont side of the border lies the Green Mountain National Forest. The Appalachian Trail crosses north-south through the town, passing just west of the peak of East Mountain, the highest point in town, at 2,300 feet (700 m). The north-south Route 8 is the only state route through town, and is the main travel way between Clarksburg and neighboring communities.

Fig. 1.2. General topography of the eastern portion of Clarksburg where development is located



Source: Jim Brandon, GeoPinda LLC, 2021

Fig. 1.3. Traverse demonstrating general terrain with locations of key features



Source: Jim Brandon, GeoPinda LLC, 2021

CHAPTER 2: PLANNING PROCESS

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

Introduction

The Town of Clarksburg was included in the 2015 *Addendum* (covering four towns) to the 2012 regional *Berkshire County Hazard Mitigation Plan* (covering 19 municipalities). This *Clarksburg Hazard Mitigation and Climate Adaptation Plan* (HMCAP) is a single-jurisdiction plan that updates the 2015 *Berkshire County Hazard Mitigation Plan Addendum.*

This chapter outlines the development of the Town of Clarksburg 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 Chapter 4.

The Town retained the services of Berkshire Regional Planning Commission (BRPC) to aid them in developing the HMCA. The Clarksburg HMCAP is a compilation of data collected by BRPC, information gathered from the Clarksburg Hazard Mitigation Planning Committee (the Planning Committee) during meetings, and interviews conducted with key stakeholders outside of working meetings. The Plan reflects comments provided by the Planning Committee, local officials and citizens, neighboring towns, and ultimately MEMA and FEMA.

Planning Meetings and Participation THIS SECTION TO BE COMPLETED AFTER THE PUBLIC COMMENT PERIOD

44 CFR § 201.6(c)(1)

During the planning process there was opportunity for public comment and the opportunity for neighboring communities, local and regional agencies or partners 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. Making the document available to the public for review meets requirements of 44 CFR § 201.6(b)(1), and solicitation of comment from neighboring towns meets requirements of 44 CFR § 201.6(b)(2), pertaining to involvement of regional partners in the planning process. See Appendices for documentation.

A grant from Federal Emergency Management Agency (FEMA) through the Massachusetts Emergency Management Agency (MEMA) made this comprehensive mitigation and climate change planning process feasible. Members of the Planning Committee include municipal department heads and representatives from the Clarksburg Council on Aging and Clarksburg Conservation Commission. The Planning Committee members are listed in Table 2.1.

In May 2020 the Town of Clarksburg formed the Planning Committee to develop a HMCAP. The Planning Committee held a series of meetings to assemble data on the Town’s infrastructure, identify known hazards to residents and businesses, and review existing plans, procedures, bylaws and protections already in place. The Planning Committee met six times, with all meetings publicly posted according to the Massachusetts Open Meeting Law.

Table 2.1: Clarksburg Hazard Mitigation and Climate Adaptation Planning Committee

Name	Affiliation
Michael Williams	Clarksburg Chief of Police
Rebecca Stone	Clarksburg Town Administrator
Lauren Norcross	Clarksburg Council on Aging
Kyle Hurlbut	Clarksburg Highway Foreman
Clebe Scott	Clarksburg Conservation Commission, Briggsville Water Department
Jim Brandon	Clarksburg Conservation Commission
Caroline Massa	BRPC
Lauren Gaherty	BRPC
Mark Maloy	BRPC
Justin Gilmore	BRPC

In an effort to reach as many residents and businesses as possible, the Town issued a public survey that asked respondent to describe the natural hazards that they had experienced and the concerns that worry them most about hazard events, including climate change impacts. The survey, which was offered online and in paper form was open for two months, during which the Town received a total of 59 responses. The Town promoted the survey by placing notices on the Town's main web page, on its Facebook feed, and through flyers sent in tax bills. Additionally, the Town sent a direct mailing to all businesses in Clarksburg, promoting both the survey and the project.

On May 12, 2021, the Town hosted a public presentation about the major findings of the planning process. The presentation was held during a joint meeting of the Board of Selectmen and the Board of Health and was promoted through the Town's website, Facebook feed, and through the Clarksburg Elementary School social media. During the presentation the public was invited to provide feedback on the major findings and to review the materials posted on the Town's website, including a copy of the presentation. The public was also invited to review and comment on the draft HMCAP, which would be offered for public review on June 11, 2021. The meeting and presentation was aired on Northern Berkshire Community Television, a non-profit public access channel that provides public information to citizens in North Adams, Adams, Clarksburg, and Cheshire.

Public Comment on the Draft HMCAP

During June 11-30, 2021 the Draft HMCAP was offered to the public for review and comment. A link to the draft plan was prominently posted on the homepage of the Town's website and paper copies were placed in the library and in the Community Center, which is the main gathering space for the Council on Aging, the VFW and other community committees and organizations. The plan's availability for public review was announced at publicly posted meetings held via Zoom and public television LIST HERE. All neighboring Towns and the Northern Berkshire Regional Emergency Planning Committee (REPC) were also formally invited to review and comment on the Plan. See Appendices for more details.

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, city services, and vulnerable people. This HMCAP update incorporates relevant data and information from existing plans, studies, reports and technical information. Main data sources and local plans include:

- Berkshire County Hazard Mitigation Plan, Addendum, 2015 (Clarksburg was included in this region-wide plan).
- Clarksburg Complete Streets Report, 2017.
- North Adams Hazard Mitigation and Climate Adaptation Plan, 2020.
- Williamstown Multi-Hazard Mitigation Plan Update, 2019.
- Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP), 2013, 2018.
- BioMap2, Conserving the Biodiversity of Massachusetts in a Changing World, Clarksburg, 2012.

This plan should be used in conjunction with other local and regional plans, specifically those developed by the Northern Berkshire REPC and those developed by MassDOT.

Plan Structure

The next chapter of this plan will analyze and assess risk, profiling each hazard with potential to affect the Town of Clarksburg. After a general profile of the Town's assets and vulnerabilities, 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 and Adaptation Mission and Goals

In developing this plan, the Town of Clarksburg is taking action to reduce or avoid long-term vulnerabilities to the hazards identified during the assessment of risk and the development of a hazard mitigation strategy. **It is the Town of Clarksburg's mission to protect the lives, health, safety, and property of residents and businesses of Clarksburg from the impacts of natural hazards and climate change**.

The following are the Town's goals for this hazard mitigation and adaptation plan:

1. Identify the present and future risks that threaten life, property and the environment in Clarksburg.
2. Protect critical facilities and essential public services from disruption during or after hazardous conditions.
3. Plan, design, and construct sustainable, cost-effective, and environmentally sound mitigation and adaptation projects.
4. Improve communication about and education of hazards for community residents, particularly those most vulnerable and isolated.
5. Integrate the risks and mitigation actions identified through this planning process into all plans for the Town and region and ensure its consideration in all land use decisions; update this plan every five years.

CHAPTER 3: RISK ASSESSMENT

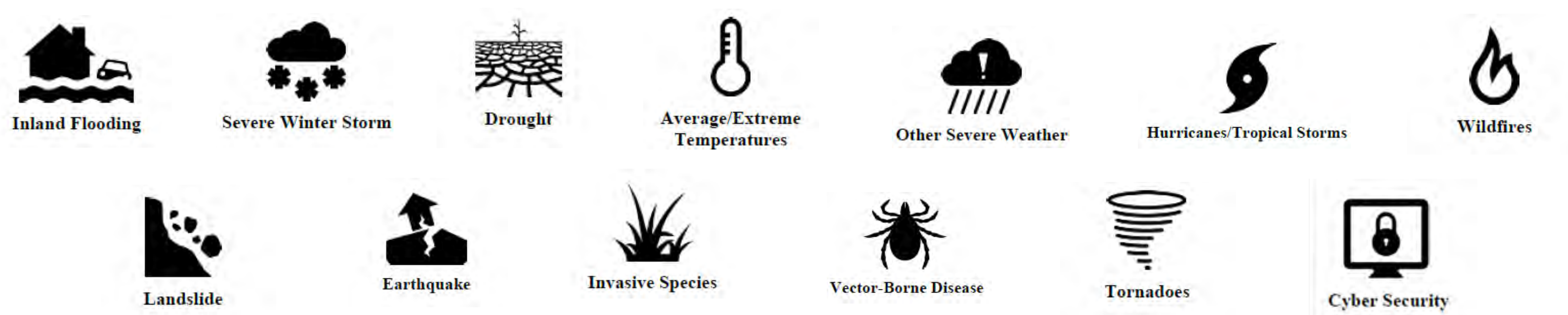
44 CFR § 201.6(c)(2)

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 Clarksburg 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 Clarksburg several resources were utilized. The information outlined in the 2012 *Berkshire County Hazard Mitigation Plan* served as a foundation on which to build. The hazards identified in the 2012 plan were Flooding, 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 *Massachusetts 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 the Town of Clarksburg must plan for the following hazards:



People

Clarksburg is a small rural town in the Berkshires. According to the American Community Survey within the US Census Bureau, the Town has a year-round population of 1,777 people, with an approximate density of 140 people per square mile. There are 709 households in the Town, resulting in a household size of 2.5 people per household. The median age of residents is 45 years of age, which is slightly lower than Berkshire

County as whole but higher than the state median age of 39.5 years (US Census, ACS, 2019 5-year projection)[2]. The median age has increased since 2000, when the it was 41 years of age. If this trend continues, it could have implications on how Clarksburg plans for future emergency preparedness, mitigation and emergency response. The Town utilizes its own elementary school, Clarksburg Elementary School, through eighth grade and residents generally send high school-aged students to Drury High School or to Charles H. McCann Technical High School, both located in neighboring North Adams.

The predominant land use in Clarksburg is forest (81%), with limited development located along main roadways. Development in the community is in the eastern half of the town. Residential development covers 2.5% of total land area, while combined commercial and industrial land uses cover less than 1% of total area (MassGIS, 2016). Land use coverage is shown on Fig. 3.3 and building locations are shown on a topographical map in Fig. 3.1. The densest neighborhoods are located in the historic villages of Houghtonville and Briggsville. These neighborhoods reflect the residential housing that was associated with the development of the mills in those sections. The Houghtonville neighborhood is located along the Town's boundary with North Adams along Houghton and Eagle Streets and Briggsville is located along the southern portion of the North Hoosic River (see locations in Fig. 3.1). Medium density neighborhoods are also found along Cross Road. The remainder of the community has low density.

Natural Environment

The predominant land uses in Clarksburg are forest (81%), wetlands (4%), and open lands (12%), the last of which includes lawns, the old golf course, grasslands, and farm fields. See Fig. 3.3 for reference. Within the Town are a wealth of natural resources, including cold water fisheries and large blocks of unfragmented or minimally fragmented forest. These forests extend outward beyond Clarksburg's boundaries to provide contiguous habitat for wildlife needing large territories to complete their life cycle and provides travel corridors for those who need to migrate,

The Massachusetts Natural Heritage & Endangered Species Program (NHESP) has conducted a state-wide inventory of its natural resources and created community-specific reports for each of the 350 municipalities on the Commonwealth. This effort is referred to as the *BioMap2* project, and combines the agency's 30 years of rigorously documented rare species and natural community data with spatial data to identify wildlife species and the habitats that support them. *BioMap2* also integrates The Nature Conservancy's assessment of large, well-connected, and intact ecosystems and landscapes across the Commonwealth, incorporating concepts of ecosystem resilience to address anticipated climate change impacts. Large Landscape Blocks are large areas of intact predominately natural vegetation consisting of contiguous forests, wetlands, rivers, lakes, and ponds. These Landscape Blocks are most likely to maintain dynamic ecological processes such as buffering, connectivity, natural

[2] *US Census, ACS, 2019 5-yr projection; margin of error is at least 10 percent of the total values; https://censusreporter.org/profiles/06000US2500314010-clarksburg-town-berkshire-county-ma/*

disturbance, and hydrological regimes, all of which help to support wide-ranging wildlife species and many other elements of biodiversity (NHESP, 2012). This type of habitat will be important as climate change alters weather patterns and ecosystem functions and health.

Clarksburg has approximately 3,740 acres of permanently protected open space (~46% of total area), most of which is within the Clarksburg State Forest and Clarksburg State Park. According to *BioMap2*, Core Habitat identifies specific areas necessary to promote the long-term persistence of rare species, other Species of Conservation Concern, exemplary natural communities, and intact ecosystems. Core Habitat covers approximately 4,600 acres, 3,490 of which are permanently protected from development. These areas are shown in light green on the map in Figure 3.2. Clarksburg hosts three rare animal species and two plant species of Special Concern, and a Priority Plant Community (Ridgetop Pitch Pine - Scrub Oak Community found in the state forest and noted as dark green patches). Critical Natural Landscape acreage, which is deemed needed to protect the biodiversity of Core Habitat acres, cover 6,110 (this includes the 3,470 Core Habitat acreage).

Clarksburg is a rural community which sits at headwaters of the North Branch Hoosic River, which joins the main stem Hoosic River in neighboring North Adams and which eventually flows into the Hudson River, which ultimately drains into the Atlantic Ocean at New York Harbor. There are two main water courses in Clarksburg: the North Branch Hoosic River which flows southward through the east-central valley of the Town and Hudson Brook, which flows out of the western hills and southeastern through the west-center of town.

Fig. 3.1 Topographical Map of Clarksburg with Building Locations

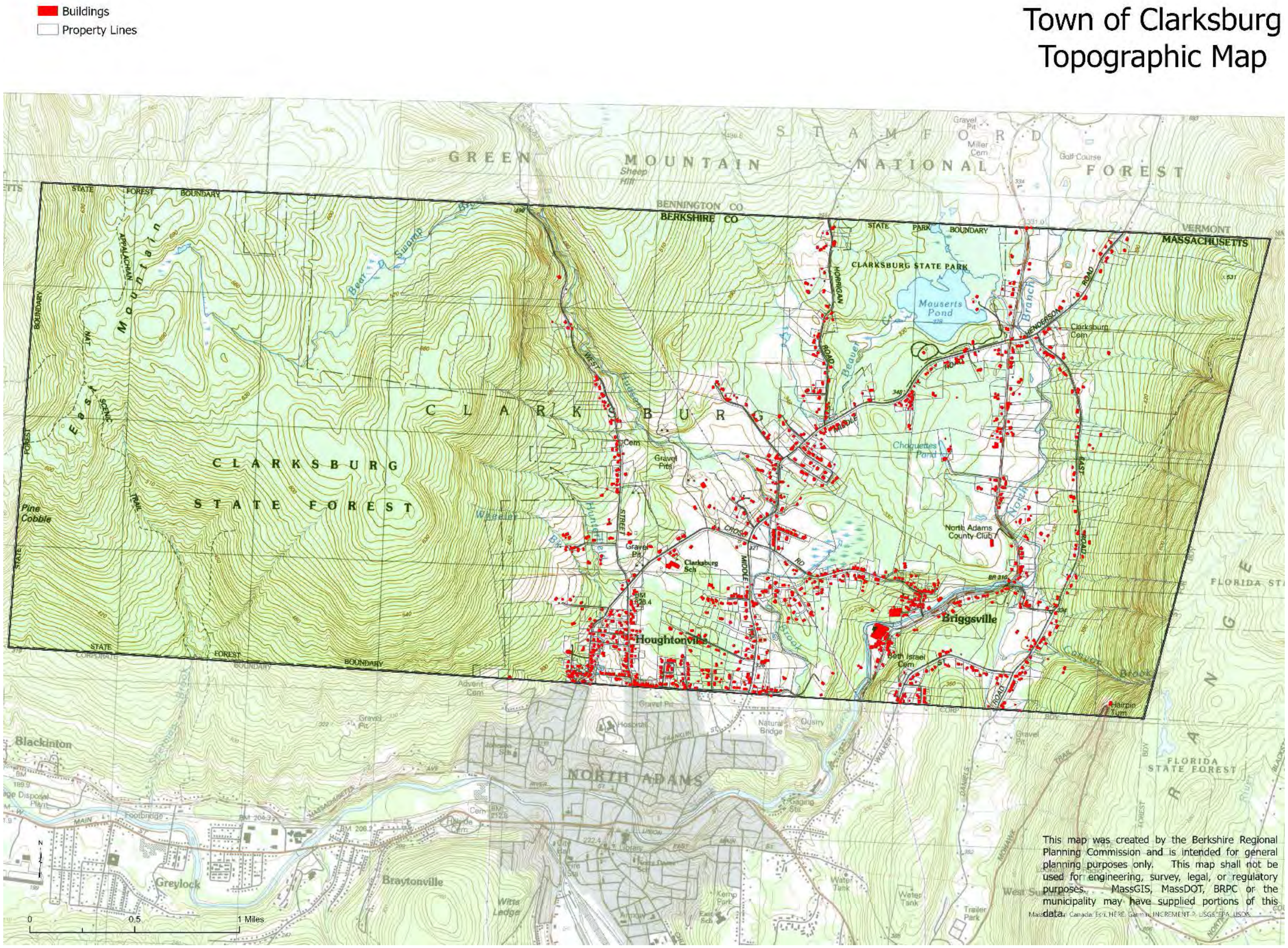


Fig. 3.2. Areas of Environmental Importance in Clarksburg

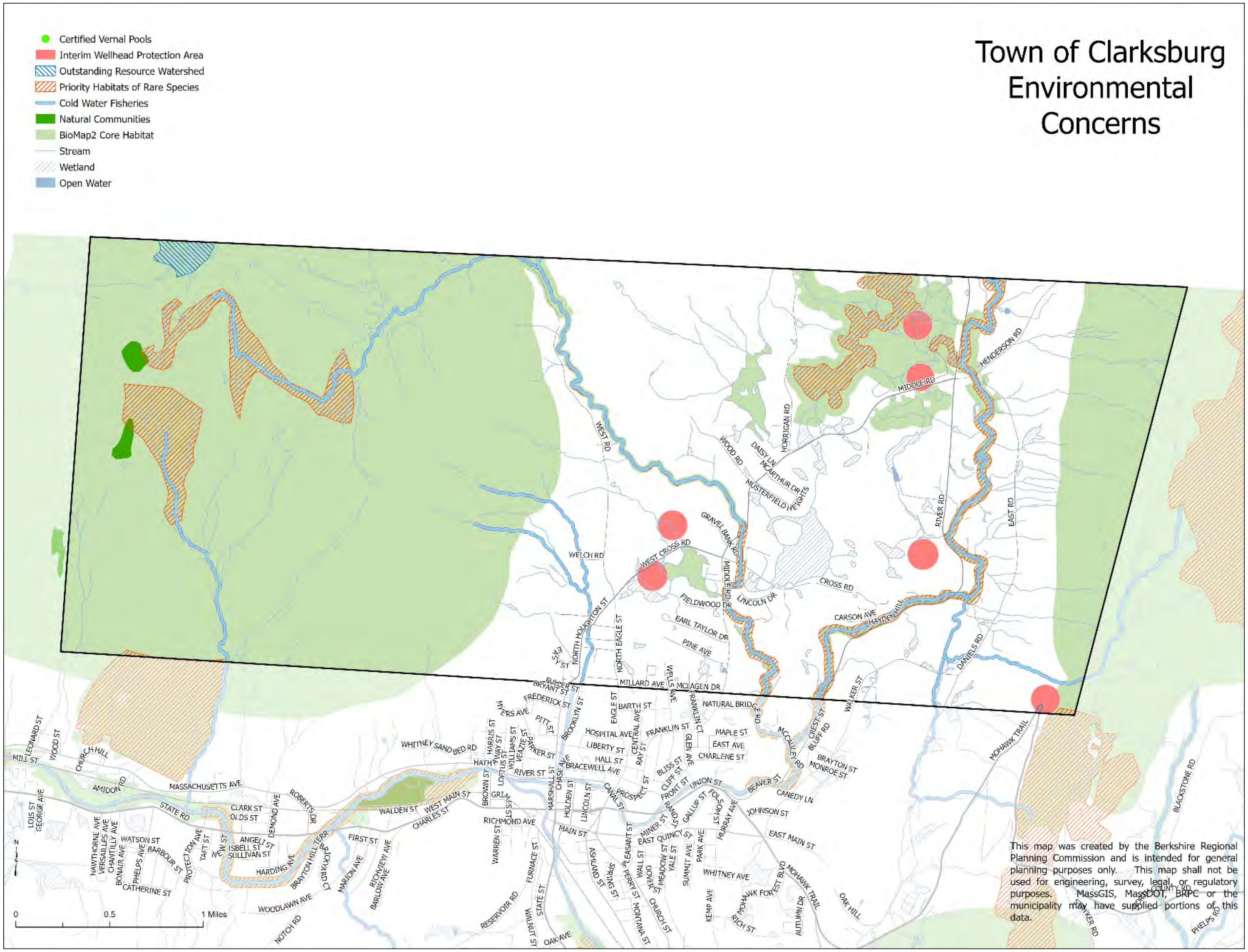
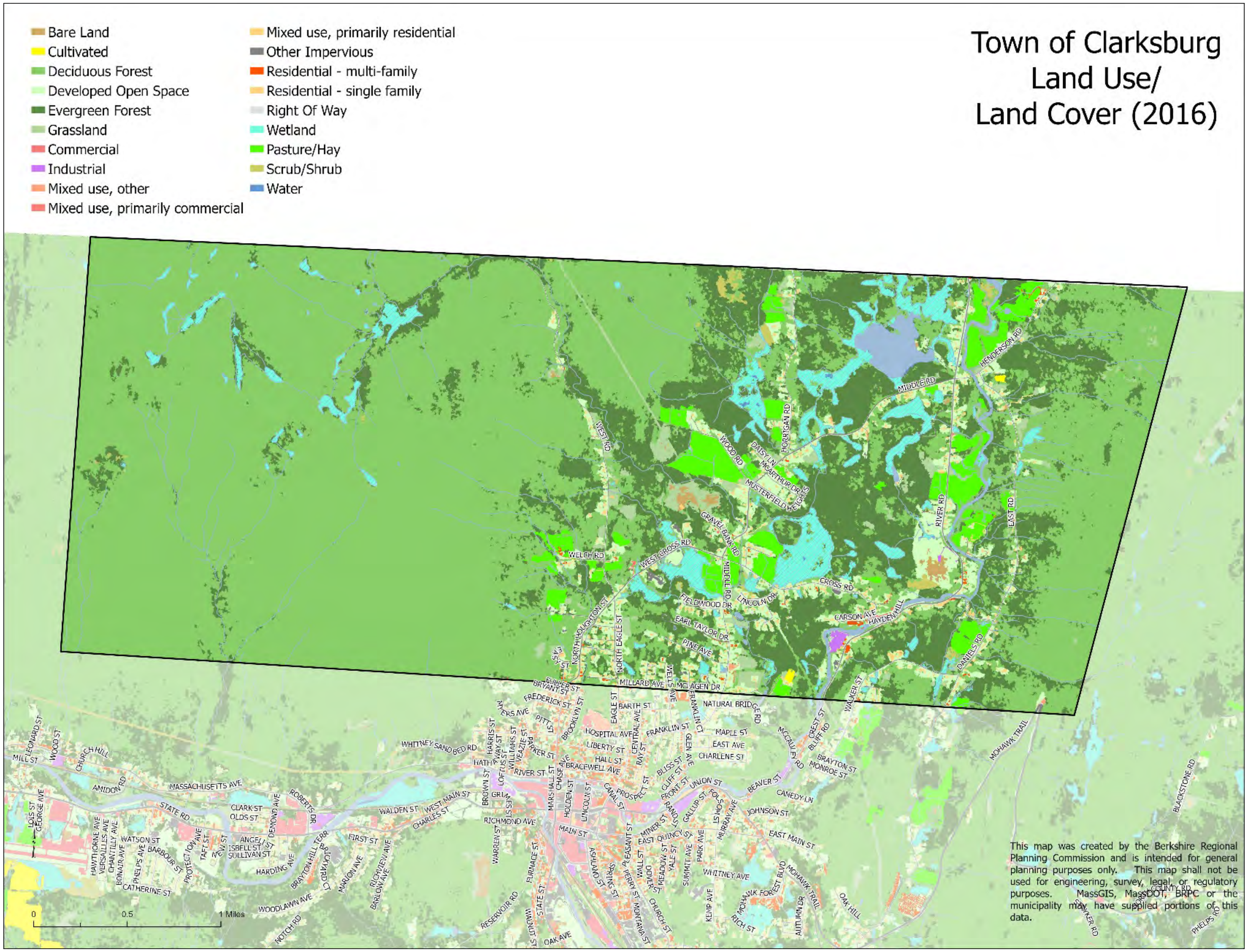


Figure 3.3: Town of Clarksburg Land Use



Built Environment

Only 2.6% of Clarksburg is developed, almost all of which is residential uses. Commercial, industrial lands and other developments combined cover less than one percent of the Town (GIS, 2016). Refer to the Land Use Map Figure 3.3.

Critical facilities are the buildings and infrastructure hubs that are necessary for continued operation during a hazardous event. Table 3.1 lists Clarksburg' Critical Facilities and Figure 3.4 provides a map of the critical facilities and areas of concern. The Briggsville Water District is the Town of Clarksburg's public water system that supplies drinking water to approximately 64 households and commercial properties along the southern portion of River Road, all of Carson Avenue and the buildings at the juncture of Carson Avenue and Cross Road. Spring-fed water is gravity fed from the source southward, with the main line running along River Road, with a junction across the river to Carson Avenue. This junction is attached to the Cross Road bridge. Additionally, several homes in the older, densely developed neighborhoods in the Houghtonville portion of Town (Middle Road, North Eagle and Houghton Street neighborhoods) receive their drinking water from the City of North Adams.

Approximately 230 customers in the southern portion of Clarksburg receive sewer services provided by the Hoosic Water Quality District (HWQD), a regional public entity that serves Clarksburg, North Adams and Williamstown. The properties served are generally the same as served by public water, except that sewer is more extensive, extending across the eastern portion of Cross Road, the southern portion of Middle Road, Earl Taylor and Pine Streets, and the cross streets between North Eagle and Houghton Streets. The effluent is pumped into Williamstown where it is treated and discharged into the Hoosic River. The collection system is owned and maintained by the Town of Clarksburg. The pump stations for this service are located at Carson Avenue and at Cross/Middle Road, both within the 100-year floodplain.

The HWQD is currently in the process of conducting an Infiltration/Inflow (I/I) Analysis of its sewer conveyance system. The Phase 1 I/I Evaluation conducted by the Town's consultant concluded that I/I is low throughout the collection system, with infiltration rates highest in the River Road Sub-Area. The general trend of sustained periods of higher total daily flows occur when groundwater levels are elevated, which is indicative of infiltration entering the Town's collection system. Peaks in total daily flow do not frequently correlate with precipitation events, which is indicative of minimal inflow and rainfall-induced infiltration entering the collection system. Recommended next steps include follow-up investigations with sonar testing, smoke testing, mapping updates and access to previously inaccessible manholes.

Municipal facilities are located in two general areas of Clarksburg. The Town Hall/Police Station and the Briggsville Spring House are located in the Briggsville section of Town, while the Elementary School, Public Works Building and Community Center are located along the West Cross Road section of Town. See Fig. 3.4 for locations.

Table 3.1: Clarksburg Critical Facilities

Type	Name	Address
Fire & Emergency Operations Center (EOC)	Fire Station	181 Cross Road
School & Staging Areas	Clarksburg Elementary School	777 W. Cross Road
Community Services, Council on Aging, Alternate EOC, & Shelter	Community Center	712 W. Cross Road
Public Works	Public Works Building	714 W. Cross Road
Administration & Police	Town Hall	111 River Road
Briggsville Water Spring House	Spring House	River Road
Hoosic Water Quality District Pump Stations	Pump Stations	Carson Ave. & Middle Rd.

Source: Town of Clarksburg, 2021

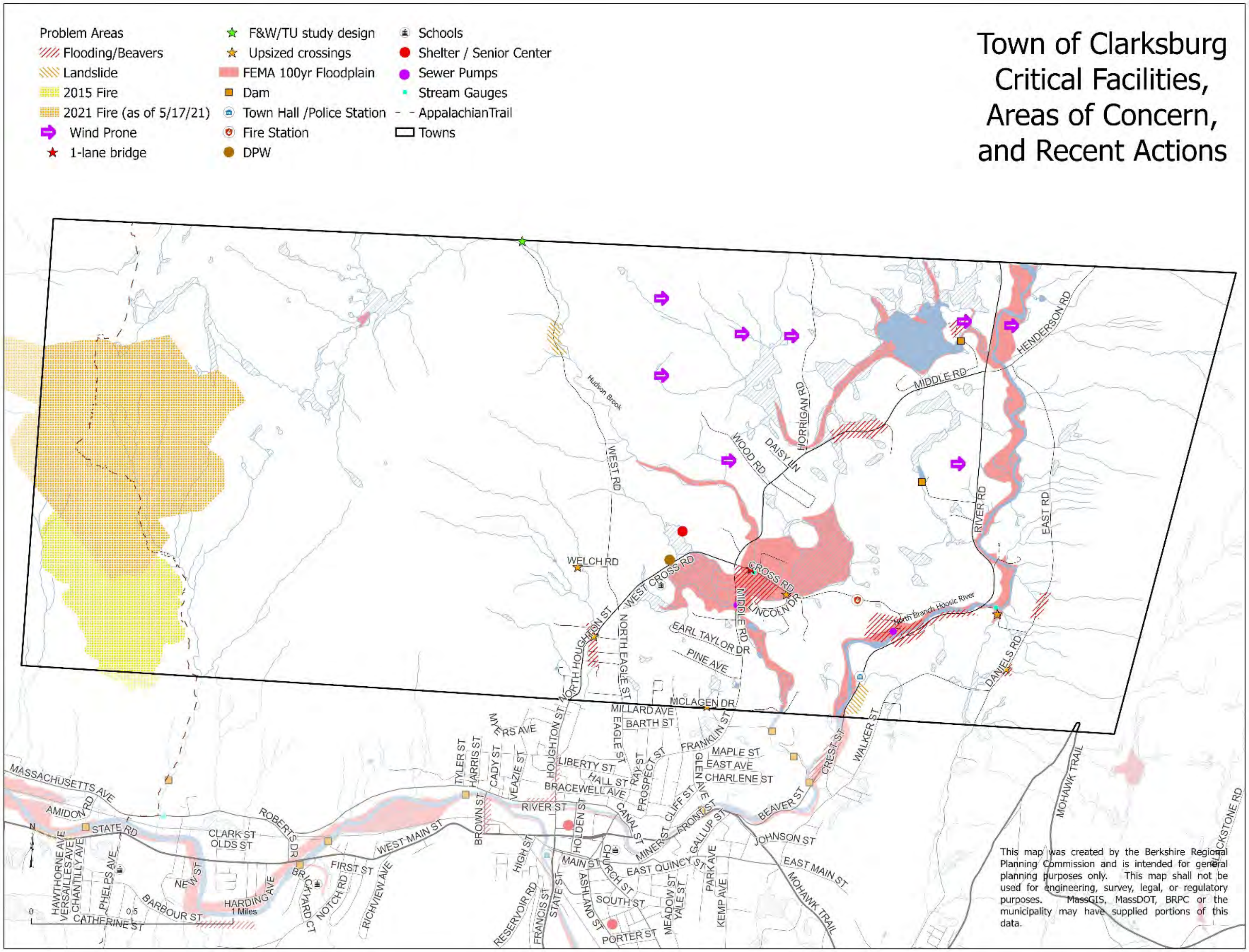
Clarksburg has one of the smallest road networks in Berkshire County with around 23 miles of roadway in total. Of these the Town has jurisdiction over 16 miles, or around 70%. River Road (Route 8), the main north-south travel way through Town, is under the jurisdiction of MassDOT and makes up around 12% of the roadway miles in Clarksburg. Private roads total around 14% of road miles in the community, while the roads under the DCR jurisdiction are within the Clarksburg State Park. The vast majority (83%) of roads in Clarksburg are paved, with most of the remaining 16% being unpaved gravel or graded earth roadways (BRPC, 2017). Refer to Table 3.2. The Town annually receives approximately $70,000 per year from the state's "Chapter 90" program, one of the smallest allocations in the county.

Table 3.2. Road Maintenance Responsibility by Entity

Maintenance Responsibility	Road Miles	Percent Total Miles
MassDOT (River Road / Rt. 8)	2.83	12.3%
MA Dept. Cons. & Rec. (DCR)	0.80	3.4%
Town	16.20	70.2%
Private or Unknown	3.26	14.1%
Total	**23.09**	**100.0%**

Source: BRPC, 2021.

Figure 3.4: Town of Clarksburg Critical Facilities, Areas of Concern and Recent Mitigation Actions



Economy

Almost all working residents (96%) drive outside Clarksburg to work. Employment within Town is provided by the Elementary School, Town government and small but important local businesses. Many of the local businesses that provide services are located in the Briggsville section. The nearest local emergency room and other critical services are located in North Adams, as are the middle and high schools. It is therefore critical that maintaining roads within Clarksburg and working with neighboring municipalities to keep commuter roads open is key for both the health and economic welfare of its inhabitants.

Prioritization

Table 3.3 illustrates the first step in the process of prioritizing hazard mitigation actions in addition to the profiling of local impacts during the risk assessment. The method of prioritization meets requirements of 44 CFR § 201.6(c)(3)(iii). After reviewing information from the 2012 regional hazard mitigation plan, discussing weather patterns and natural hazards that occurred since that time, and considering changing weather patterns expected due to climate change, the Planning Committee worked through and attempted to quantify potential effects of natural hazards on Clarksburg and its citizens. Prioritization also considered public input that residents provided to the Planning Committee through the town-wide survey. Hazards other than flooding are difficult to prioritize without this or a similar ranking system.

Table 3.3: Hazard Prioritization for the Town of Clarksburg

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	
Flooding (include Dam Failure, Ice Jam, Beaver Activity)	3	3	2	7
Severe Winter Events (Ice Storm, Blizzard, Nor'easter)	3	3	1	7
Hurricane & Tropical Storm	2	2	2	6
High Wind & Thunderstorm	2	3	1	6
Drought	3	2	1	6
Wildfire	1	3	1	5
Invasive Species / Forest Pests	1	3	1	5
Vector-borne Diseases	2	2	1	5
Annual & Extreme Temperature Changes	1	2	1	4
Landslide	1	2	1	4
Earthquake	3	1	1	4
Tornado	1	0	2	3
Cyber Attack	1	0	1	3

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	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	events that occur from once in 100 years to once in 1,000 years (0.1% to 1% per year)
2=Medium	events that occur from once in 10 years to once in 100 years (1% to 10% per year)
3=High	events that occur more frequently than once in 10 years (greater than 10% per year)
Magnitude/Severity	
1=limited	injuries and/or illnesses treatable with first aid; minor "quality or life" loss; shutdown of critical facilities & 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 >1 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 2 weeks; property severely damaged <50% and >25%
4=catastrophic	multiple deaths; complete shutdown of facilities for 30 days or more; property severely damaged >50%

Hazard Profile

Inland flooding is generally the result of moderate precipitation over several days, intense precipitation over a short period, or melting snowpack. Developed, impervious areas increased surface runoff and can contribute to inland flooding. Common types of local or regional flooding categorized as inland flooding including riverine, ground failures, ice jams, dam overtopping or failure, beaver activity (tree removal, dam construction, and dam failure), levee failure, and urban drainage. 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." (FEMA, 2011b as cited in MEMA & EOEEA, 2018[3]). The hazards that produce these flooding events in the region include hurricanes, tropical storms, heavy rain events, winter rain-on-snow, thunderstorms, and recovering beaver populations.

In Clarksburg the rivers and streams tend to be dynamic systems, with stream channel and bank erosion common in both headwater and secondary streams. This is especially true for the streams flowing down from the hillsides along the Town's eastern and western sections. 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, especially older mills, homes, barns and other structures that were historically built in floodplain or just upgradient of streambank. 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).

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 to carry heavy debris, erode banks and cause damage. 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.

[3] *MEMA & EOEEA 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

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 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.

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 3.4.

Table 3.4: 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

The classification for potential hazard is in accordance with Table 3.5. The Hazard Potential Classification rating pertains to potential loss of human life or property damage in the event of failure or improper operation of the dam or appurtenant works. The hazard potential classification for a dam has no relationship to the current structural integrity, operational status, flood routing capability, or safety condition of the dam or its appurtenances[4]. Poor condition indicates a dam that presents a significant risk to public safety due to deficiencies such as significant seepage, erosion or sink holes, cracking of structural elements, or vegetation undermining the structural stability of the dam. In Massachusetts the Office of Dam Safety, within the Department of Conservation & Recreation (DCR), is the regulating authority that oversees dam safety.

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

Table 3.5: 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.

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. Mausert's Pond dam has a Significant Hazard classification and Choquette Pond dam has a Low Hazard classification. Neither of these dams is a High Hazard classification that would require that the owner develop and maintain an Emergency Action Plan.

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 3.6: Recurrence Intervals and Probabilities of Occurances

Recurrence interval, in years	Probability of occurrence in any given year	Percent chance occurrence in any given year
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 steep slopes and minimal soil cover, hilltowns such as Clarksburg are particularly susceptible to flash flooding caused by rapid runoff that occurs during heavy precipitation in combination with spring snowmelt. The North Branch Hoosic River and Hudson Brook watersheds are steeply sloped with notoriously flashy water flow regimes. These conditions contribute to riverine flooding that occurs rapidly during heavy rain events. 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).

Historic Data

Flooding has historically occurred across Clarksburg during several severe storm events during the 20th and early 21st century. The North Branch Hoosic River flows southward through the eastern portion of the Town. The North Branch, and the Main Branch, into which it flows was harnessed for power to serve mills throughout the region, including the historic Briggsville mill complex along River Street in Clarksburg and several more mills all along the Hoosic River in North Adams. Buildings were constructed along the riverbanks, including the mills themselves, single- and multi-family homes, and several row houses built for mill workers. Many of these structures survive today, with varying levels of risk associated with them. As noted in historical records, numerous bridges and dams throughout Clarksburg were damaged or destroyed during flood events throughout the 19th and 20th century, including 1898 (Briggsville bridge and coffer dam), 1928 (Hall's Ground bridge, aka Mary Baker bridge), 1948, 1950 (Middle Road, Strong-Hewat dam), 1959, 1964 (footbridge). A local news article stated that the 1950 heavy rain and wind event of November 25th was the sixth extensive flood event in 23 years, where the North and South Hoosic Rivers "went berserk again," even though the rain total was only three inches. River Road has a long history of cracking, sinking, and being undermined, flooded and damages by floodwaters.[5]

A few key streams and rivers in Clarksburg sustained alterations such as channel dredging and armoring. Hudson Brook was periodically dredged and the removed materials were placed along the banks to act as dikes to protect the adjacent land from flooding. This was done largely to protect homes, barns and farm fields from flooding. A *North Adams Transcript* article from September 1957 describes the work as adding 10-20 extra feet above the five-foot deep channel, and involving an additional 1,500 yards of fill and 250 tons of stone to complete the work. Additionally, a cement wall was added to protect a specific property. Once completed, the contractor overseeing the work estimated that it would allow "the water to flow three times as fast through the cleared brook channel." The same article mentions tree cutting along the bank of the North Branch Hoosic River near the Vermont border so that the channel can be dug out and rip rap and fill brought in to armor the banks. This work was in response to the damages and sediment deposition due mainly from the flood of 1948.[6]

There have been dozens of severe precipitation events that caused flooding in the Berkshire County region, the more severe of which are listed with a brief description in Table 3.7. Between 1938 and 2017, four flood events equaling or exceeding the 1% annual chance flood have been documented the Berkshire County region, those being in 1938, 1949, 1955 and 2011. These four events are bolded in Table 3.7. Peak flows and storm velocities in the Hoosic River during the storms of 1938 and 1948 were so high and strong that the waters flooded buildings and streets, washing away structures, bridges, automobiles and debris.

According to data from the USGS gauge #01332500 on the Hoosic River in North Adams (the city adjacent and downstream of Clarksburg), which provides data from 1941 to the present, there have been 37 times when the peak flow exceeded flood stage, which at this site is nine feet. At this site four events exceeded Major Flood Stage (13 feet): 1948/49, 1950, 2011, and 1976. The flood event of record, with the highest water level, was the New Year's Flood of 1948/49, with a peak level of almost 15 feet. In North Adams during this event the Phelps Avenue and Protection Avenue bridges were destroyed and the Petri Cleaning Store on Eagle Street collapsed into the river. Damage to houses in the Greylock section, Front Street, Brooklyn Street and Beaver Street were the worse. All pavement from Wood Street ended up at the Blackinton Mill. Damage in the city was put at $1.2 million. [7]

In addition to these events, there are an additional 17 events that were near flood stage, being between 8.5-9.0 feet. The normal low water elevation for this Hoosic River site is four feet. Because this gauge does not have data prior to 1941, it does not capture the Great Hurricane of 1938, which was one of the most devastating storms experienced in the Hoosic River Watershed. Of the 37 flood exceedances at the North Adams gauge, all but five events have occurred since 1975, and 14 have occurred since the beginning of 2000. Although this data only discusses

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[5] *Author unknown, 11-27-50. "Flood and Gale Cause Heavy Damage in North Berkshire Area," North Adams Transcript.*
[6] *White, Nellie, 9-10-57. "Clarksburg Stream Clearance Nearing Completion," North Adams Transcript.*
[7] *T. Ennis, Before the Chutes, Hoosic Floods Raged, iBerkshires 2-11-04.*

historic peak flows, this coincides with the noticed "stepped" increase in stream flow in USGS stream gauges beginning in the 1970s. Refer to Table 3.7. for a list of flood events impacting the Berkshire region.

There are three USGS gauges in Clarksburg for which flow data was collected a few times during short periods. Flow data were collected on seven separate dates between 1967-69 for a site on Canyon Brook in Briggsville (USGS gauge #01331880 off East Road) and one on Hudson Brook (#01331950 near Stony Brook Drive). Another set of nine flow data sets were collected 1994-96 (USGS #01331960). The data is very sparse and does not have any qualifying specifications, such as water level compared to bank height or compared to normal or peak flows. In fact, when compared against flow data on the Main Stem Hoosic River on the North Adams/Williamstown border (USGS #01332500), the data seems to correlate with very low flow, dry periods in that river, perhaps capturing low flow during predicted drought. Therefore, these gauges do not provide any insight on flood conditions for their respective stream channels or watersheds.

According to the data, local officials and residents, the more notable flood events that occurred in recent years in Clarksburg were that of a severe rain event in 1987, Tropical Storm (T.S.) Irene in 2011 and Hurricane Sandy in 2012. Of these, T.S. Irene was definitely the most destructive.

Table 3.7. 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.
1938	"The Great Hurricane of 1938" was considered a 1% annual chance flood event in several. The Hoosic River flooded downtown areas of North Adams, with loss of life and extensive damage to buildings.
Dec. 31, 1948 - Jan. 1, 1949	The New Year's Flood hit North Adams severely wiping out buildings along the Hoosic River and with many of areas registering the flood as a 1% annual chance flood event.
Nov. 1950*	Heavy rains cause damages throughout county, particularly in North County; bridges, roads, dams, water lines damaged; N. Branch Hoosic River crests higher than 1948; heavy winds cause widespread electricity and phone outages.
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).

April 1987**	Several days of rain dropped more than 8" of rain in some places in MA; Berkshire County and Lowell/Lawrence areas hardest hit
Sept. 1999	The remnants from Hurricane Floyd brought between 2.5-5" of rain and produced significant flooding throughout the region. Due to significant amounts of rain and the accompanying wind, there were numerous reports of trees down.
Dec. 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
Mar. 2003	An area of low pressure brought 1-2" of rain, however this and the unseasonable temperatures caused a rapid melting of the snowpack.
Aug.t 2003	Isolated thunderstorms developed that were slow moving and prolific rainmakers. Flooding led to the evacuation of Berkshire residents.
Sept. 2004	The remnants from Hurricane Ivan brought 3-6" of rain. This, combined with previously saturated soils, caused flooding throughout the region.
Oct. 2005	A stationary cold front brought over 6" of rain and caused widespread flooding throughout the region.
Nov. 2005	Widespread rainfall across the region of 1-1.5", which was preceded by 1-2 feet of snow, resulted in widespread minor flooding.
Sept. 2007	Moderate to heavy rainfall occurred, which lead to localized flooding.
Mar. 2008	Heavy rainfall ranging from 1-3" impact the area. Combined with frozen ground and snowmelt, this led to flooding across the region.
Aug. 2008	A storm brought very heavy rainfall and resulted in flash flooding across parts of the region.
Dec. 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 with intense rainfalls and up to 6" of hail. This led to flash flooding in the region.
July 2009	Thunderstorms across the region caused heavy rainfall and flash flooding.
Aug. 2009	An upper-level disturbance moved across the region during the afternoon hours and triggered isolated thunderstorms causing road flooding.
Oct. 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.
Mar. 2010	Heavy rainfall of 1.5-3" across the region closed roads due to flooding.
Oct. 2010	The remnants from Tropical Storm Nicole brought 50-60 mph winds and 4-6" of rain resulting in urban flooding.
Mar. 2011	Heavy rainfall combined with runoff from snowmelt due to mild temperatures resulted in flooding of waterways, roads, and basements.
July 2011	Scattered strong to severe thunderstorms spread across the region resulting in small stream and urban flooding.

Aug. 2011	Two distinct rounds of thunderstorms occurred producing heavy rainfall and localized flooding of roads.
Aug. 2011	Tropical Storm Irene tracked over the region with widespread flooding and damaging winds. Riverine and flash flooding resulted from 3-9 inches of rain within a 12-hour period. Widespread road closures occurred throughout the region. This event was a 1% annual chance flood event in Northern Berkshire County.
Sept. 2011	Remnants of Tropical Storm Lee brought 4-9” of heavy rainfall to the region. Due to the saturated soils from T.S. Irene, this rainfall led to widespread flooding on rivers as well as small streams.
Oct. 2012	Remnants from Hurricane Sandy brought thunderstorms repeatedly bringing heavy rains over 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.
Aug. 2013	Heavy rainfall repeatedly moved across the region with more than 3 inches of rain in just a few hours. Streams and creeks overflowed causing flash flooding. Roads were closed and water rushed into some basements.
Sept. 2013	Showers and thunderstorms tracked over region and resulted in persistent heavy rain, flash flooding and road closures.
June 2014	Slow moving showers and thunderstorms developed producing very heavy rain over a short period of time. This led to some flash flooding and road closers, especially in urban and poor drainage areas.
June 2014	Showers and thunderstorms repeatedly passed over the same locations with heavy rainfall and significant runoff, causing flash flooding in some areas. Many roads were closed and some homes were affected.
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. Heavy rainfall repeatedly fell over the area resulting in flash flooding and some roads were temporarily closed.
Aug. 2017	Widespread rain moved through the area resulting in isolated flash flooding.

*Table Source: BRPC 2018 (unless otherwise noted); * as reported in North Adams Transcript 11-57-50; **as reported in North Adams Transcript newspaper 12-27-87*

April 1987

According to articles in the *North Adams Transcript* newspaper, several days of downpours dropped more than eight inches of rain across the state, with Berkshire County being one of the hardest hit. High flood waters raged along the North Branch Hoosic River, flooding and threatening the integrity of River Road. Thirty residents in Clarksburg and North Adams had been evacuated due to flood damage risk. At one point opening the Briggsville Dam (just south of the Mary Baker bridge) was considered to release water and reduce pressure against the roadway. This option was considered risky as it could flood and damage many buildings downstream in Clarksburg and North Adams. The apartment building just north of the Beaver Mill dam in North Adams was already flooding due to the deteriorated condition of that dam. In the end the dam's headgate was too rusted to move, not having been operated in several years, and flooding and eventual receding of floodwaters continued without mitigation.

State and local funding paid for dredging of sediment from behind the Briggsville dam. In May 1987 $148,000 in federal funding was used to install rip rap armoring along the bank of the river to protect River Road. According to the newspaper article, local officials were not pleased with the armoring, saying that the rip rap used was not large enough to withstand the pressure of flooding, and that other land along the river was still threatened with flooding and erosion.[8] The light-colored material for this rip rap came from the local lime mining operation in Adams. This material would eventually be dislodged and distributed downstream over a series of flood events, much of which contributed to a medial deposition bar in the middle of the river. An additional $415,000 was awarded to the town to repair other sustained damages across Clarksburg, including repairing roads (such as washed-out West Road) and waterways.

August 2011 Tropical Storm (T.S.) Irene

According to the data, local officials and residents, the more notable flood events that occurred in recent years in Clarksburg were that of Tropical Storm Irene in 2011 and Hurricane Sandy in 2012. Of these, T.S. Irene was definitely the most destructive, resulting in town-wide flooding of roads, properties and homes. Brooks that never overflowed before were overtopping their banks and flooding adjacent land.

Although the North Branch Hoosic River generally flows through a deep and steep channel, the flood waters filled the channel to the very top of the bank. Where the river flows alongside River Road, rip rap and bank armoring was washed away and severe erosion of both sides of the banks occurred. A portion of the west lane of River Road collapsed into the river. Debris was deposited downstream. Floodwaters were close to hitting the public water line that is attached to the bottom of the Mary Baker (Cross Road) bridge. Floodwaters flowed over the bank and into the yard and parking lot of the Cascade School Supply property (former Briggsville mill). If emergency evacuation of Carson Avenue residents were to occur, it would probably have been through flood waters. Flooding of roads and bridges downstream of Clarksburg, in North Adams, were also a concern, as this would cut off first response routes to and from Clarksburg. Floodwaters were approaching the bottoms of the bridges at Natural Bridge State Park and on Beaver Street in North Adams.

It was fortunate that in 2010 the Briggsville Dam was removed. This was done because of the poor condition of the dam and its risk of failure, as well as to improve aquatic connectivity in this cold-water fisheries resource. As part of this work, built-up sediment from behind the dam was removed, the river channel was dug out and newly exposed riverbank was planted with vegetation to anchor the banks. It is believed that removing the deteriorated dam and sediment was a blessing, as the force of the floodwaters could have caused irreparable harm to the dam and

[8] Sweet, William, 12-27-87. "Storms Swell in Clarksburg: from Skies and in Town Hall," *North Adams Transcript.*

caused higher floodwater levels in the area of the old impoundment, possible causing more flooding of Carson Avenue and the homes located there.

The river behind Town Hall, which is typically shallow, overtopped the bank and was flooding the adjacent lawn and parking lot behind the building. As a precaution, equipment and valuable records were moved out of the ground floor to upper levels and the EOC was moved from the Police Station to the Fire Station. This is the only time in memory that the building was severely threatened by floodwaters.

Fig. 3.5. Damage to River Road (Rt. 8) from T.S. Irene

Hudson Brook, a tributary to the North Branch Hoosic, was above bankfull and flooding properties. Trees that had fallen into the swollen channel from above were carried downstream and large items, such as whole trees, were sucked under the Cross Road bridge by force of the floodwaters. There was concern that the bridge would collapse from the strain of floodwaters and debris, partly because of the strain of floodwaters and partly because of the deteriorating condition of the bridge itself. Fortunately, although the area around the Cross Street bridge was flooded, the bridge did not overflow or force closure of the road during the storm.

During this flood event, the Town maintained communications within Clarksburg and with neighboring communities. Town staff (Highway, Police) and volunteers (Fire Company) worked around the clock for two days to maintain travel and evacuation routes where possible, re-route traffic where necessary, communicate with and assist residents and move sensitive equipment from the basement of Town Hall, the yard of which was flooding. First responders went house to house in high-risk areas and suggested that residents evacuate, some of which did. Clarksburg police expanded house-to-house efforts in North Adams to help the overwhelmed first responders in that city. The Clarksburg Fire Company fielded more than 50 calls from residents for major flooding and for trees and power lines down. Many calls were for help with pumping out basements, even for people who never experienced flooding before. In one instance, the flood waters were flowing in one basement window and out the other, with water rising up the cellar stairs.

By the end of the storm, lower River Road (Rt 8), East Road and Daniels Roads were closed due to loss or damage to roads and culverts. Fortunately, Middle Road remained open and in the aftermath of the storm became a north-south route for residents in Clarksburg and for residents in neighboring towns in Vermont. Because Route 9 in Vermont, a major east-west route, was damaged, Middle Road became a travel way for those who needed to travel to north Berkshire County or to Pownal or Bennington, VT.

Figs. 3.6-3.7. Cross Road Bridge has deteriorated to the point that it is down to a one-lane road.

Table 3.8. Summary of Damages in Clarksburg from T.S. Irene 2011

Site	Description of Damages	Repairs / Restoration
River Road (Rt. 8)	River at top of riverbank; floods undermined roadbed and half the road collapses into river in several places; road closed	Eroded riverbank armored with stone, roadbed filled and pavement replaced
Lower East Road	One culvert overwhelmed and damaged; road closed	New upsized culverts replaced damaged ones 2013-14
Carson Avenue*	Flooded; big concern for flooding and loss of evacuation route for residents	No improvements made here; remains high priority flood concern
Daniels Road*	Culvert flooded and damaged	Culvert upsized with concrete wing walls 2012
Northern Middle Road	Culvert plugged up with debris	Cleared but not upsized as it probably should be
Cross Road /Lincoln Drive area*	Double 12" culverts flooded, collapsed	Culvert upsized with new 3'X5' open-bottom span; culvert 1.5 times bank width
Cross Road bridge*	Severe flooding in this whole area; Hudson Brook overflows banks onto adjacent properties in this area but road remains passable; fallen trees and large debris carried downstream and hit bridge; in 2014 upstream (north) side of bridge closed to traffic per MassDOT	Load beam damaged and rotting; wing walls collapsing; traffic down to 1 lane; engineers provided preliminary cost estimate
Henderson Road*	Drainage ditch plugged; caused severe erosion of road bed; road washed out	Repaired

** Site located within 100-year floodplain*
Source: Town of Clarksburg, 2021

October 2012

In 2012 Hurricane Sandy again created high and destructive flows in the North Branch Hoosic River. The armoring along the riverbanks installed after T.S. Irene were washed out and down the river. Large amounts of sediment were redistributed and created an island in the middle of the river, just downstream of the Mary Baker (Cross Street) Bridge. This island has enlarged as vegetation has grown and debris builds up on the island. Now, during periods of high flows, water is diverted around this island and causing accelerated erosion of the bank on the north/west side of the river. Continued erosion could threaten to expose the water line that is located along the river. If severe erosion continues to occur, it could threaten the properties on Carson Avenue.

North Branch Hoosic River Lateral Movement

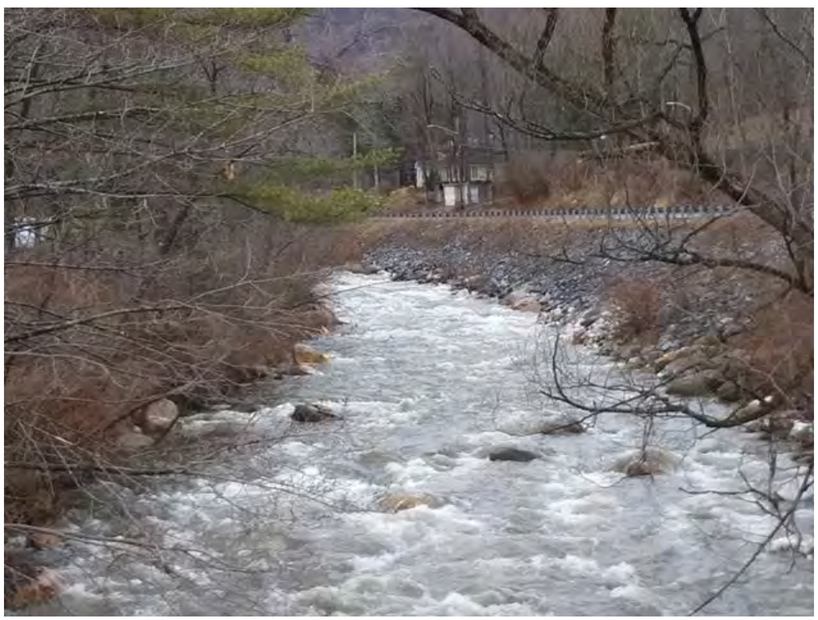
The North Branch Hoosic River is a dynamic river prone to extremely high flows and volumes of water during spring snow melt season and times of extreme precipitation events. The river channel is fairly narrow with high banks on both sides. River Road (Rt. 8) runs along the eastern/southern side of the river here and development is located along the western/northern side of the river. Homes and businesses are located along Carson Avenue and its junction with Cross Road at the Mary Baker Bridge. Powerful floodwaters erode the banks of the river and for decades has periodically damaged River Road, requiring frequent re-armoring of the riverbank and repairs to the roadway. According to historic newspaper reports, several repair projects involving adding fill and asphalt to the sinking road surface and armoring the bank with rip rap have been conducted along the river in the years preceding 1976, 1978-79, 1987, and 2011.


The Transcript

RIVER WORK—Truck dumps load of lime rock for riverbed in the North Branch of the Hoosac River in Clarksburg, just north of the Mary Baker bridge. The project is in its second year to support a small section of road that has been sinking for the past few years. (Transcript-Trabold)

Source: North Adams Transcript 5-22-79.

Fig. 3.8 Above: Rip rap armoring of North Branch Hoosic River May 1979 just north of Mary Baker Bridge.



Source: BRPC 2021.

Fig. 3.9 Left: The same stretch of river March 2021 showing rip rap armoring to protect River Road.

There is a history of deposition in the river just upstream of the former Briggsville dam. Rip rap, debris and other materials are periodically dislodged during flooding events and moved downstream. As shown in the succession of aerial views of the river (Figs. 3.10-3.13), a medial bar island has been created mid-stream in the river. Flooding in 1984 dislodged and moved downstream much of the limestone rip rap that was installed in the late 1970s, with some flowing over the dam and being deposited downstream and some left behind the dam. In 2005 this was present just upstream of the Briggsville dam, presumably due to a combination of normal settling of sediment behind the impoundment and of deposition of cobbles, rock, rip rap and debris during successive high flow events. The island has been there so long that shrubs and trees have become established on it. The eastern/southern bank of the river is armored to protect the road but the western/northern bank is not armored. Over the course of the years, the island has created a constriction in the river, with the main flow passing on the western/northern side of the island. During high peak volumes, the water erodes and undercuts the unprotected bank. This erosion of the river was severe during T.S. Irene flooding, stripping away bank vegetation and exposing glacial soils. Additional erosion and deposition occurred during Hurricane Sandy in 2012, and continues with each successive flood event. Homes and other structures located along the western/northern bank of the river could become threatened if the frequency and severity of flood events increase in the future, as is predicted.

Fig. 3.10. Changes in the channel of the North Branch Hoosic River 2005-2018

Development of a vegetated, longitudinal, teardrop-shaped medial bar over time within the Hoosic River (north branch) near Carson Avenue, following removal of the Briggsville dam in Dec 2010. Tropical storm Irene struck during late August 2011.

Source: Courtesy Jim Brandon, GeoPinva LLC, 2021.

Fig. 3.11. North Branch Hoosic River showing lateral movement in proximity of Carson Avenue structures

Source: Courtesy Jim Brandon, GeoPinva LLC, 2021.

Figs. 3.12 – 3.13. 2021. North Branch Hoosic River below right: the medial bar downstream from the Mary Baker bridge causes flood waters to erode the western/northern river bank. **Below left**: the erosion of the west/north riverbank with Carson Avenue homes in the background.

Source: BRPC, 2021.

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.

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% 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).

Table 3.9 lists the two dams that are located in Clarksburg, providing a summary of Hazard Code, condition and location. Records available indicate that the Mausert's Pond dam was last inspected in 2016 and that the dam was found to be in good condition. If the dam were to fail, properties downstream would likely be impacted, the extent of which would depend on the severity of the failure. The extent of damages is unknown due to the lack of a detailed study.

The Choquette Pond dam is categorized as "non jurisdictional" meaning it is defined as being less than six feet in height and store less than 15 acre-feet of water. There is no data available on the condition of this dams because the Office of Dam Safety does not inspect dams of this small size. The locations of the two dams are found on the Critical Facilities Map (Fig. 3.4, found in the early pages of Section 3 of this plan).

The historic Briggsville Dam (aka Strong, Hewat & Co. dam) on the North Branch Hoosic River was removed in 2010 as part of an effort to restore aquatic connectivity and remove a flood hazard risk. The dam removal project was one of the largest that had ever been undertaken in the state at that time. A kiosk was installed at the edge of the river to educate the public about the dam's history and removal.

Table 3.9: Dam Hazard Status for Clarksburg

Name	Hazard Code	Size Class	Inspection Condition & Date	Owner	Location
Choquette Pond Dam	Low	Non-jurisdictional	NA, 1975	J. White	Choquette Pond outlet, trib. of North Branch Hoosic River
Mauserts Pond Dam	Significant	Intermediate	Good, 2016	Comm of Mass - D C R	Trib. of North Branch Hoosic River

Source: Office of Dam Safety, 2004; ??, 2018.

Historically, dam failure has had a low occurrence in Berkshire County. However, there have been two dam failures in East Lee in southern Berkshire County, from dams that impounded the same pond. On April 20, 1886 the Basin Pond dam breached and flooded East Lee, killing seven people and damaging almost every house along the Basin Pond Brook corridor on Water and Cape Streets. In 1965 a developer constructed a new dam at Basin Pond, and that one breached in March 1968, killing one person and damaging buildings along the brook corridor. The floodwaters damaged the Clarke Aiken paper mill to the point where it was demolished and the site abandoned, causing the loss of a key local employer. The deaths from these dam failures, although unique, make this hazard one of the deadliest in the county.

More recently, in September 2004 an incident occurred at the Plunkett Lake dam in Hinsdale, a few towns south of Clarksburg. On September 18, 2004, after the effects of Hurricane Ivan dropped more than three inches of rain on the area in 24 hours, the flash boards at the Plunkett Lake dam gave way. The Emergency Management Director for Hinsdale calculated that approximately 8 million gallons of water flooded the Housatonic River downstream of the lake, causing some minor flooding. There was no permanent damage or real estate damage, but the CSX rail line was undermined in the Hinsdale Flats area. This was largely due to beaver activity, where culverts were partially plugged; impeding and redirecting flood waters (BRPC, 2012).

Vulnerability Assessment

Geographic Areas Likely Impacted

Clarksburg has relatively few acres of land identified as being within the 100-year floodplain. Using the FIRM boundaries as delineated in MassGIS, there are 396 acres of land within the 100-year floodplain, which is 4.8% of the Town. Of these floodplain acres, 51 acres are developed, representing 13% of floodplain in the Town. Many of these buildings are clustered near Hudson Brook and the two wetlands that drains into it in the Cross Road / Middle Road / Lincoln Drive area of Town. The main east-west travel way in Clarksburg is Cross Road, which serves as a connection between residences and community facilities along the River Road corridor (Town Hall, Police Department, businesses) with residences and facilities along the West Cross Road corridor (Clarksburg Elementary School, Highway Department, Community Center/Shelter). The Clarksburg Fire Company, which also serves as the Town's EOC, is located on Cross Road. The bridge over Hudson Brook in poor/fair condition and was restricted to a one-lane road in 2014 because the bearing capacity bridge is significantly deteriorated. According to an engineer's report, the concrete deck has significant spalls and cracking with exposed rebar. The substructure is in poor to fair condition with scaling, spalling, efflorescence and cracking at various locations of the concrete abutment bridge seats, backwalls and breastwalls. The wingwalls are also heavily cracked/scaled throughout and concrete footings are exposed in many areas. Full bridge removal and replacement options that will meet the state Stream Crossing Standards are being considered, with cost estimates ranging $550,000-700,000.

If a flood event were to further damage or destroy the bridge, fire and police emergency response times to the West Cross Road area and the western part of Clarksburg would increase substantially because they would have to travel southward through North Adams and re-enter Clarksburg or travel north along River and Middle Roads. These detours add approximately 10-20 minutes to emergency response times, depending on the exactly where the response was needed and where first responders would be dispatched from. River Road itself has become damaged and impassible several times in the past 100 years. To add to these emergency response concerns, the Cross Road / Carson Avenue area and the Cross Road / Lincoln Drive / Middle Road area are prone to periodic flooding. Location of Critical Facilities and areas of flooding concern are shown in the map in Figure 3.4.

Another cluster of buildings within floodplain are along Carson Avenue and the Cross Road junction, an area with a history of flooding. Homes on Carson Avenue are single family and multifamily (former mill housing structures), with a few small businesses nestled at the junction. Basements and driveways in this area commonly flood. More recently flooding in this area has been increasing, with local officials believing that land use changes on Demers Avenue upgradient of Carson Avenue have contributed to increased surface runoff and groundwater seepage.

According to a local newspaper article in May 1957, raising of the road and installation of a large subsurface drainage pipe was installed in this area to direct water into the North Branch Hoosic was planned. The Cross Road stormdrain system of five or six catch basins converge here and, through one or two outlets, drains into the North Branch Hoosic River. The drainage system may be undersized for current flows, and the outlets themselves may become submerged by floodwaters during high flow events, disallowing discharges and causing backup of water. The Town is conducting work on a section of Cross Road that includes a retaining wall just upgradient of the junction. It is hoped that the work done to redesign and reconstruct the retaining wall, including new drainage, will lessen flooding in this area.

Concern about flooding in this area goes beyond damages to private property. The Fire Station is located just up the hill on Cross Road, and if the roadway in this area is flooded fire trucks would be cut off from easily responding to calls along River Road and the eastern portion of Town. Similarly, if the Cross Road bridge on Hudson Brook were to be closed completely or lost during a storm, responding to calls west of Middle Road would require a long detour.

Other buildings within floodplain tend to be located along the North Branch Hoosic River corridor. These floodplain areas are noted in the map in Figures 3.14A-C, with each building represented by a red dot. Major transportation routes within the 100-year floodplain include River Road

(Rt. 8), which is the main north-south route that links Clarksburg to North Adams and other areas in Berkshire County and to Vermont. Cross and Middle Roads are the other two main travel ways linking residents to neighboring communities.

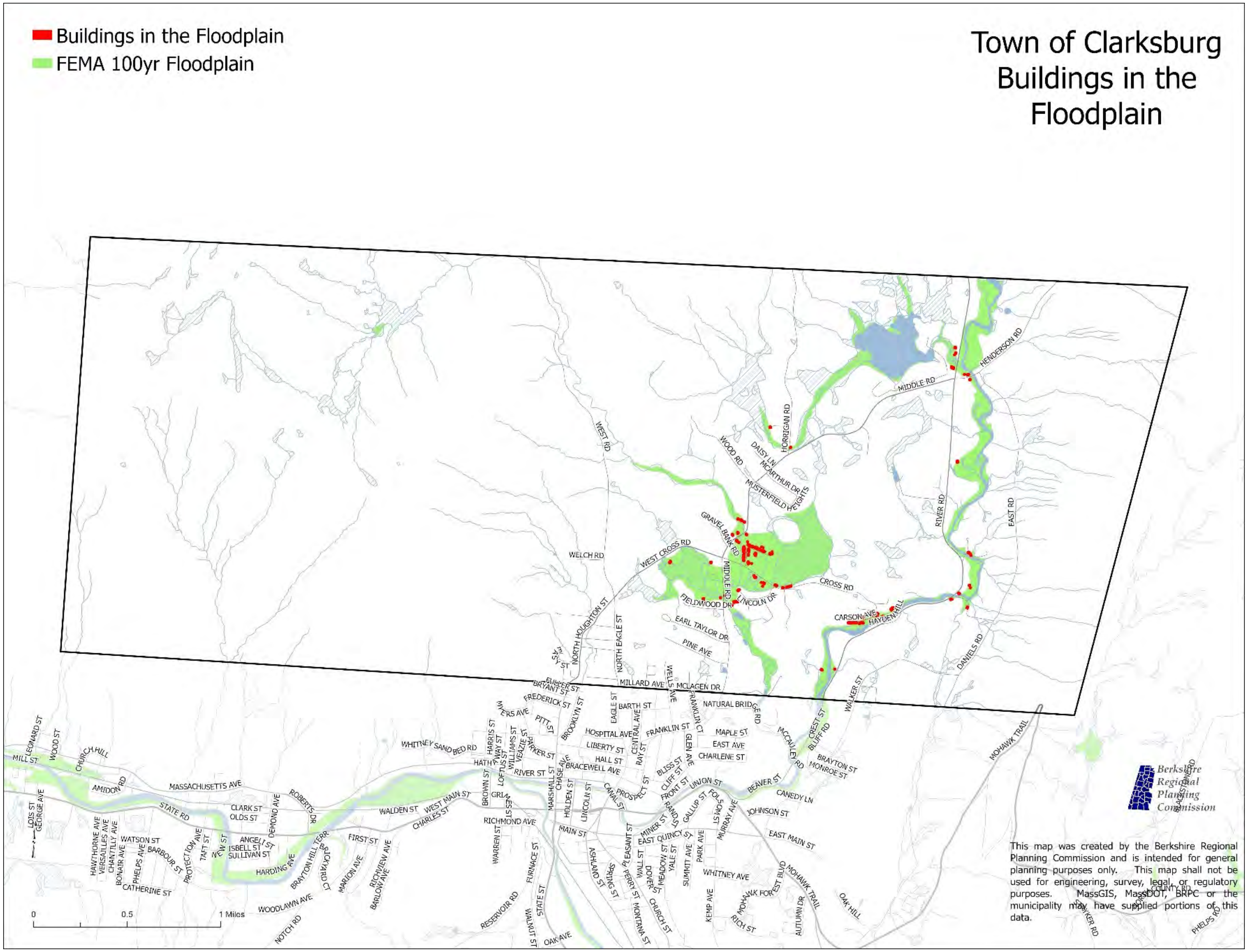
Listed below are several sections in Clarksburg that are flood-prone and which need to be monitored during spring runoff and heavy rain events. Of this list, only the Middle Road/Cross Road/Lincoln Drive is in the 100-year floodplain. Generally, these areas are monitored most closely and are shown on the Critical Facilities and Areas of Concern map in Figure 3.4:

- Roads and residential properties at Middle Road / Cross Road / Lincoln Drive junction, where Hudson Brook and two tributaries converge (new upsized culvert replacement will hopefully alleviate some flooding here)
- East Road with steeply sloped terrain
- Several sites along northern Middle Road
- Demers Avenue (private road)
- Several areas along Houghton Street at junctions of Inga Avenue and School and Gleason Streets (repairs at Gleason will hopefully alleviate flooding here)

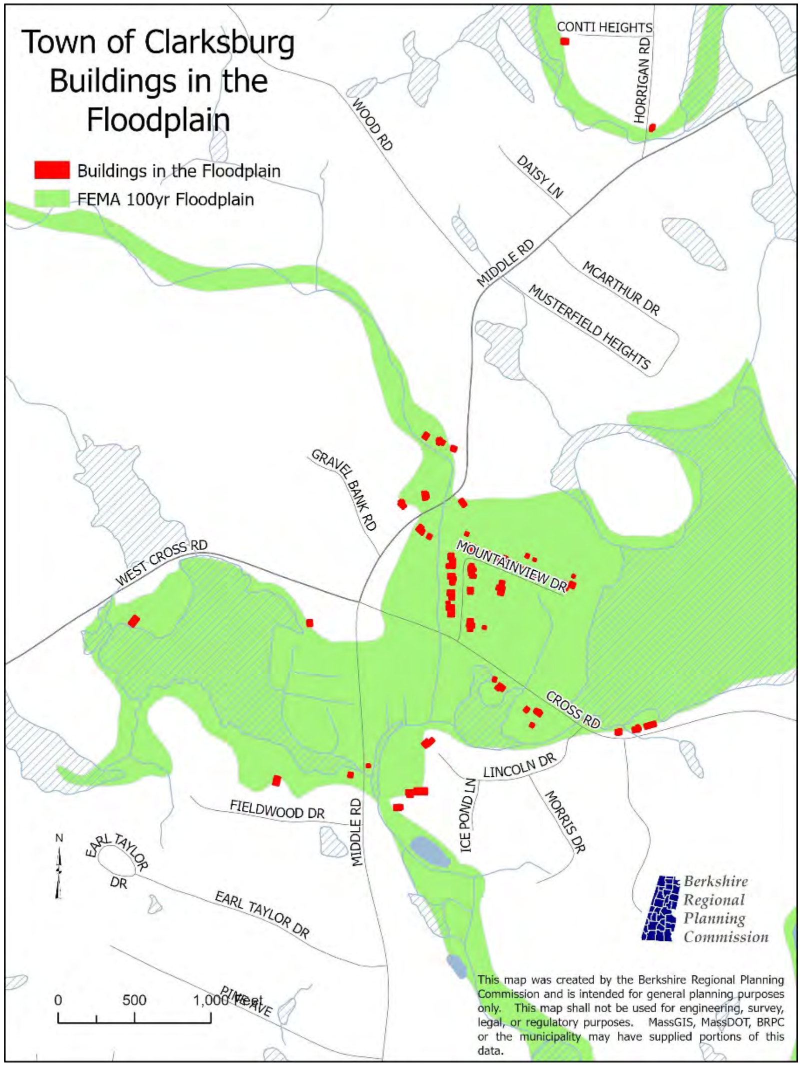
Risk of adverse beaver activity occurs periodically throughout Clarksburg. An article in the *North Adams Transcript* in May 1951 describes a set of dams and other beaver activity that was flooding properties off of Horrigan Road and hampering the use of the rifle range of Company K of the local National Guard. A previous beaver dam of concern failed in 2020, flooding a portion of the former golf course and no longer presents a hazard. Of concern in 2021 is near Mauserts Pond, where beavers have created a dam where two tributaries converge at the pond's outlet. The culvert and two properties are at risk of flooding in this area.

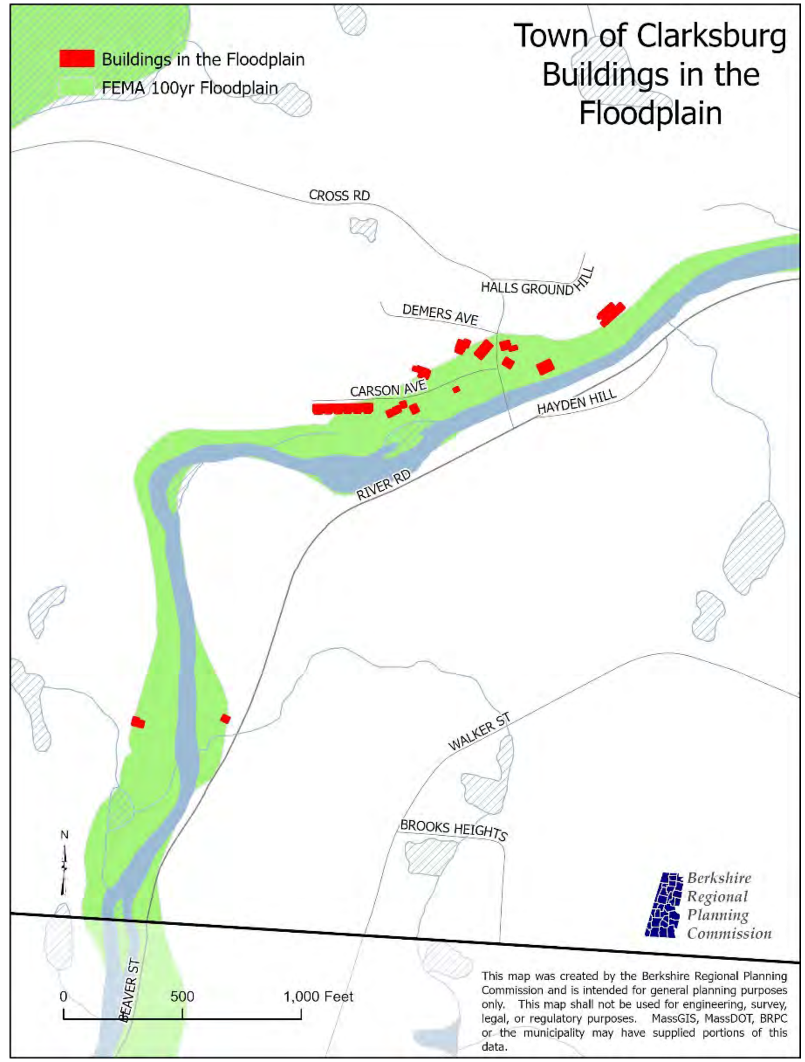
The Mausert's Pond dam is categorized as an Intermediate-sized dam with a Significant Hazard rating. If the dam were to fail, properties downstream would likely be impacted, the extent of which would depend on the severity of the failure. The extent of potential damages within the inundation area is unknown due to the lack of a detailed study or Emergency Action Plan, which is not required for a dam of this hazard rating.

Figure 3.14.A: Town of Clarksburg Floodplain Development



Figures 3.14.B. and 3.14.C. Buildings in 100-year Floodplain in the Cross Road / Middle Road area and in the Briggsville section of Clarksburg.





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. According to MassGIS and assessor parcel data, there are 58 residential and one mixed-use building in the 100-year floodplain in Clarksburg. According to 2019 data from the American Community Survey, there are an average of 2.5 people per household in the Town. Presuming that people occupy both the residential and mixed-use buildings, potentially 148 people could be impacted by flooding during a 100-year storm event (59 units * 2.5 people = 148 total people). In a worst-case scenario, a significant number of these people may need to be evacuated during their homes and sheltered. It should be noted that historical records indicate that total loss of all buildings and content in floodplain has never occurred in Clarksburg, and is very rare in the region. It is more likely that flooding would result in partial damages or loss of a building and its content, as demonstrated through past flood insurance claims in the region.

This figure captures only those people whose homes are located within the floodplain. It does not capture people who might be stranded due to roads washing out, bridges being compromised or destroyed, or flooding of properties not in floodplain but impacted from debris blocking streams channels, bridges or culverts. Fortunately the total number of injuries and casualties resulting from typical riverine flooding is generally limited due to advance weather forecasting, blockades, and warnings.

The historical record from 1993 to 2017 indicates that there have been two fatalities in in Massachusetts associated with flooding, both in Topsfield during the Mother's Day Flood of 2006, and five injuries associated with two flood events, occurring within two weeks of each other in March 2010. However, flooding can result in direct mortality to individuals in the flood zone. This hazard is particularly dangerous because even a relatively low-level flood can be more hazardous than many residents realize. For example, while 6 inches of moving water can cause adults to fall, 1 foot to 2 feet of water can sweep cars away. Downed powerlines, sharp objects in the water, or fast-moving debris that may be moving in or near the water all present an immediate danger to individuals in the flood zone. Events that cause loss of electricity and flooding in basements, which are where heating systems are typically located in Massachusetts homes, increase the risk of carbon monoxide poisoning.

According to the U.S. Environmental Protection Agency (EPA), floodwater often contains a wide range of infectious organisms from raw sewage mainly intestinal bacteria (OSHA, 2005). Flooded streets and roadblocks can also make it difficult for emergency vehicles to respond to calls for service, particularly in rural areas such as Clarksburg.

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

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. There is often limited warning time for a dam failure event, which increases the risk for injury or death from a severe failure. This was the case of the deaths associated with the dam failures in Lee. 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 (MEMA & EOEEA, 2013).

Built Environment

Approximately 51 acres of Clarksburg's 100-year floodplain has been developed, with represents 13% of total floodplain. The Clarksburg Town Hall building is located in the vicinity of the outer boundary of the 100-year floodplain. Flooding from the North Branch Hoosic River, which flows along the back of the property, has historically not flooded the building. However, floodwaters from the river came right up to building during T.S. Irene in 2011. Critical equipment and communications were moved from the ground level to protect them from possible damage. Seepage into the lower level required the Town to have the carpets professionally cleaned. The FIRM map for Clarksburg was drafted in 1982, almost 40 years ago. As precipitation patterns and flow regimes change in a warming climate, the boundaries of the 100-year floodplain could shift. The Town sewer pumps on Carson Avenue and Middle Road are both located within the floodplain but to date have not been damaged.

Table 3.10 summarizes the number and types of buildings in the floodplain according to the GIS FIRM data, as well as the potential value of the building and building contents lost in a 100-year flood event. With the aid of GIS technology using FIRM boundaries and MassGIS parcel data, 62 buildings in Clarksburg have been identified as being located in the 100-year floodplain. Of these, 58 are residential buildings (representing 9% of total residential stock in Town), one is a mixed-use buildings (12% of total stock), and three are commercial buildings (60% of total stock). It should be noted that the commercial and industrial figures are now less than the eight buildings identified in the floodplain in the previous Hazard Mitigation Plan of 2015. This is because the advances in GIS technology now offer much better identification of buildings within the 1982 FIRM boundaries.

Table 3.10 summarizes the potential lost value of buildings and their contents. For the purposes of this analysis, the value of contents for residential buildings is 50% of property value, mixed use is 75% of property value, and commercial is 100% of property value

Table 3.10: Estimated Number of Buildings in the Floodplain and Potential Value Lost in a 100-Year Flood Event

Type	Number of Buildings	Value of Buildings	Value of Contents	Total
Residential	58	$11,288,300	$5,644,150	$16,932,450
Mixed Use	1	$71,700	$53,775	$125,475
Commercial	3	$112,400	$112,400	$224,800
Total	62	$11,472,400	$5,810,325	$17,282,725

Source: MassGIS Assessor Parcel Data 2020 and BRPC 2021.

The Town of Clarksburg is a NFIP community. 44 CFR § 201.6(c)(2)(ii) requires all plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods. According to data received in July 2020 from Joy Duperault at FEMA, there are seven active single family home flood insurance policies in force (for a total premium cost of $7,034) and one 2-4 unit family flood insurance policy in force (premium cost of $1,826). The total amount of insurance value in force for all these properties is $791,000. Only the 2-4 unit home has received a NFIP flood insurance payment of $2,255. This property is one that existed prior to the development of the FIRM in 1982. There are no policies for commercial properties. All the properties are located in the A01-30 & AE Zones. There are no repetitive losses in Clarksburg (FEMA Community Information System data 7-2-20).

As noted earlier, flood damages have been incurred by private and public owners at sites across Clarksburg for more than 120 years. Several Town roads sustain damages during severe storms, with costs totaling approximately $223,480 just for T.S. Irene. Of this $109,000 was spent on repairing and upsizing the culvert on Daniels Road. FEMA funds reimbursed much of these costs. MassDOT has incurred multiple damages to River Road over many storms and decades, including heavy damages during T.S. Irene, even though the section that is damaged most often is not within the 100-year floodplain as delineated in the 1982 FIRM.

Although the Town has many bridges and culverts that are prone to periodic flooding, the bridge that is of most concern is the Cross Road bridge over Hudson Brook. The crossing is located in a Flood Hazard Zone A area and an improved span of a properly-designed bridge for this site is costly. An engineering firm's cost estimate for a permanent, long-term bridge replacement is $550,000-750,000. To undertake such a replacement, the Town must seek state or federal funding assistance. If a flood event were to further damage or destroy the bridge, fire and police emergency response times to the West Cross Road area and the western part of Clarksburg would increase substantially because they would have to travel northward and use Middle Road or travel southward through North Adams and re-enter Clarksburg. These detours add approximately 20 minutes to emergency response times. River Road itself has become damaged and impassible by flooding several times in the past 100 years, which would eliminate the northern detour option. Location of Critical Facilities and areas of flooding concern are shown in the map in Figure 3.4.

The lateral movement and erosion of bank along the North Hoosic River in the vicinity of the Mary Baker Bridge most immediately threatens the long-term safety of A-1 Inc. Erosion here could undermine the bank and cause the building to subside into the river during a severe flood event. Also in this vicinity, the Briggsville Water District's water line is buried on the north/west side of the river. Although erosion has not yet reach or exposed the pipes, it is a situation that needs to be monitored to protect public water for residents and businesses in this area of Clarksburg.

Recently a bridge on the two-mile trail that circles around Mauserts Pond in Clarksburg State Park was damaged and lost during a flood event. Although the footbridge is not of a level that would be considered a critical facility, it is the main, most popular trail in the park and it located at a key junction. The loss of this bridge impacts the recreation value of the trail and may hinder some people's ability to fully enjoy being surrounded by nature.

Severe flooding can threaten the functionality or structural integrity of dams. Dam failures, which are defined as uncontrolled releases of impounded water due to structural deficiencies in the dam, can occur due to heavy rain events and/or unusually high runoff events (MEMA, 2013). 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. River Road and residential properties downstream of Mauserts Pond would likely be impacted if the dam were to fail completely. The dam is an earthen dam with a concrete spillway at which flash boards are used to control water level. DCR staff are responsible for managing safe water levels and currently draw the pond down 2-3 feet each fall to create additional storage capacity. The dam is not a High Hazard dam, so an emergency action plan and inundation map have not been developed for this structure, and it is therefore not possible to quantify potential damages from failure of this dam.

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

Electrical power outages can occur during flood storm events, particularly when storm events are accompanied by high winds, such as during hurricanes, tropical storms, thunderstorms and micro-bursts. As demonstrated by local news articles, this type of impact has occurred several times during the last several decades. Heavy winds accompanied T.S. Irene in 2011.

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

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

Natural Environment

Flooding has the potential to affect the natural environment in several ways. Septic systems can flood as can a wastewater treatment plant, contaminating the surrounding areas, posing health risks, and damaging the environment. A common effect of septic overflows due to flooding is nutrient overloads in nearby bodies of water that can kill native wildlife and vegetation. Flooding can spread chemical and bacterial contamination potentially harmful to people, the environment, and wildlife.

Flooding can remove trees, other vegetation, rocks and soil causing erosion, high turbidity and the loss of community assets. Stormwater collects contaminants and sediment from roads and other surfaces and transports it into waterways if there is not a sufficient buffer to filter out the contaminants and sediment. Typically, there is no infrastructure in place to protect from nonpoint source pollution of this type.

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 and debris downstream including at culverts and bridges leading to further damage.

Additionally, flooding can spread invasive species that damage aquatic and terrestrial plant communities and degrade water quality. Invasive species can be carried downstream and dispersed into new areas in flood waters. Japanese knotweed, an invasive plant already found along the North Branch Hoosic River, is readily spread when fragments of stems, roots and crowns are pulled and transported in floodwaters.

Economy

The impacts of flooding on the economy include the value of buildings and businesses potentially lost during a flood event, the loss of business revenue during the response and recovery period, economic loss due to an inability to commute to work or communicate, and the burden of paying for recovery and the rebuilding of infrastructure. The ongoing operation of the local businesses in the floodplain are critical to the long-term sustainability of Clarksburg, not only for the tax revenue that they generate but also for the services they provide to residents in Town and in neighboring communities. 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.

By law dam owners are required to maintain their dams in good working order, which is a costly endeavor and a liability risk. The owners of the Cascade School Supply Company in Briggsville, a small, family-owned business, were facing over $250,000 in estimated costs to repair the Briggsville dam adjacent to their former mill complex. The dam was rated as being in Poor condition by the Office of Dam Safety, was continuing to deteriorate and was an attractive nuisance. The repair costs were making it difficult for the company to continue to operate at the site. As an alternative to repair, a coalition of state, federal and non-profit provided funding to remove the dam and restore the river to a more natural flow regime. Removal would also likely reduce floodwater levels during storm events. According to the Mass. Department of Ecological Restoration, the total cost to remove the dam was approximately $920,000 for engineering, permitting, and construction, of which 5% of that cost came from the company.[9] Cascade continues to operate in the former mill complex and contribute to the economic health of the community. The former mill buildings are not located within the 100-year floodplain, being located on high ground above the river.

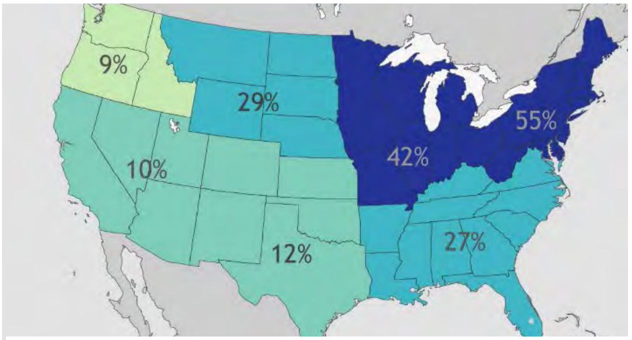
Future Conditions

The scientific community agrees that climate change is altering the weather and precipitation patterns of the northeastern region of the U.S. 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 55% in the Northeast between 1958-2012 (see Fig. 3.15). It is projected that this trend will increase at least another 40% by the end of the century.[10] During that period the region experienced the drought of record, a nine-year drought 1961-69, which may skew or underestimate the long-term trend.

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 pattern events could increase the risk of ice jams. Many studies agree that warmer temperatures late in the 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).

Figure 3.15 Increase in Precipitation Falling in Top 1% Extreme Precipitation Events 1958-2016



Source: NOAA, 2019.

[9] *https://www.mass.gov/service-details/briggsville-dam-removal-hoosic-river-restoration*

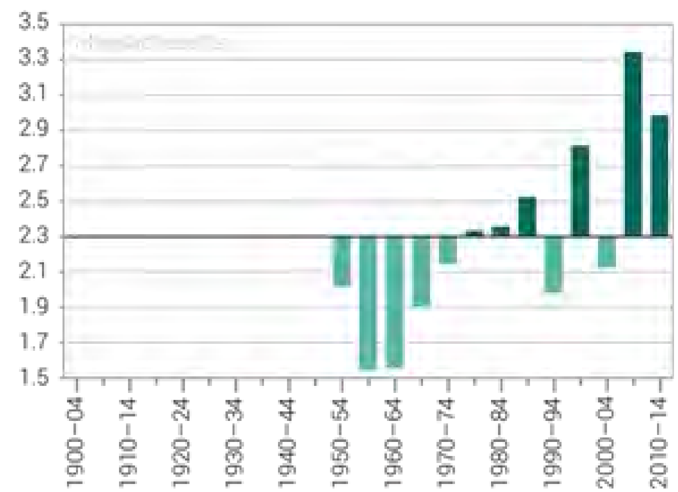
[10] *Scott, Michon, NOAA, 7-10-19. https://www.climate.gov/news-features/featured-images/prepare-more-downpours-heavy-rain-has-increased-across-most-united-0*

Data from USGS streamflow gauges 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). The peak flow data at the North Adams gauge mirrors this trend, where all but five of 37 flood-stage events have occurred since 1975.

The FIRM maps for Clarksburg were developed in 1982, and therefore the recurrence intervals and 100-year flood boundaries may no longer read true. Future development should therefore not only be directed away from mapped FIRM areas, but should reflect current conditions. For example, if areas in Clarksburg are found to be flooding more often than in the past, or certain pond or streambanks are eroding more severely, it may be prudent to discourage or deny new building development in those areas.

Days with precipitation of more than one inch in the Hoosic River Watershed, as predicted in the Northeast Cliamte Adaptation Science Center, 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[11]. 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. 3.16)[12].

Figure 3.16: Number of Extreme Precipitation Events of 2" or more in 1 Day



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

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 the most updated precipitation and stream gauge information available.

It may be prudent, therefore, to slightly overdesign the size of new stormwater management and flood control systems so that they have the capacity to accept the increase in flow or volume without failing. For many piped systems, such as culverts, drainage ditches and swales, the slight increase in size may provide a large increase in capacity, and for very little

[11] *Northeast Climate Adaptation Science Center, Massachusetts Climate Change Projections, 2017. https://resilientma.org/resources/resource::2152 Northeast Climate Adaptation Science Center*

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

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.

According to MEMA, dams are designed partly based on assumptions about a river's or pond'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 hydrographic 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 (MEMA, 2013).

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

Hazard Profile

Snow and other winter precipitation occur very frequently across the entire Commonwealth. According to the 2018 SHMCAP, the average annual snowfall for the snowiest municipality in each of four regions are:

- Chatham (Cape Cod and Islands): 28.9 inches
- Milton (Eastern MA): 62.7 inches
- East Brimfield (Central MA): 59.0 inches
- Worthington (Western MA): 79.7 inches

Worthington is a hilltown in the Berkshire Range south of Clarksburg, and so can be used as a gauge of snowfall. Severe winter storms in Clarksburg typically include heavy snow, blizzards, Nor'easters, and ice storms. A blizzard is a winter snowstorm with sustained or frequent wind gusts to 35 mph or more, accompanied by falling or blowing snow reducing visibility to or below a quarter mile. These conditions must be the predominant condition over a three-hour period. Extremely cold temperatures are often associated with blizzard conditions but are not a formal part of this definition. However, the hazard created by the combination of snow, wind, and low visibility increases significantly with temperatures below 20ºF. A severe blizzard is categorized as having temperatures near or below 10°F, winds exceeding 45 mph, and visibility reduced by snow to near zero (MEMA, 2013).

A Nor'easter is typically a large counterclockwise wind circulation around a low-pressure center often resulting in heavy snow, high winds, and rain. Strong areas of low pressure often form off the southern east coast of the U.S, moving northward with heavy moisture and colliding with cooler winter inland temperatures. Sustained wind speeds of 20-40 mph are common during a nor'easter, with short-term wind speeds gusting up to 50-60 mph or even to hurricane force winds (MEMA, 2013). This is currently the most frequently occurring natural hazard in Massachusetts (EOEEA-MEMA, 2018).

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).

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.

Table 3.11 Regional Snowfall Index Ranking Categories

Category	Description	RSI-Value
1	Notable	1-3
2	Significant	3-6
3	Major	6-10
4	Crippling	10-18
5	Extreme	18+

Source: MEMA 2013.

The Northeast States Consortium has been tracking one- and three-day record snowfall totals. According to their data, 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 3.12). A local resident and scientist maintains a weather station on his property on East Road in Clarksburg. Maximum snowfall events for the last three years at his property show a snapshot of the types of snow that is experienced in the Town (see Table 3.13).

Table 3.12. Record Snowfall Events and Snow Depts 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 Consortium, 2017

Table 3.13. Maximum Snowfall Events and Snow Depths (Inches) at Residence on East Road, Clarksburg

Year	Dates	Snowfall
2018	March 7, 8, 9	36.5”
2019	Dec. 1, 2	20”
2020	Dec. 16, 17	19”

Source: J. Brandon, Clarksburg, MA 2021.

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. In Clarksburg this storm had minimal effects. This ice storm did not impact Clarksburg residents as severely as it did the residents in other hilltowns in the region, because the developed areas of Clarksburg lie in the relatively lower elevations of the broad North Branch Hoosic/Hudson valley, where the temperature was just one or two degrees warmer than in the higher elevations. In this way the roads and power lines were spared the thick and heavy accumulations that so devastated other parts of the county.

While severe winter weather declarations became more prominent starting in the 1990s, it is not believed that this reflects more severe weather conditions than the Berkshires experienced in the 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 municipal 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’s location in the Berkshire Highlands places it at a high-risk for winter storms. The severe storms that the County gets are added to the higher annual snowfall the County normally has due to its slightly higher elevation relative to 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 Clarksburg 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 than 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). 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 or ice, which can bring concerns for road travel, human injuries, and risk of roof failures.

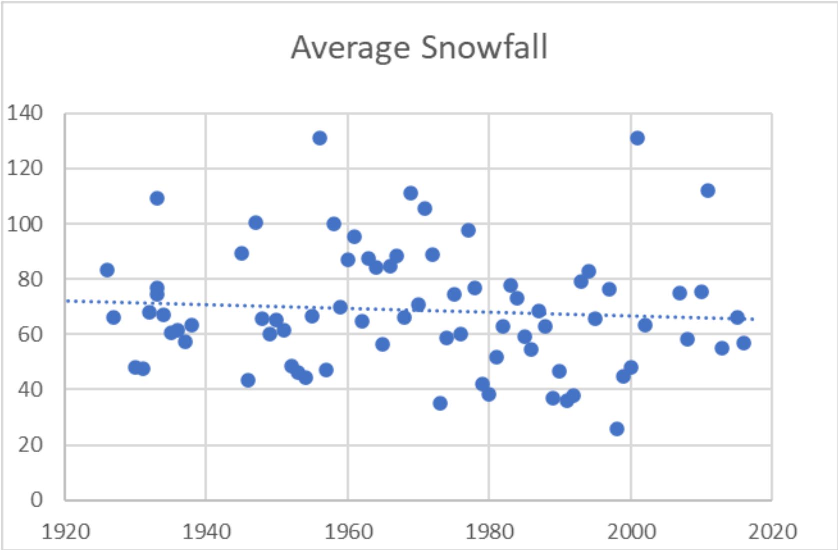
Geographic Areas Likely Impacted

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 Clarksburg, although the higher elevations in the western and eastern portions of the Town may have slightly higher snow depths and ice accumulation. Higher winds blow across open fields and cause snowdrifts along portions of Horrigan, Henderson and River Roads.

Historic Data

Although the entire community is at risk from severe winter storms, the higher terrains in the county tend to receive higher snowfall amounts, and these same areas may receive snow when the lower elevations received mixed snow/rain or just rain. 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. As can be seen in Figure 3.17, the average snowfall levels are trending downward. 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, ranging from one during 2006 to 18 during 2008.

Figure 3.17: Average Snowfall in Berkshire County in Inches



Source: NOAA, 2017.

Data from a local resident's weather station on East Road in Clarksburg demonstrate the variety in total snowfall accumulations (Table 3.14).

Table 3.14. Total Snowfall (Inches) at Residence on East Road, Clarksburg

Year	Amount
2018	117"
2019	93"
2020	40.5"
2021 (thru June 2021)	50"

Autumn snowstorms can cause damage to trees and other vegetation which still have leaves on them. The weight of heavy wet snow brings down tree branches and power lines. Slick road conditions can catch unprepared both road crews and drivers who have not yet put on snow tires. A notable autumn snowstorm hit the region in October of 1987, causing widespread damages, power outages and school closures. An article in the North Adams Transcript states that Clarksburg road crews were still cleaning up debris from the storm in November.[13]

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 Table 3.15). None have been declared in for the county since 2013. 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 3.15: 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 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

[13] *Sweet, William, 12-27-87. "Storms Swell in Clarksburg: From the Skies and in Town," North Adams Transcript.*

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.; $49+ 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; $70+ million from FEMA statewide	DR-4051
02/08/13-02/09/13	Severe Winter Snowstorm and Flooding; $65+ million from FEMA statewide	DR-4110

Source: MEMA 2018.

Vulnerability Assessment

People

The natural hazard that most likely injures or kills more people per year than any other in Berkshire County is winter weather, primarily because of the number of vehicle accidents that occur during these events. 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 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).

In rural areas such as Clarksburg, 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.

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

Built Environment

Severe winter storms can damage the built environment by collapsing roofs under the weight of snow, making roads impassable due to snow or ice, damaging roads by freezing or unintended damage due to snowplows, freezing and bursting pipes, downing trees and power lines, and the flooding damages that result from melting snow. Stretches of Horrigan, Middle, River and Henderson Roads experience higher winds and snowdrifts than other areas of Town, especially in areas where there are large expanses of open fields. These areas are shown with purple arrows on Fig. 3.4.

Natural environment

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 individual plants and animals and felling of trees, the latter of which can alter 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. 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. These damages can stress trees and reduce the quality of the trees in forests that are being managed for timber. 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. 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 heavy wet snow, ice or rain rather than the fluffier snow that had been more typical for the region. The transition to wetter snow, rain and ice formation has implications for how roads and other infrastructure will be maintained.

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 (T.S.) is a named event defined as having sustained winds from 34 to 73 mph.
- A hurricane is a storm with sustained winds reach 74 mph or greater. The hurricanes are categorized based on sustained winds; wind gusts associated with hurricanes may exceed the sustained winds and cause more severe localized damage.

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 ranks hurricanes based on sustained wind speeds—from Category 1 (74 - 95 mph, minimal intensity) to Category 5 (156 mph or more, catastrophic intensity). Category 3, 4, and 5 hurricanes are considered “major” hurricanes. The Commonwealth has not been impacted by any Category 4 or 5 hurricanes; however, Category 3 storms have historically caused widespread flooding. 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), and those resulted in devastating flooding. T. S. Irene in 2011 was the most destructive tropical storms in recent decades.

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.

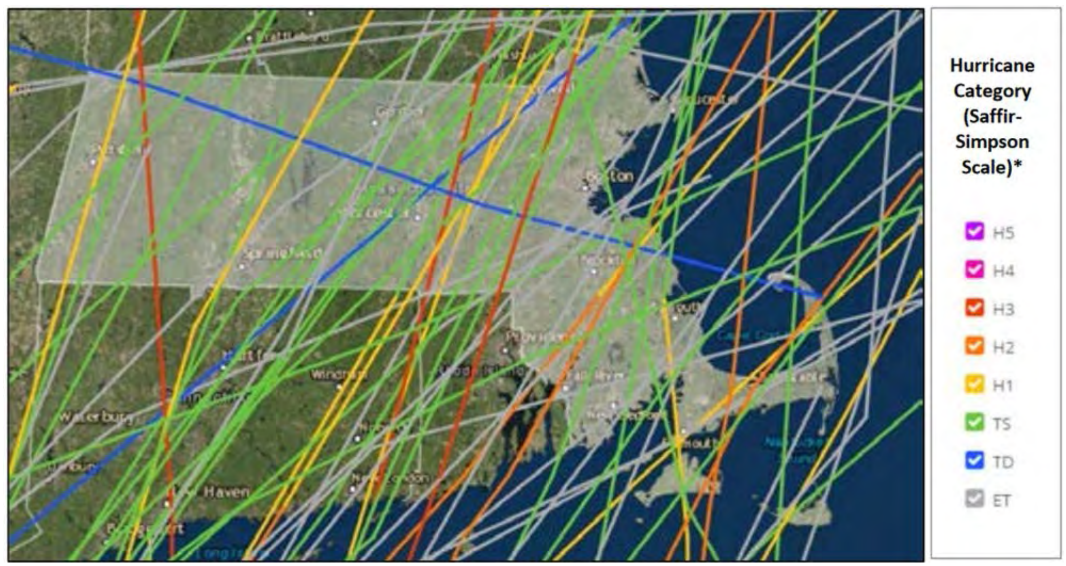
The NOAA Hurricane Research Division published a map showing the chance that a tropical storm or hurricane (of any intensity) will affect a given area during the hurricane season (June to November). This analysis was based on historical data from 1944 to 1999. Based on this analysis, the community has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

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. Inland areas, especially those in floodplains, near waterways, or isolated in the hills and mountains are 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 shows tropical storm tracks that have traveled through Massachusetts, where H = Hurricane, TS = Tropical Storm, and TD = Tropical Depression.

Figure 3.18: Historical Hurricane Paths within 65 miles of Massachusetts



Source: NOAA, as cited in MEMA & EOEEA, 2018

Historic Data

The National Oceanic and Atmospheric Administration (NOAA) has been keeping records of hurricanes since 1842. From 1842 to 2018, there have been several tropical storms that passed directly through Berkshire County (see Fig. 3.16) and Table 3.16. 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 North Adams. In the Berkshires, 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.

Table 3.16. Tropical Depressions, Storms and Hurricanes Traveling Directly Through 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, MEMA & EOEEA, 2018.

Other storms whose tracks came near but not directly through the county caused damage. 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 T.S. 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)

T.S Irene (August 27-29, 2011) was the most recent and damaging tropical storm event in Clarksburg, due largely to flooding. Details of damages in the Town are described in Flooding section of the Plan. Regionally, T.S. Irene is the most memorable storm event in recent history due to the flooding that occurred throughout northern Berkshire and Franklin Counties in Massachusetts, and in southern Vermont. This storm's track did traverse the county. This storm event 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).

The Berkshires suffered $35 million in damages, of which $23 million was for the reconstruction of the Mohawk Trail (Route 2). A six-mile stretch of the Trail through Florida, Savoy and Charlemont was damaged and closed for construction for 110 days. During the construction, the only detour traversed winding and sometimes steep roads along Routes 8, 116, and 112 for nearly 37 miles through rural forestland.[14] The closure of the Trail not only impacted travel and movement of goods, it also impacted the region's tourist industry, especially as the road was closed during peak fall foliage season.

MassDOT stated that the reconstruction of Route 2 was unique in that mobilization, manpower and completion, which would normally have taken an entire construction season, was done in a little more than three months. Highway Administrator Frank DePaola stated that it took the involvement of multiple agencies: "What would have normally taken us four months [to prepare] was reduced to a matter of a few weeks and contractors were set to work immediately after in the beginning of October." Bidding time that takes months was done in nine days; transportation and environmental officials worked together to get Cold River restoration on track. Crews worked 12-hour shifts (with only one shift off during the Halloween snowstorm) and have been living in the area for months (*iBerkshires*, 2011)[15]

Figure 3.19. Mohawk Trail (Rt. 2) damage from T.S. Irene

T. S. Irene caused flood levels equal to or greater than a 100-year flood event in Williamstown and North Adams. 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. Immediately after this event the USGS recorded flood levels and recalculated and re-delineated the boundaries for the 100-year floodplain for the Hoosic River as it flows through portions of North Adams and Williamstown. This is one of the very few areas where floodplain maps have been updated in Berkshire County since the 1980s.

In September 2011 T.S. Lee brought additional rains to the region right on the heels of T.S. Irene. T.S. Sandy in 2012 caused flooding in the North Branch Hoosic River, which included high flood flows and bank erosion. It also left behind an enlarged sediment island in the middle of the river channel, just south of the Cross Road bridge. This island diverts water around it and during high flow events it causes severe erosion the western/northern bank of the river. The erosion on the bank is likely because the eastern bank is armored with heavy rip rap to protect River Road.

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[14] *https://www.masslive.com/news/2011/12/storm-damaged_stretch_of_route.html*

[15] *Daniels, Tammy; 12-15-11. "Hurricane-Damaged Route 2 Reopens to Traffic", iBerkshires, https://www.iberkshires.com/story/40079/Hurricane-Damaged-Route-2-Reopens-to-Traffic.html*

Vulnerability Assessment

People

It is believed that the only fatalities that occurred due to tropical storms in Berkshire County was during the hurricane of 1938, and those were from flooding, not high winds. 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. Findings reveal that human behavior contributes to flood fatality occurrences, and this was seen during flooding of The Spruces in Williamstown when some residents only left their homes when forcibly removed by emergency personnel during T.S. Irene. Similarly, although emergency personnel encouraged many residents in several parts of Clarksburg to evacuate during this same storm, not all did so. Fortunately, most residents in Clarksburg were spared the devastating impacts of those in The Spruces.

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. During and after an event, rescue workers and utility workers are vulnerable to impacts from high water, swift currents, rescues, and submerged debris. Vulnerable populations may also be less likely to have adequate resources to recover from the loss of their homes and jobs or to relocate from a damaged neighborhood (MEMA & EOEEA, 2018).

Built Environment

Hurricanes and tropical storms can destroy homes with wind, flooding, or even fire that results from the destructive forces of the storm. Critical facilities are mostly impacted during a hurricane by flooding, and these impacts are discussed in the flooding section of this plan. Wind-related damages from downed trees, limbs, electricity lines and communications systems would be at risk during high winds. Local and state-owned police and fire stations, other public safety buildings, and facilities that serve as emergency operation centers may experience direct loss (damage) during a hurricane or tropical storm. Emergency responders may also be exposed to hazardous situations when responding to calls. Road blockages caused by downed trees may impair travel. Heavy rains can lead to contamination of well water and can release contaminants from septic systems (DPH, 2014 as cited in MEMA & EOEEA, 2018). Additionally, hurricanes and tropical storms often result in power outages and contact with damaged power lines during and after a storm, which may result in electrocution. Several residential, commercial and industrial buildings were destroyed during the floods of 1938, 1949 and 1955 in northern Berkshire County during tropical storm events. Most recently the full destruction and permanent removal of all homes in The Spruces mobile home park in Williamstown demonstrates the vulnerability of structures due to flooding.

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. Invasive aquatic species and floodplain species such as knotweed are readily dispersed when plant fragments are transported by floodwaters. 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. From T.S. Irene (FEMA DR4028), the Berkshires alone experienced $35 million in damages, including $23 million for the reconstruction of six miles of the Mohawk Trail. The Commonwealth received over $31 million in individual and public assistance from FEMA for damages from the storm (MEMA & EOEEA, 2018).

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. The 2020 Atlantic hurricane season closed with a record-breaking 30 named storms and 12 landfalling storms in the continental United States. The season surpassed the 28 named storms from 2005, with the second-highest number of hurricanes on record. This is the fifth consecutive year with an above-normal Atlantic hurricane season, with 18 above-normal seasons out of the past 26. This increased hurricane activity is attributed to the warm phase of the Atlantic Multi-Decadal Oscillation — which began in 1995 — and has favored more, stronger, and longer-lasting storms since that time. Such active eras for Atlantic hurricanes have historically lasted about 25 to 40 years. [16]

[16] *NOAA, at https://www.noaa.gov/media-release/record-breaking-atlantic-hurricane-season-draws-to-end*

High Winds and Thunderstorms

Hazard Profile

Other severe weather captures the natural hazardous events that occur outside of notable storm events, but still can cause significant damages. These events primarily include high winds and thunderstorms. Clarksburg, like other Berkshire County communities, 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

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.

A thunderstorm is classified as "severe" when it produces damaging wind gusts in excess of 58 mph (50 knots), hail that is one 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).

Probability

Over a ten-year period (January 1, 2008 through December 31, 2017), a total of 435 high wind events occurred in Massachusetts for an annual average of 43.5 events occurred per year. High winds are defined by NWS as sustained non-convective winds of 35 knots or greater (~40 mph) or lasting for one hour or longer, or gusts of 50 knots or greater (58 mph) 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.

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).

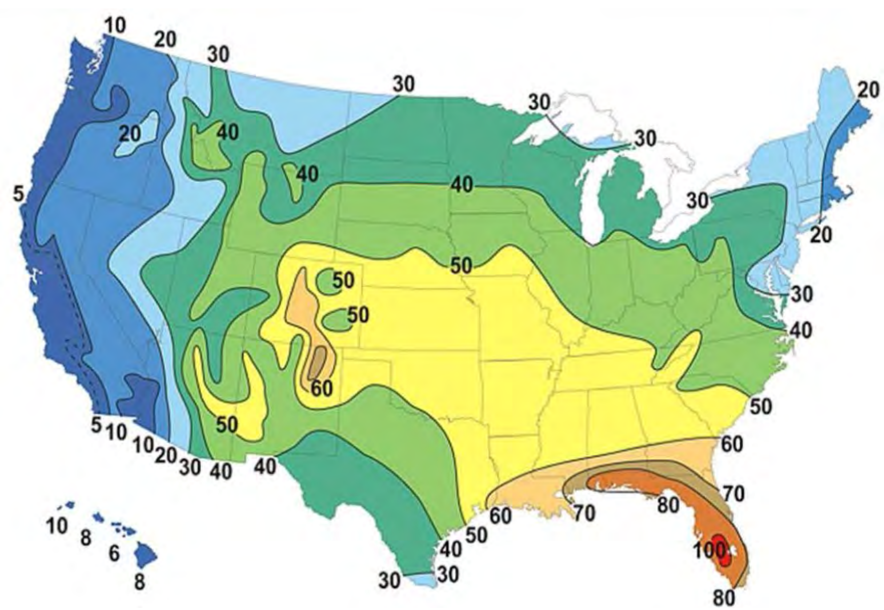
Geographic Areas Likely Impacted

All of Clarksburg is vulnerable to high winds that can cause extensive damage. Even more so than high wind, thunderstorms have the potential of impacting residents and infrastructure. Microbursts can also occur anywhere associated with thunderstorms. High winds occur more intensely along areas of Horrigan, River and Henderson Roads, largely due to large open fields that allow the prevailing western winds to move unhindered. Snow drifts are also more common in these areas.

Historic Data

It is difficult to define the number of other severe weather events experienced by Clarksburg each year. Figure 3.20 shows number of annual thunderstorm days across the United States. According to a map created by NOAA and NWS, and featured in the SHMCAP, Western Massachusetts experiences approximately 30 thunderstorm days each year. Local residents report that a severe wind event in 2019 damaged the iconic red barn on River Road and upended trees across the valley.

Figure 3.20: Annual Average Number of Thunderstorm Days in the U.S.



Source: NOAA NWS, MEMA & EOEEA, 2018.

Vulnerability Assessment

People

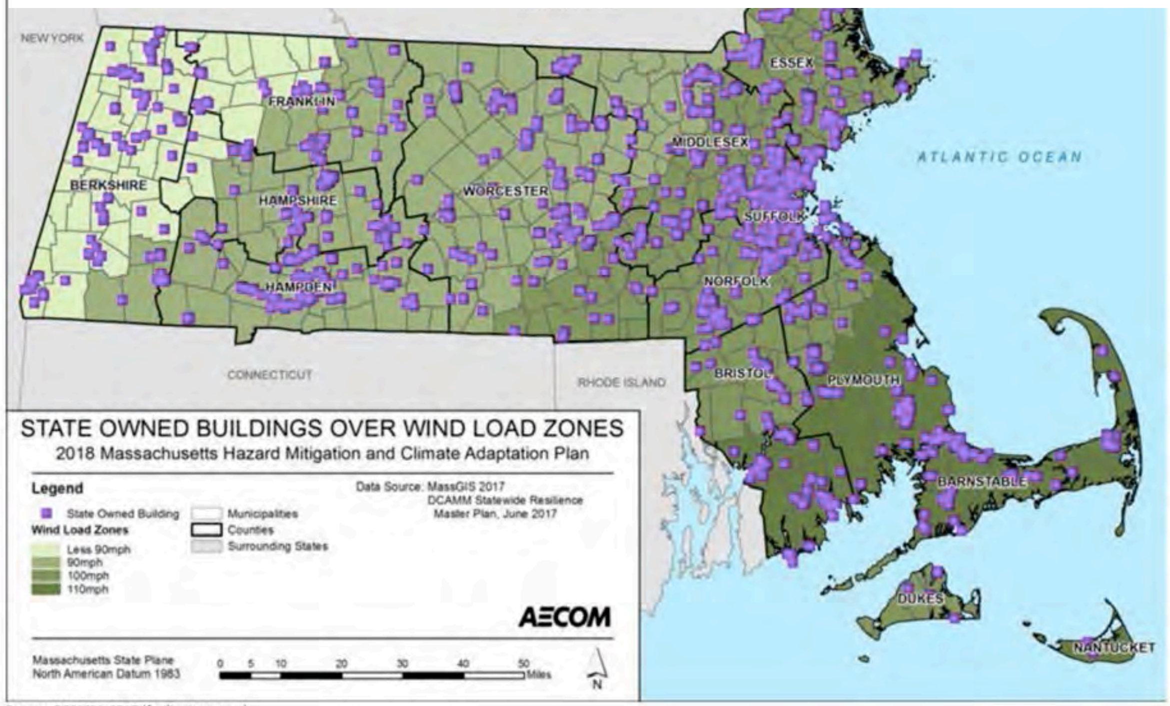
The entire population of Clarksburg is considered exposed to high-wind and thunderstorm events. Downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss of life. The most common problem associated with severe weather is loss of utilities. Severe windstorms causing downed trees can create serious impacts on electricity and aboveground communication lines. 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 systems and cause loss of electricity to power oxygen and other life-sustaining equipment. Downed wires can create the risk of fire, electrocution, or an explosion. People who work or engage in recreation outdoors are also vulnerable to severe weather, including downed live wires or lighting strikes.

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 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.

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 (MA SHMCAP, 2018).

Built Environment

Fig. 3.21. Wind Load Zones for Massachusetts According to MA State Building Code



Source: DCAMM, 2017 (facility inventory)

Source: MEMA & EOEEA, 2018.

All elements of the built environment are exposed to severe weather events such as high winds and thunderstorms. Damage to buildings is dependent upon several factors, including wind speed, storm duration, path of the storm track, and building construction. The state is divided into four risk categories, the limits of which are defined by the Massachusetts State Building Code (9th Ed.). National wind data prepared by the American Society of Civil Engineers serve as the basis of these wind design. Generally speaking, structures should be designed to withstand the total wind load of their location. Massachusetts used these load zone determinations to determine risk to state facilities from wind hazards, and this map shows that Clarksburg is located in the lowest load zone set at less than 90 mph.

Public safety facilities and equipment may experience a direct loss (damage) from high winds. Roads may become impassable due to flash 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. 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

Research into the impact of climate change on severe storms such as thunderstorms has looked at the impact of the increased convective available potential energy (CAPE) on frequency and intensity of storms, and a decrease in wind shear as the Artic warms. Some studies show no change in the number of storms, but an increase in intensity due to more energy and evaporated moisture available to fuel storms. Other studies have shown an increase in the number and intensity of storms because the increase in CAPE compensated for a decrease in wind shear[17]. We can expect greater impacts of severe storms in the region while the exact changes are still being determined. Educating residents to be prepared emergency situations where loss of electricity occurs and maintaining an emergency communications system that can be used to reach isolated residents during power outages will become more important, especially to meet the needs of an increasingly elderly population.

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[17] *https://earthobservatory.nasa.gov/features/ClimateStorms*

Hazard Profile

Drought is a period characterized by long durations of below normal precipitation. 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 Office of Energy and Environmental Affairs (EEA) and MEMA partnered to develop the *Massachusetts Drought Management Plan*, of which September 2019 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, 2019). The Massachusetts DCR 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, 2018). 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 50-66% 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). Farming in Clarksburg is limited and of small scale, and in general there are less droughts here in Berkshire County than in other areas of the U.S.

For the purposes of the state *Drought Management Plan*, drought conditions are classified into five levels: ‘Level 0-Normal’ (i.e., No Drought), ‘Level 1-Mild Drought’ (formerly Advisory), ‘Level 2-Significant Drought’ (formerly Watch), ‘Level 3-Critical Drought’ (formerly Warning), and ‘Level 4-Emergency Drought’ (formerly Emergency). These levels were selected to provide distinction between different levels of drought severity and for adequate warning of worsening drought conditions. Six Drought Indices are used as the primary drivers of drought determinations: 1) Precipitation, 2) Streamflow, 3) Groundwater, 4) Lakes and Impoundments, 5) Fire Danger, and 6) Evapotranspiration (EEA & MEMA, 2019).

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 in conjunction with the DEP monitors drinking water quality in communities.

Probability

As described below, Berkshire County is generally at a lower risk of drought relative to the rest of the Commonwealth. However, that does not eliminate the hazard from potentially impacting the County and Clarksburg. The recorded historic patterns show near misses of severe drought conditions. Increases in temperature lead to faster evaporation of reservoirs, waterways, soils, and greater evapotranspiration rates in plants.

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 Clarksburg is at risk of drought.

Historic Data

Massachusetts is relatively water-rich, with few documented drought occurrences. The most severe, state-wide droughts occurred in 1879-1883, 1908-1912, 1929-1932, 1939-1944, 1961-1969, 1980-1983, and 2016-2017. Several less-severe droughts occurred in 1999, 2001, 2002, 2007, 2008, 2010, 2014 and 2020. The nine-year drought from 1961-1969 is considered the drought of record. The longevity and severity of this drought forced public water suppliers to implement water-use restrictions, and numerous communities utilized emergency water supplies[18].

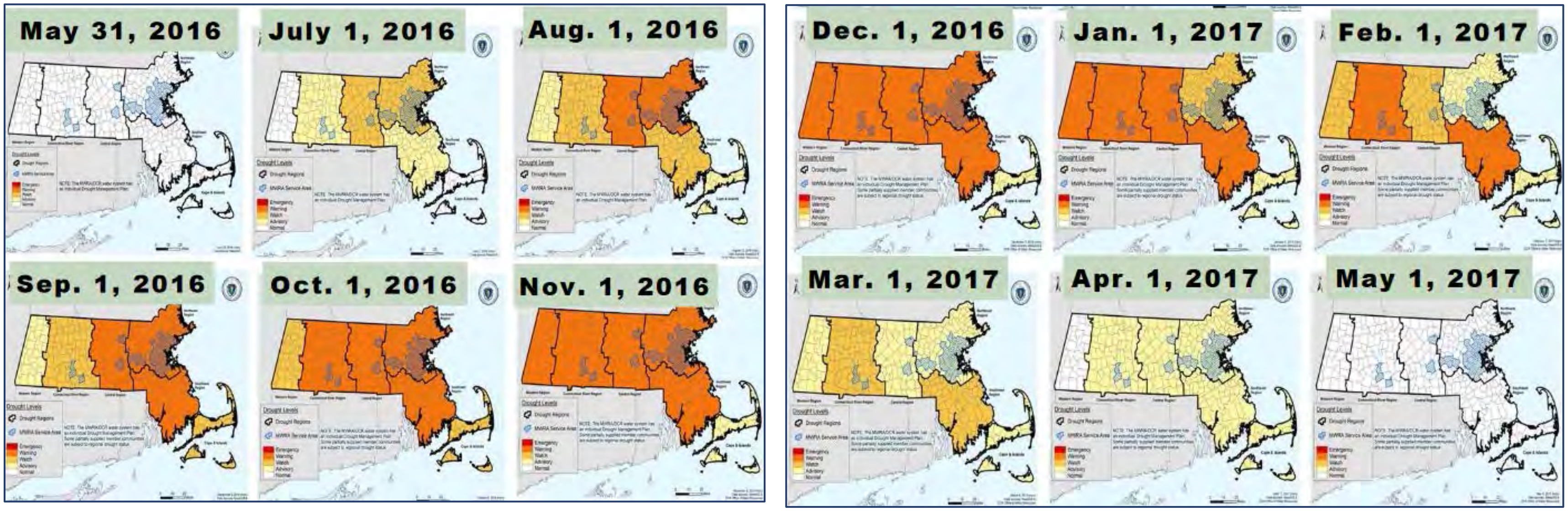
There are three USGS gauges in Clarksburg for which flow data was collected a few times during short periods. Flow data were collected on seven separate dates between 1967-69 for a site on Canyon Brook in Briggsville (USGS gauge #01331880 off East Road) and one on Hudson Brook (#01331950 near Stony Brook Drive). Another set of nine flow data sets were collected 1994-96 (USGS #01331960). The data is very sparse and does not have any qualifying specifications, such as water level compared to bank height or compared to normal or peak flows. However, when compared against flow data on the Main Stem Hoosic River on the North Adams/Williamstown border (USGS #01332500), the data seems to correlate with very low flow, dry periods recorded in that river. The Clarksburg 1967-69 data was collected in the summer/fall during the last few years of the drought of record. According to the Main Stem Hoosic River gauge, for which daily data on water level and flow is available from 1941 to the present, 1965 was the driest year of the drought, with the years 1967-69 showing some improvement back to normalcy. Data at this gauge also indicates that water flows were also low during the summer/fall periods of 1994-96.

The most recent and significant drought in Massachusetts since the 1960s 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. 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. 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[19].

[18] *https://www.mass.gov/doc/massachusetts-drought-management-plan/download*

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

Figure 3.22: Progression of the 2016-17 Drought



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

Vulnerability Assessment

People

The entire population of Clarksburg is exposed and vulnerable to drought. The Briggsville Water District supplies water to approximately 64 households along River Road, Carson Avenue and Cross Road. Approximately 105 households receive public drinking water from the City of North Adams in the older, more urban neighborhoods on the southwestern portion of Town. The rest of the population draws its water supply through private wells. In general, those with shallow or low-yield drinking water wells are at higher risk than those with deeper wells. Residents and stakeholders who depend on water for their means of income, such as farmers and camp owners, could also be significantly impacted. During the development of this plan, local officials have heard that some individual property owners have had their wells periodically go dry, but this does not appear to have a history of being a wide-ranging issue. As a hazard, drought ranked very low as a concern in the public survey that was issued as part of the planning process, and was not mentioned at all in the open-ended responses submitted. The Berkshire region has not suffered a severe, emergency level drought since the 1960s, and it is unclear how well Clarksburg residents would fair during a prolonged drought given changes in population, water use, and precipitation patterns.

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

Built Environment

Drought does not threaten the physical stability of critical facilities in the same manner as other hazards such as wind-based or flood-related events. However, if drought led to wildfire across the entire Town, structures across Clarksburg would be at risk. Wildfire could also damage or destroy electrical and communication systems.

Natural Environment

The natural environment is at greatest risk due to drought. Drought can lead to low flow and low groundwater levels, threatening the continued flow of streams and rivers. The cold-water fishery streams, on which native brook trout and other cold-water species depend for survival, could become too dry to too warm to sustain them. Lower, shallower lake and pond waters force aquatic life to congregate in smaller water volumes with lower oxygen levels, leading to stress and fish kills. Lower soil moisture causes vegetated to become stressed or die, causing trees and other vegetation to drop leaves and forbs to die back. The lower moisture reduces the ability of soil organisms to break down accumulated plant and animal matter. This combination of greater build-up of dry matter on the forest floor increases the risk of wildfire. These drier conditions can lead to decreases in plant and animal populations that need moist conditions to survive. Benefits of such conditions can mean lower populations of insects that carry pathogens, such as mosquitoes and ticks.

Economy

The economic impacts of drought can be substantial, and would primarily affect the agriculture, recreation and tourism, forestry, and energy sectors. Drier summers and intermittent droughts may strain irrigation water supplies, stress crops, and delay or cause harvest which may result in higher demand than can be locally supplied. This can increase importation of produce and drive up the price of food, leading to economic stress on a broader portion of the economy.

Future Conditions

While precipitation is generally expected to increase in the region, the way it is delivered will more frequently be in severe events that favor heavy surface runoff and less soil infiltration. This could lead to conditions with dryer soils and lower groundwater levels between the bouts of heavy precipitation. Changes in winter temperatures will lead to less snowpack and more rain-on-snow events, leading to more surface runoff and less groundwater recharge, leading to less stream and river base flows. Higher temperatures in warmer seasons can more severely impact the reduced base flows due to higher rates of evaporation of moisture from soil and lower groundwater and surface water inputs. Given that Clarksburg is 81% forested, the risk of wildfire during drought conditions is a concern.

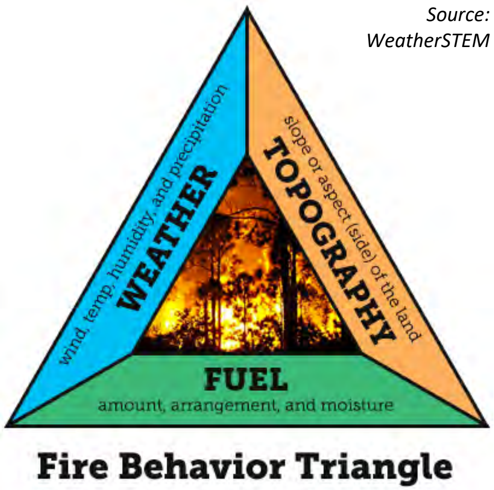
Hazard Profile

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). The Town of Clarksburg considers itself to be at a moderate risk to wildfires due to the size that Clarksburg State Forest encompasses in the western region of the town and the number of camping sites in Clarksburg State Park. Fires could occur anywhere in town that is forested, which is almost the entire town, however local officials believe there is a higher likelihood in the western portion, within the State Forest. Local resident camp and brush fires, due to the climate and vegetation, tend to only burn understory brush. Any wildfire would most likely be isolated and impact only a house or two and would most likely provide enough notice to prevent casualties.

Likely severity

Given that Clarksburg is 81% forested, and that its neighboring communities are also heavily forested, the risk of wildfire is definitely present. Clarksburg has the distinction of being the site of the two largest wildfires to occur in Berkshire County since records have been kept. The fire of 2021 is the largest in acreage to occur in the state since 1999. This was the largest fire in Western Massachusetts since the 1999 Tekoa Mountain fire in Russell that burned 1,100 acres and claimed the life of a local firefighter.

Source: WeatherSTEM



Small brush fires are a much more common occurrence in the region. Clarksburg has a well-equipped volunteer fire company that has coordinated with neighboring fire companies through mutual aid and with the Commonwealth's Bureau of Forest Fire Control and Forestry. Given the ability to respond regionally, and limited ideal fuel for a large-scale forest fire, Clarksburg believes that it is at medium risk of forest fire relative to other high-risk hazards such as flooding.

The "wildfire behavior triangle" reflects how three primary factors influence wildfire behavior: fuel, topography, and weather. Each point of the triangle represents one of the three factors, and arrows along the sides represent the interplay between the factors. For example, drier and warmer weather with low relative humidity combined with dense fuel loads and steeper slopes can result in dangerous to extreme fire behavior. How a fire behaves primarily depends on the characteristics of available fuel, weather conditions, and terrain.

Fuel:

- Lighter fuels such as grasses, leaves, and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs, and trunks take longer to warm and ignite.
- Snags and hazard trees, especially those that are diseased or dying, become receptive to ignition when influenced by environmental factors such as drought, low humidity, and warm temperatures.

Weather:

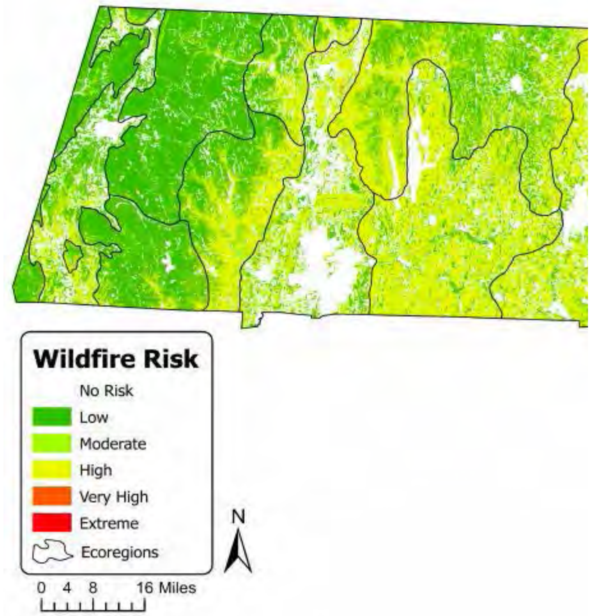
- Strong winds, especially wind events that persist for long periods or ones with significant sustained wind speeds, can exacerbate extreme fire conditions or accelerate the spread of wildfire.
- Dry spring and summer conditions, or drought at any point of the year, increases fire risk. Similarly, the passage of a dry, cold front through the region can result in sudden wind speed increases and changes in wind direction.
- Thunderstorms in Massachusetts are usually accompanied by rainfall; however, during periods of drought, lightning from thunderstorm cells can result in fire ignition. Thunderstorms with little or no rainfall are rare in New England but have occurred.

Terrain

- Topography of a region or a local area influences the amount and moisture of fuel.
- Barriers such as highways and lakes can affect the spread of fire.
- Elevation and slope of landforms can influence fire behavior because fire spreads more easily uphill compared to downhill.

Probability

Fig. 3.23 Wildfire Risk (NE Wildfire Risk Assessment)



Source: Northeast Wildfire Risk Assessment Geospatial Working Group 2009

According to the2020 Massachusetts State Forest Action Plan, there are relatively few natural forest fires in the state because lightning is almost always accompanied by rain. Fires occur primarily as a result of human activity; thus, the risk of forest fire increases in forest areas that are close to development and/or open to public use. A working group led by the U.S. Forest Service developed the Northeast Wildfire Risk Assessment model that considered three components: 1) fuels, 2) wildland-urban interface, and 3) topography (slope and aspect). These three characteristics are combined to identify wildfire prone areas where hazard mitigation practices would be most effective. As seen in Figure 3.23, Clarksburg has been assessed to have Low and Moderate risk for wildfire. High and very high-risk areas have fire prone forest types (pitch pine-scrub oak and oak) and significant forest-human interaction. There a small pocket pitch pine – scrub oak within the Clarksburg State Forest that has been documented by the state's Natural Heritage & Endangered Species Program. To date this population does not seem to have been a factor in two the recent wildfires of 2015 and 2021.

The risk assessment has a flaw in that it does not take into account human activity outside the wildland interface and intermix areas. Local firefighters and other first responders highlight the fact that many wildland fires occur in remote areas where campfires or discarded lit cigarettes were the cause of the fire and, due to lack of access, the fires can get an extensive start before fire crews and equipment can reach these areas. Despite the risk assessment model's predictions, there have been two regionally significant wildfires in Clarksburg, that of April 2015 (272 acres burned) and May 2021 (950+ acres burned). The cause of the 2015 was a campfire that got out of control along the AT. As of May 17, 2021, the cause of the 2021 fire has not been publicly announced. TO BE UPDATED WHEN AVAILABLE.

Clarksburg State Forest, the site of both large fires, is designated and maintained by the DCR as a Forest Reserve. As stated by the DCR, the purpose of these lands are to conserve large contiguous blocks of high-value ecosystems. These are areas where the dominant ecosystem service objectives will be biodiversity maintenance, nutrient cycling and soil formation, and long-term carbon sequestration. Reserves are areas where only passive recreation is allowed and where no commercial harvesting of timber will take place. Forest management will generally consist of letting natural processes take their course, although under specific circumstances, more active management might be permitted.[20] Maintaining the forest for its wilderness experience, with limited access and trail miles, is the very reason that fighting fires there are so difficult.

Geographic Areas Likely Impacted

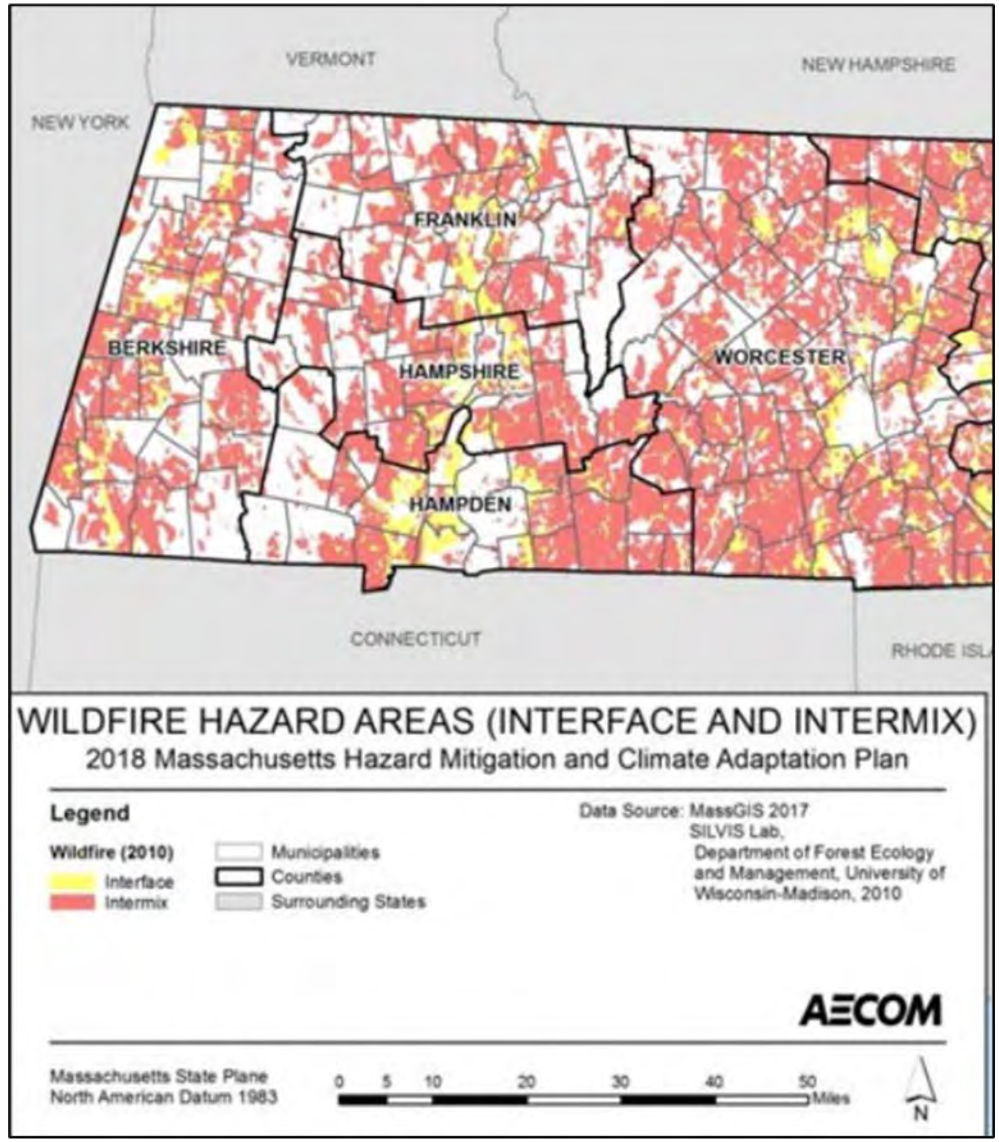
Clarksburg is vulnerable to fire across the Town. Fire risk and associated damages increases where there is a mix of development and forested land. While the risk of fire in Clarksburg has been determined from forest modeling to be relatively low compared to the Commonwealth as a whole, there is still risk posed by wildfire. The ecosystems that are most susceptible to the wildfire hazard are pitch pine, scrub oak, and oak forests, as these areas contain the most flammable vegetative fuels. Patches of Ridgetop Pitch Pine – Scrub Oak Plant Communities are found in Clarksburg deep within Clarksburg State Forest along the Appalachian Trail (AT). They are shown in dark green polygons on Fig. 3.2. Given predictions for increasing temperature, evaporation, and short-term periods of drought, forest fire concerns are a growing concern in rural communities. Remote areas where campfires or discarded burning cigarettes can start wildfires are most at risk.

[20] *DCR, 2012. Landscape Designations for DCR Parks & Forests: Selection Criteria and Management Guidelines, Boston, MA.*

The SILVIS Lab at the University of Wisconsin-Madison Department of Forest Ecology and Management classifies exposure to wildlife hazard as "interface" or "intermix." Intermix communities are those where housing and vegetation intermingle and where the area includes more than 50 percent vegetation and has a housing density greater than one house per 16 hectares (approximately 6.5 acres). Inventoried assets (population, building stock, and critical facilities) were overlaid with these data to determine potential exposure and impacts related to this hazard. Figure 3.24 shows the results of a geospatial analysis of fire risk by the Northeast Wildfire Risk Assessment Geospatial Work Group. According to this analysis, the portion of Clarksburg east of West Road/Houghton Street is categorized as Intermix and estimated to be more at risk of fire than the western, undeveloped portion of the Town.

While this analysis can be used as a general estimation of risk, it does not consider human activity in the forest, such as hiking and camping. As such, it does not assign any risk to Clarksburg State Park, located on the Clarksburg/VT border, and Clarksburg State Forest, which encompasses the western portion of the Town. However, local fire officials note that campfires are standard practice in the campground at the State Park and that increased risk is associated with AT, which winds its way through the State Forest. In fact, it is known that the Clarksburg forest fire of 2015 was started by a hiker along the AT. It is not known at this time what caused the wildfire of 2021. The other large fire that occurred in Lanesborough is also believed to be started by hiker/campers.

Figure 3.24: Wildland-Urban Interface and Intermix for Massachusetts



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, as it typically coincides with the brush burning season, which ends May 1st. 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: one that burned 168 acres in Lanesborough in 2008 and one that burned 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. In 2021 a wildfire started in eastern Williamstown and quickly moved eastward across the town border into Clarksburg, consuming more than 950 acres of forest land.

Clarksburg has the distinction of having battled the two largest forest fires to occur within Berkshire County since records have been kept. It is known that the 2015 fire started as a cooking fire at the Sherman Brook primitive campsite along the AT that got out of control. Forest conditions at the time were dry, a Class 4 High fire danger rating. The fire burned outward from its origins and eventually burned a total of 272 acres of forest land within the Clarksburg State Forest. The fire was first reported by a hiker who was on the AT on the afternoon of April 29, 2015. According to Incident Reports filled out at the time, the fire was largely a surface fire, burning hardwood leaf litter and Mountain Laurel shrub fuel and did not become a major tree or crown fire. Although crews thought that they had knocked the fire down by evening, new hot spots sprung out and crews had to actively fight the fire for the next two days before they were able to knock it down completely. Dry conditions allowed the fire to spread relatively quickly and keep smoldering. Crews spent a fourth day closing out the response.

The fire was difficult to fight because the site was so inaccessible and because of the rugged and steep elevations that fire fighters had to traverse to reach the fire sites. Brush trucks and tankers were not able to reach the site, so crews at first had to hike in and use back packs and portable water pumps, refilling equipment in small mountain streams. Crews used shovels, chainsaws and leaf blowers to create fire breaks where they could. Fire fighting improved once crews found a more accessible route to the fire site and were able to access and carry equipment closer to the site with ATVs. Finally, the tool that was able to really stop the fire was when DCR staff arranged to have a National Guard Black Hawk helicopter drop water on the fire, ferrying 500 gallons of water at a time from Mount Williams Reservoir in North Adams.[21] Photos of the fire and response are shown in Figures 3.26-3.29.

Through mutual aid, more than a dozen fire companies from the region, including companies from Vermont, responded with crews and equipment. State DCR forest fire crews, including DCR's Chief Fire Warden, also responded. In all, Clarksburg's Fire Chief reports that 376 firemen responded over the course of four days. Despite the difficult terrain and conditions no serious injuries were reported.

The 2021 fire started on Friday, May 14th off Henderson Road in Williamstown, and by the next day had swept eastward into Clarksburg and consumed more than 220 acres along East Mountain. By the end of day on May 16th the fire had quadrupled to almost 800 acres, and by the time the fire was 90% contained on May 18th it had consumed 950+ acres of land, the majority of it in Clarksburg. As in 2015, the fire occurred in rugged, steeply-sloped terrain that fire trucks or tankers could not access. And once again fire fighters and equipment had to be hauled to the sight on ATVs or, in many places where there are no trails, by foot. Firefighters accessed the site from landings in Williamstown and North Adams. More than 120 firefighters from 19 different companies and agencies in Massachusetts and Vermont battled the fire for four days, including water dropping helicopters from the state police and National Guard. Like the fire of 2015 this fire was predominantly a surface fire, burning leaf litter, twigs, branches and debris, fueled on by unusually dry conditions that officials believe are residual effects from the dry 2020 summer/fall season.[22] One firefighter was hospitalized with non-life threatening injuries.

GOT UPDATES? Cause?

Fig. 3.25. Progression of the 2021 Williamstown/Clarksburg Wildfire as of May 17, 2021

Source: iBerkshires, 5-17-21

[21] *Daniels, T., 5-1-15. "Clarksburg Brush Fire Contained on Third Day", as reported in iBerkshires*

[22] *Guerino, Jack, 5-17-21. "Tuesday UPDATE: Forest Fire Operation Transitioning to 'Mop Up'", as reported in iBerkshires*

Figs. 3.26-3.29. The 2015 Clarksburg fire burned outward from its origins along Sherman Brook camp site. The area was very inaccessible and much of the fire fighting was done on foot using portable water packs. A helicopter bringing water from Mt. Williams Reservoir in North Adams made the difference in fighting the fire. *Photos taken from "Clarksburg Brush Fire Contained on Third Day," iBerkshires, 5-1-15.*


iBerkshires.com 2015


iBerkshires.com 2015

Vulnerability Assessment

People

Historically Clarksburg residents and firefighters have not suffered serious injuries or death due to wildfire, even during the Clarksburg State Forest Fire of 2015. However, potential losses from wildfire include human health and the lives of residents and responders. Injuries sustained by firefighters and other first responders are common and can be deadly, such as the loss of a local firefighter battling the Tekoa Mountain fire in Russell. The most vulnerable populations include emergency responders and those within a short distance of the interface between the built environment and the wildland environment. In 2018 MEMA and EOEEA estimated the population vulnerable to the wildfire hazard by overlaying the Interface and Intermix hazard areas with the 2010 U.S. Census population data. The Census blocks identified as Interface or Intermix, those areas where buildings intermingle with forest, were used to calculate the estimated population exposed to the wildfire hazard. In Berkshire County 55,486 people live in in Interface areas, and 39,171 people live in Intermix areas. Refer to Figure 3.24 for these areas in Clarksburg.

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 five, 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.

Smoke and air pollution from wildfires can be a severe health hazard. Smoke generated by wildfire consists of visible and invisible emissions containing particulate matter (soot, tar, and minerals), gases (water vapor, carbon monoxide, carbon dioxide (CO2), and nitrogen oxides), and toxics (formaldehyde and benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Other public health impacts associated with wildfire include difficulty in breathing, reactions to odor, and reduction in visibility. Due to the high prevalence of asthma in Massachusetts, there is a high incidence of emergency department visits when respiratory irritants like smoke envelop an area. Wildfires may also threaten the health and safety of those fighting the fires. First responders are exposed to dangers from the initial incident and the aftereffects of smoke inhalation and heat-related illness.

Built Environment

All buildings and other facilities are vulnerable to wildfire through direct impacts of burning or indirect through cut off from utilities. If any portion of a communications or and electrical systems were impacted by wildfire it would impact a portion or the entire system. Large transmission lines traverse the forested Berkshire landscape. Most roads 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 as well (MEMA & EOEEA, 2018).

Natural environment

Fire is a natural part of many ecosystems and serves important ecological purposes, including facilitating the nutrient cycling from dead and decaying matter, removing diseased plants and pests, and regenerating seeds or stimulating germination of certain plants. However, many wildfires, particularly man-made wildfires, can also have significant negative impacts on the environment. In addition to direct mortality, wildfires and the ash they generate can distort the flow of nutrients through an ecosystem, reducing the biodiversity that can be supported. Frequent wildfires can eradicate native plant species and encourage the growth of invasive species. There are also risks related to hazardous material releases, where 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). The risk of hazardous materials releases is higher in the urban-wildland intermix and interface areas.

Fig. 3.30. Fire on East Mountain, Clarksburg, MA. Photo taken May 16, 2021 from Stop & Shop parking lot on Route 2 in North Adams.

Source: Berkshire Eagle 5-18-21, "A volcanic-like glow over the Berkshires: Residents share their wildland fire photo." This photo taken by Brenda Armstrong.

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).

According to the Incident Status Summary drafted by the state DCR Bureau of Forest Fire Control at the close of the Clarksburg State Forest Fire of 2015, the cost to put out that fire was estimated to be between $20,000-30,000. This figure was for state-incurred costs and did not include locate fire company costs. The cost to the Clarksburg Fire Company was in the low thousands of dollars for food, water, equipment and other direct costs; uncompensated were the hundreds of volunteer firefighters who attended the fire and the local citizens who came to the staging area and provided food and support to the firefighters and other first responders at the scene.

Future Conditions

While climate change is unlikely to change topography, it can alter the weather and fuel factors of wildfires. As noted in the Extreme Temperature section of this plan, the mean annual summer temperature is projected to increase 3-6°F by mid-century and 4-11°F by the 2090s, and the days where the summer temperature exceeds 90°F is expected to increase from zero days per year to nine days by mid-century and to 17 days by the 2090s. Hot dry spells create the highest fire risk, due to decreased soil moisture and increased evaporation and evapotranspiration. While in general annual precipitation has slightly increased Massachusetts in the past decades, the timing of snow and rainfall is changing. Less snowfall can lead to drier soils earlier in the spring and possible drought conditions in summer. More of our rain is falling in downpours, with higher rates of runoff and less soil infiltration. Such conditions would exacerbate summer drought and further promote high elevation wildfires where soil depths are generally thin. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods (MEMA, 2013).

Hazard Profile

The Town of Clarksburg chose to examine the hazard of both plant and animal invasive species. Invasive species are a widespread problem in Massachusetts and throughout the country. The damage rendered by invasive species can be significant. The Massachusetts Invasive Plant Advisory Group (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 is 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. 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. Uncontrolled growth of invasive species can alter soils, increase erosion, and reduce habitat value for native wildlife. Early detection and rapid response are key components to successful invasive species control.

Likely Severity

The damage rendered by invasive species is significant. 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 (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, both on land and in aquatic systems. Areas with high amounts of plant or animal life may be at higher risk of exposure to invasive species than less vegetated urban areas; however, invasive species can disrupt ecosystems of all kinds (MEMA & EEA, 2018). Because plant and animal life is so abundant throughout Clarksburg and the Berkshire region, the entire area is considered to be at high risk of invasive species infestation.

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, although Massachusetts has established prohibition on the propagation and sale of many invasive plant species. Invasive species can also be spread by animals, people, equipment and machines as they travel through the region’s landscape and waterways. Hikers, mountain bikers, ATVs and boaters can unwittingly spread invasive species if they travel from an infested area to a non-infested areas. As outdoor recreational tourism continues to increase in the Berkshires, this risk will also increase.

Several natural hazards increase the risk of invasive species spreading beyond their current ranges. Many invasive plant species are readily uprooted, transported and/or distributed to new areas during flood events. Plant fragments and seeds from semi-aquatic and aquatic plants such as Japanese knotweed, purple loosestrife, common reed, water chestnut, Eurasian water milfoil and curly leaf pondweed are spread in this fashion. Berries and seeds from terrestrial invasive plants are also distributed in this way, particularly if they are found in along river corridors or floodplain areas. Wind or ice storms that fragment or open up the tree canopy of forested landscapes can damage or stress the remaining trees and create the temporary conditions that allow invasive species to take hold and suppress regeneration of native trees. The same wind storm that damaged the tree canopy may be the mechanism by which dispersal of invasive plant seeds arrive in the damaged forest. Wildfires in the Berkshires are typically surface fires, burning forest duff and damaging/killing seedlings and ground forbs. The die-back of plants on the forest floor temporarily could open the way for invasive understory species to take hold, such as honeysuckles species, buckthorn species, bittersweet and hardy kiwi vine. The risk of invasive infestation increases if the burned area is in close proximity to (and particularly downwind of) existing invasive species populations and seed sources. Risk if further increased if hikers and mountain bikers track seeds or plant fragments from the infested area prior to traveling through the burned site.

Risk of invasive aquatic species infestation from one to riverine, pond and lake ecosystem to another is largely due to human activity, although transport and distribution by birds and mammals is also possible. Plant fragments and seeds, and aquatic animals, easily travel from one water body to another via kayak, canoes, boats and equipment, including waders. As water recreational activity increases, so too will the risk of invasive species infestation.

Geographic Areas Likely Impacted

All of Clarksburg and the surrounding region is at risk of invasive species. Mauserts Pond is relatively shallow, with an average depth of only five feet and maximum depth at eight feet. The shallow warm waters provide the perfect growth medium for aquatic plant communities and favoring proliferation of invasive species, particularly fanwort (*Cabomba Carolinians*) and watershield (*Brasenia Schreberi*). The DCR has undertaken an aquatic plant management program to control these plants, which has been largely successful. Monitoring and targeted treatment of these species where needed has been recommended to keep populations from rebounding.

Historic Data

Invasive species are a human-caused hazard, often resulting from release of foreign species brought into the country by the landscaping industry and pet trade. Invasive species are also inadvertently released when they escape from wood or produce products or from being unwittingly transported in shipping containers. 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.

Addressing the issue of propagating and selling of invasive plants within the landscaping nursery industry began in the 1990s. MIPAG conducted field research to determine the most invasive plant species in the region, and in 2005 published its first list of plants designated as invasive or likely to be invasive in Massachusetts. Out of this list emerged a list of plants for which importation and propagation is currently prohibited within the state of Massachusetts. The sale, trade, purchase, distribution and related activities for these species, including all cultivars, varieties and hybrids, are not allowed. The latest list, revised in 2017, includes 140 species. The full list can be viewed at this site: https://www.mass.gov/doc/prohibited-plant-list-sorted-by-common-name/download. Active links to details on each species is found here.

Forests damage from insect and other pests can be extensive, and many of these are invasive species from other continents or other regions of the U.S. According to the 2020 Massachusetts State Forest Action Plan, the annual tree canopy damage from insects and diseases in Massachusetts ranged from 23,563 acres in 2012 to 939,051 acres in 2017. The average annual area of canopy damage was 201,681 acres (about 6% of total forest area) between 2009 and 2018. The three primary agents of canopy damage in total over that period were gypsy moth (1,481,115 acres), winter moth (300,571 acres), and weather events such as snow, ice, wind, tornado, frost, or hail (75,244 acres). Table 3.17 summarizes the most serious infestations facing Western Massachusetts forests.

Table 3.17: Current Invasive and Nuisance Insect Threats to Clarksburg Forests

Insect	Origin	Host Trees	DCR-Management Approach
Gypsy Moth	Introduced	Oaks, other deciduous species	Discovered in 1869, current management relies on natural population controls: naturally abundant virus and fungus populations regulate gypsy moth population cycles.
Winter Moth	Introduced	Maples, oaks, other deciduous trees (fruit)	Identified in state in 2003, it was introduced to Canada in the 1930s; a biocontrol species has been released and successfully established to manage populations in eastern MA.
Hemlock Woolly Adelgid	Introduced	Eastern hemlock	Discovered in 1989, two biocontrol species have been released in MA to limited establishment success.
Southern Pine Beetle	Native	Pitch pine	Population densities monitored through annual trapping; the impacts of climate change could significantly alter generation periods and devastate pitch pine stands.
Emerald Ash Borer	Introduced	All ash species	Discovered in 2012, three biocontrol species, were successfully released in MA; continued releases are planned.
White Pine Needlecast	Native	Eastern white pines	Needlecast has been identified to be caused by multiple fungal pathogens; white pine defoliation is being monitored across the state.
Red Pine Scale	Introduced	Red pine	Control with insecticides has not been successful and natural enemies are ineffective in reducing the population.

Sources: MA State Forest Action Plan 2020; https://www.mass.gov/service-details/current-forest-health-threats.

As of 2014, White Ash was the 7th most common forest tree in the state, with the highest density of ash tree species residing in Berkshire County. As such it is a major component of our northern hardwood forests. The Emerald Ash Borer was first discovered in Massachusetts in Dalton, in central Berkshire County, in 2012. Since then it has been detected in every community in Berkshire County, including Clarksburg in 2020. Infestations of the borer result in a very high mortality rate. Early stages of infestation in a tree will focus in the canopy and upper trunk, but as the population density grows, EAB will infest the lower trunk. Tree damage and eventual mortality is caused by the larval feeding on the trees' cambium, eventually girdling and killing the tree. Many town officials in Berkshire County have reported having to take down dead and dying ash trees along public roadways for public safety.

Fig. 3.31 Left: Emerald Ash Borer Adult.

Fig. 3.32 Right: Damages caused by larvae under tree bark

Warmer winter temperatures are raising the survival rates of some insect pests and allowing them to expand their range. The Hemlock Woolly Adelgid is an insect that kills Eastern Hemlocks. This insect has been expanding northward, having crossed into the Housatonic River Valley from Connecticut in the early 2000s. In the Berkshires, hemlocks are valuable because they survive along steep ravines and help to hold soil in place. Streams within hemlock forests have a greater diversity of aquatic invertebrates to support fish as compared to those within hardwood forests. Native brook trout are three times more likely to be found in streams surrounded by hemlock, which provide cooler water temperatures and more stable flows.

Other Plants?

Zebra mussels?

OTHERS?

Fig. 3.33 Right: Hemlock Woolly Adelgid Infestation

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. Those who rely on natural systems for their livelihood, such as timber production, or mental and emotional well-being are more likely to experience negative repercussions from the expansion of invasive species.

Built Environment

Mature roadside trees provide natural and cultural benefits to the community, creating the rural New England landscape that defines the region. Trees help to hold roadside soils in place and can act as windbreaks. Accelerated die-back of roadside trees can occur due to invasive pests such as the EAB, or stressed and pulled down by prolific invasive vines such as bittersweet. Damage and die-off of these trees present increased risk to homeowners who live in close proximity, to utility lines and to travelers who frequent the roads they are located on. Buildings are expected to be directly impacted by invasive species under circumstances similar to our roadways. Facilities that rely on native species, biodiversity or the health of surrounding ecosystems, such as outdoor recreation areas, public or botanical gardens or agricultural/forestry operations, could be more vulnerable to impacts from invasive species.

Natural Environment

An analysis of threats to endangered and threatened species in the U.S. indicates that invasive species are implicated in the decline of 42% of the endangered and threatened species. In 18% of the cases, invasive species were listed as the primary cause of the species being threatened, whereas in 24% 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

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 one 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 (MEMA & EOEEA, 2018).

Forest-based employment in the recreation and tourism sector is quite broad, including not just the outfitters, guides, and sporting goods vendors, but also the full suite of support services, such as dining and lodging. These services facilitate and promote the enjoyment of the greater experience of engaging in forest-based recreation. Fall foliage viewing, camping, hiking, and snowmobiling are examples of exceedingly popular activities that hinge upon the greater forested landscape, but also require a host of support services to make them successful. Other noteworthy forest-based recreational activities include cross-country skiing, mountain biking, wildlife tracking, and birdwatching. A 2015 report estimated that about 9,000 people are employed in the diverse industries that support this sector, with a total annual payroll equivalent of $293 million.[23] This includes all individuals working in outdoor recreation activities and tourism based on maintaining a natural landscape. This is especially important in Berkshire County, where the scenic beauty and outdoor recreational opportunities complement the region's international status as a cultural destination.

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.

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 CO2 concentrations 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

[23] *EOEEA, DCR, Bureau of Forest Fire Control & Forestry, 2020.*

of successful establishment or expansion. Other climate change impacts that could increase the severity of the invasive species hazard include the following (as cited in MEMA & EOEEA, 2018):

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

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

Hazard Profile

The Town of Clarksburg chose to examine the hazard of vector-borne diseases in their community. Vector-borne disease are defined by the CDC as illnesses in humans derived from a vector, including rodents, mosquitoes, ticks, and fleas that spread pathogens. The damage rendered by vector-borne diseases can be significant in a community, and can drastically affect quality of life, ability to work, loss of specific bodily functions, increase life-long morbidity and increase mortality. For the purposes of this study, the Town of Clarksburg is focusing solely on risk from tick- and mosquito-borne diseases.

Likely severity

Lyme disease is caused by bacteria that are spread by infected black-legged (deer) ticks. If untreated, people with Lyme disease can develop late-stage and chronic symptoms that can become a factor in pre-mature death. The joints, nervous system and heart are most commonly affected, although severe heart damage can occur. Chronic, long term fibromyalgia may result from untreated Lyme disease.

- About 60% of people with untreated Lyme disease get arthritis in their knees, elbows and/or wrists. The arthritis can move from joint to joint and become chronic.
- Many people who don't get treatment develop nervous system problems. These problems include meningitis (an inflammation of the membranes covering the brain and spinal cord), facial weakness (Bell's palsy) or other problems with nerves of the head, and weakness or pain (or both) in the hands, arms, feet and/or legs. These symptoms can last for months, often shifting between mild and severe.
- The heart also can be affected in Lyme disease, with slowing down of the heart rate and fainting. The effect on the heart can be early or late.[24]

West Nile Virus (WNV) and Eastern Equine Encephalitis (EEE) are viruses that occur in Massachusetts and can cause illness ranging from a mild fever to more serious disease like encephalitis or meningitis. According to the *2020 Massachusetts Arbovirus Surveillance and Response Plan,* between 2002-2019 there have been 208 cases of WNV among Massachusetts residents resulting in at least 12 deaths, with all but three of these fatalities in individuals 80 years of age or older. Since 2000 there were 38 cases of EEE resulting in at least 20 deaths.[25]

[24] *https://www.mass.gov/service-details/lyme-disease*

[25] *Bharel, Monica; Cranston, Kevin, 2020. 2020 MA Arbovirus Surveillance and Response Plan, MA Dept. Public Health, Boston, MA.*

Probability

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

An overabundance of ticks threaten the health of humans and wildlife. The black-legged (aka deer) tick, which carries Lyme disease, has rapidly expanded its range northward throughout Berkshire County. Environmental factors that favor tick survival rates and periods of activity are mild winters that can include snow cover (snow cover helps to insulate them from the severe, dry air temperatures that can kill them) and moist, humid conditions (ticks are less active in dry, windy conditions).

WNV first appeared in the U.S. in New York City in 1999. The principal mosquito vectors for WNV on the East may be abundant in urban areas, breeding easily in artificial containers, such as birdbaths, discarded tires, buckets, clogged gutters, catch basins, and other standing water sources. Several highly urbanized areas in Massachusetts have accounted for over 80% of the human WNV infections between 2001 and 2019. The risk of EEE in humans varies by geographical area in Massachusetts, and is correlated with the location of the necessary swamp habitats. In Massachusetts, these areas occur across the state, but are most common in southeastern Massachusetts (MA DPH, 2020).

The Berkshires provide outdoor recreation opportunities for both residents and visitors, including hiking, swimming, mountain biking, and camping. Increased exposure to the outdoors, particularly to areas with heavy tree and forest cover, and areas with tall grass or standing water, significantly increase a person’s exposure to vector-borne illnesses. Increases in average year-round temperature during the past few decades has also led to the over-wintering of ticks in Berkshire County, and a lengthening warm season, among other characteristics of the Berkshire environment, has increased tick and mosquito populations significantly.

Risk for mosquito-borne disease is almost fully eliminated by the first local hard frost, which kills most remaining adult mosquitoes, although the species that spreads WNV in warmer urban areas may find warm, protected areas to survive the winter. A hard, or killing frost/freeze, has variable definitions but is often considered to be when temperatures fall below 28ºF (MA DPH, 2020).

Geographic Areas Likely Impacted

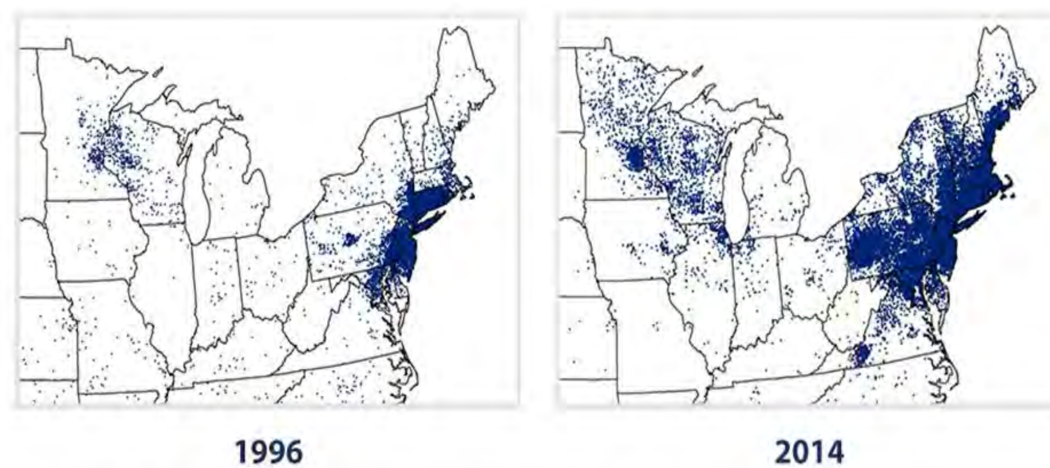
The Town of Clarksburg in its entirety is likely already impacted by vector-borne disease and is likely to be increasingly impacted. Exposure to any outdoor area with tall grasses or ferns, shrubs and trees increases risk for tick-related disease. Wetlands and standing water sources increase risk of mosquito-related disease.

Historic Data

Black-legged (deer) ticks and the Lyme disease that they can carry spread northward into the Berkshires in the early 1990s. In Berkshire county there was a 94.5% increase in Lyme disease 2005-2016. The CDC estimates that just 10% of cases of Lyme disease are actually reported, so the actual prevalence of disease is probably much higher.

In Berkshire County WNV has only been documented in Pittsfield and Lenox. As of 2020 EEE has not been recorded in the county (MA DPH, 2020). See Figures 3.35 and 3.36 for locations in Massachusetts where these diseases have been recorded.

Fig. 3.34. Reported Lyme Disease Cases in 1996 and 2014



Data source: CDC (Centers for Disease Control and Prevention). 2015. Lyme disease data and statistics. www.cdc.gov/lyme/stats/index.html. Accessed December 2015.

Fig. 3.35. Municipality of Residence of West Nile Virus Human Cases, 2001-2019

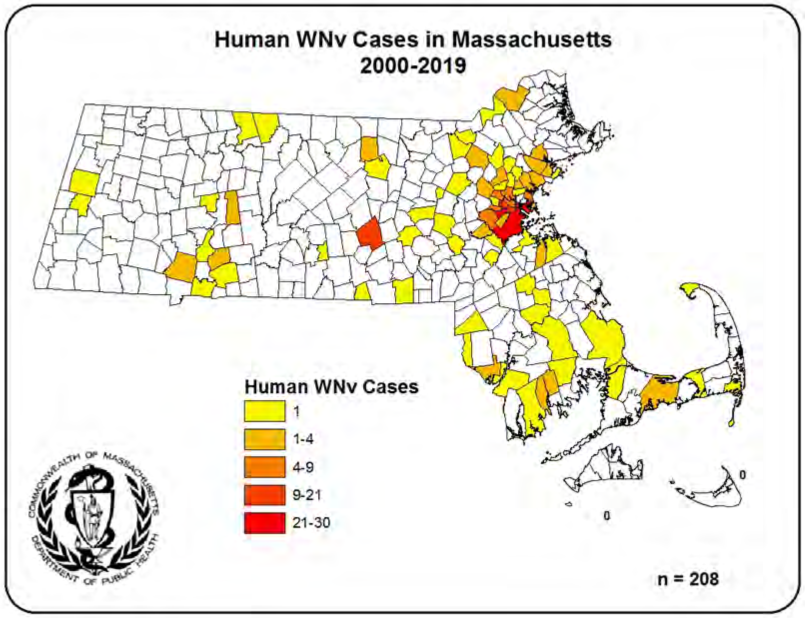
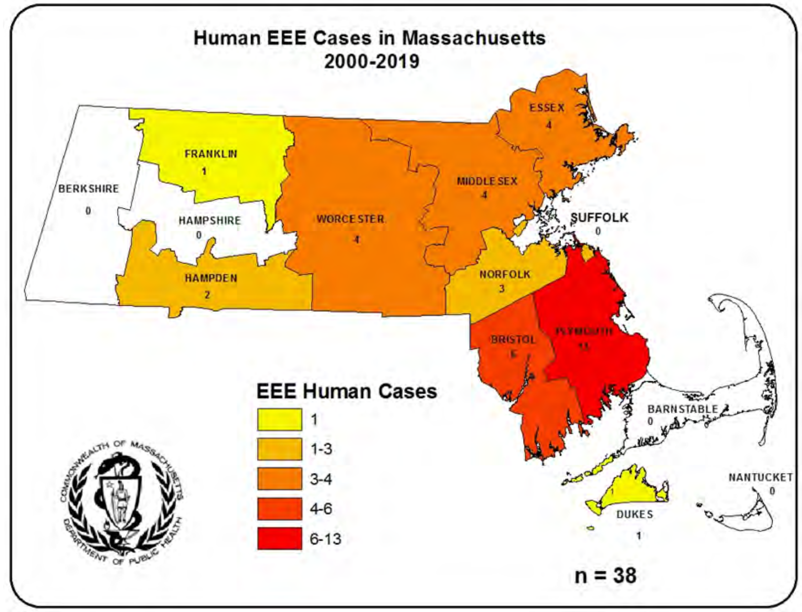


Fig. 3.36. County of Residence of EEE Human Cases, 2000-2019



Source for both graphics: MA DPH, 2020.

Vulnerability Assessment

People

Vector-borne illness can have an impact on human health, significantly affecting overall health, long-term morbidity and mortality, quality of life, and can significantly reduce a persons' ability to work or contribute to the community in other ways.

There are 51 knowns species of mosquitos in Massachusetts and most mosquito bites will only cause itching or skin irritation. However, a few species can carry viruses that can cause illness. Mosquitos thrive in humid environments near water sources where they start their life cycles. They are ubiquitous throughout the region, found most often around wetland areas or damp forested areas. They can breed in small pools of shady, stagnant water in residential areas, including the inside of discarded rubber tires or old jugs or abandoned kiddie pools. There are two diseases carried by mosquitos in the Berkshires, West Nile Virus (WNV) and Eastern Equine Encephalitis (EEE), which are being tracked by Massachusetts. Luckily, the current risk in Clarksburg of contracting WNV is categorized as Low (infection is unlikely) and EEE is categorized as Remote (not usually found in this area).[26] Warmer, moister conditions in the future could favor an increased risk. Clarksburg is enrolled in the Berkshire County Mosquito Control Project and call upon this regional program when the need arises.

In addition to the direct effect of vector-borne illnesses on a person, pesticides and herbicides used to control populations of vectors can also negatively impact human health.

Built Environment

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

Natural Environment

Several tick species threaten the health of the area's small moose population, with some individuals suffering acute anemia and other related illness due to being infested by hundreds or thousands of them. Moose are not especially agile and are not able to scratch or bite them off as well as other animals.

Increases in vector-borne illnesses can increase the likelihood that a community would choose or need to use chemical pesticides and herbicides to control vector populations. The increased use of these products and chemicals can significantly affect the natural environment. Direct reductions in populations of ticks and mosquitos can reduce the food source for other dependent animal populations, severely damaging long-term ecosystem health. Although annoying, the vast majority of mosquitos are largely harmless, and they are actually a beneficial and substantial food source for fish such as trout and bass, as well as frogs, birds and bats. Learning to live with them rather than using chemical sprays is important for the protection of wildlife.

Economy

The economy is susceptible to the indirect impacts of vector-borne illnesses. If a community decides to engage in a pest-control program or another program to reduce vector populations, this can significantly affect their operating budget. Incorporation of any program to reduce vector populations in a community will likely cause tax increases within the municipality. Long-term, the more individuals in a population affected by vector-borne disease that can cause life-long morbidity or mortality will reduce the overall economic participation and output of the

[26] *https://www.mass.gov/info-details/massachusetts-arbovirus-update, 4-18-21*

population in a municipality. There will also be the impacts on outdoor recreation, which is a major revenue driver for Berkshire County. People today choose to or are advised by officials to avoid outdoor activities in fear of tick and mosquito bites.

Future Conditions

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

Hazard Profile

Temperature is a fundamental measurement of describing climate, which is the prevailing weather patterns in a given area. Climate determines the types of plant and animal species that are able to survive in a region, and changes in climate will have significant impacts on the landscape because most species will not have the time to evolve and adapt over multiple generations to the new climate[27]. Scientists are still uncovering ways climate change will impact our lives both directly and indirectly.

Likely severity

Relative to the rest of the Commonwealth, the Town of Clarksburg is somewhat protected from extreme heat by the Town's northern location and higher elevation. The environment and people have adapted to cooler conditions; however, extremes in hot and cold still can and will occur, particularly in the changing climate. Homes here have traditionally been built with heating systems and some level of insulation to keep in warmth, but few were built with central air conditioning systems.

NOAA utilizes data to determine average temperature using land-based weather station measurements and by satellite measurements that cover the lowest level of the Earth's atmosphere. In moderate climate like in the Berkshires, the most severe impacts of the change in average temperature will be on our environmental composition, as well as on our vulnerable populations, particularly the elderly, people with underlying health conditions and low-income residents.

A heat wave is defined as three 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).

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.

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

Probability

According to extensive scientific study, the global changes in climate will lead to temperature shifts as weather patterns are altered. In general air temperatures are increasing across the globe, with relatively higher increases in the Northeast than in most other portions of the U.S. The Massachusetts Climate Change Clearinghouse (resilient MA) is a gateway to data and information relevant to climate change adaptation and mitigation across the state. It provides the most up-to-date climate change science and decision support tools to support scientifically sound and cost-effective decision making for policy-makers, practitioners, and the public. As part of this effort, the clearinghouse is linked to the Department of Interior's Northeast Climate Adaptation Science Center (NE CASC), which is hosted by the University of Massachusetts, Amherst. NE CASC is part of a federal network of eight Climate Adaptation Science Centers created to work with natural and cultural resource managers to gather the scientific information and build the tools needed to help fish, wildlife, and ecosystems adapt to the impacts of climate change.

NE CASC is the main source used in this hazard mitigation plan to understand observed and projected changes in temperatures. As noted in the computer models, the temperature in Massachusetts is expected to rise and cause these projections for the mid-21st century (2050s), as relative to the observed 1971-2000 baseline average. The details for projections for mid-century and 2090s are outlined in Table 3.18.[28]

- Mean annual temperatures in Massachusetts are expected to be 2.8-6.2°F warmer than over recent decades.
- There will be 7-26 more days per year when daily maximum temperatures exceed 90°F.
- There will be 19-40 fewer days when minimum temperatures fall below 32°F (a decline of 13-27%).
- Total heating degree days will be 11-24% lower, but cooling degree days will be 57-150% higher.

Table 3.18. Projected Statewide Temperature Changes from Observed 1971-2000 to Projected 2050s and 2090s

Variable	Observed value 1971 - 2000 average	Change by 2050s	Change by 2090s
Annual average temperature	47.5°F	Increase by 2.8 - 6.2°F	Increase by 3.8 - 10.8°F
Number of days per year with daily Total max >90°F	5 days	Increase by 7 - 26 days	Increase by 10 - 63 days
Number of days per year with daily Total min <32°F	146 days	Decrease by 19 - 40 days	Decrease by 24 - 64 days
Heating degree-days per year (HDD)	6839 Degree-Day °F	Decrease by 773 - 1627	Decrease by 1033 - 2533
Cooling degree-days per year (CDD)	457 Degree-Day °F	Increase by 261 - 689	Increase by 356 - 1417

Source: https://resilientma.org/datagrapher/?c=Temp/state/maxt/ANN/MA/

[28] *https://resilientma.org/datagrapher/?c=Temp/state/maxt/ANN/MA/*

Geographic Areas Likely Impacted

All of Clarksburg is exposed to the impacts of increased annual and extreme temperatures.

Historic Data

According to according to scientists from NOAA's National Centers for Environmental Information (NCEI), the last seven years prior to 2020 were the hottest years on record, as ranked by their departure from the 20th century average temperature. Projections by NOAA and other scientific organizations across the globe expect the trend to continue upwards, with the magnitude of the change depending on the amount of greenhouse gas levels in the atmosphere. In general, the highest temperatures in the Berkshires occur in July, and the lowest tend to occur in January.

The following are some of the highest temperatures recorded for the period from 1895 to 2017, showing as comparison 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

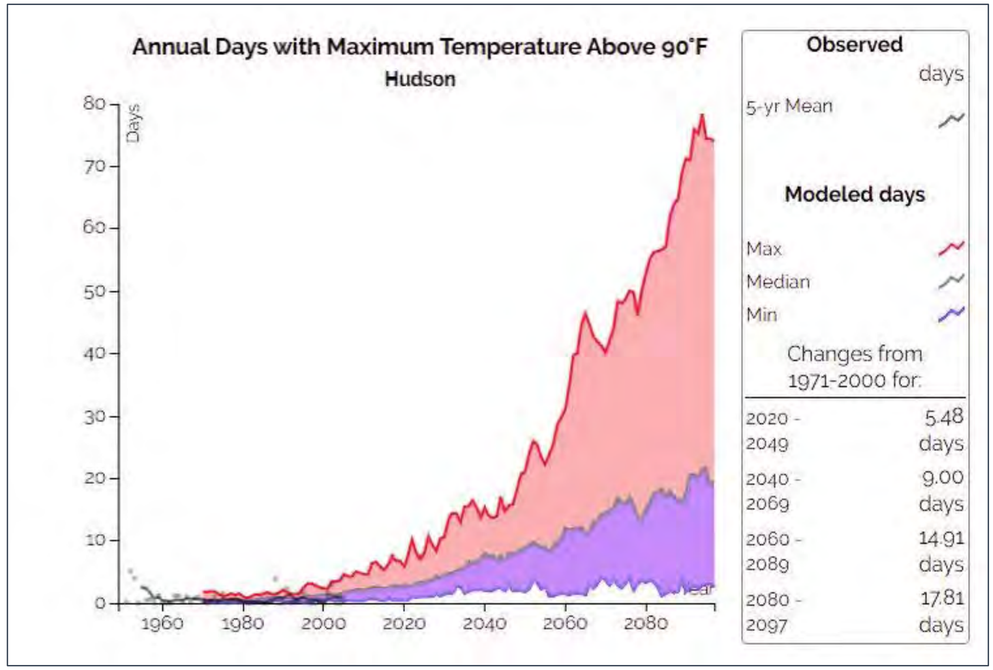
Historically, Clarksburg has little experience with days when the air temperature exceeds 90°F, but that will soon change as we see an increase in the number of days with dangerous levels of heat. As seen in Figure 3.37, during the years 1960-2000, there were consistently few if any days where the temperature was above 90°F. During the baseline years 1971-2000 there was an average of less than one day per summer (0.48 days) when the temperature exceeded 90°F.

The CMIP5 model offered by the NE CASC projects that the median number of days per year when the air temperature exceeds 90°F will increase to nine per year by mid-century and to 18 by the 2090s. Under a high-greenhouse gas emissions scenario, the maximum number of days when the air temperature exceed 90°F could reach 26 days per year by mid-century and 74 days per year by the 2090s (NE CASC 2017).[29] Clarksburg is located in Hoosic River Watershed, which is categorized by some state agencies as the Hudson River Watershed.

Just as the summers tend to be cooler in the Berkshires than in other parts of the state, so too are the winters. Again, the slightly higher elevations of the Berkshire hills are largely responsible for the cooler temperatures. Additionally, Clarksburg one of the most northerly town in Berkshire County. The following are some of the lowest temperatures recorded in the Berkshire region for the period from 1895 to 2017 (National Climatic Data Center, 2017).

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

Fig. 3.37. Observed and Projected Extreme Temperatures for Hudson River Watershed

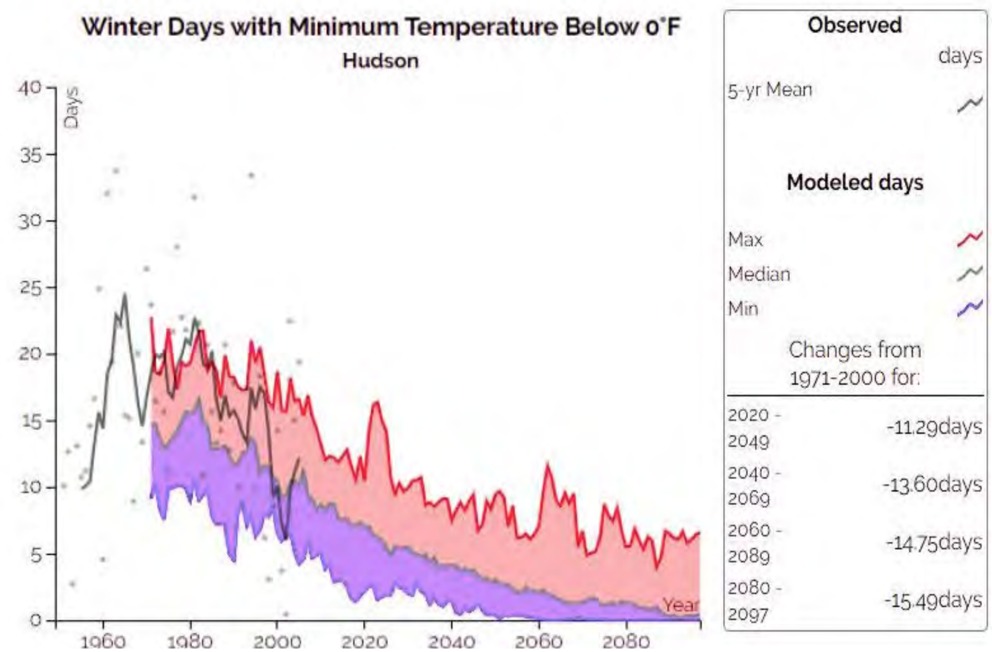


Source: NE CASC, 2017.

[29] *NE CASC, 2017. https://resilientma.org/datagrapher/?c=Temp/basin/tx90/JJA/Hudson/*

In the same manner that climate change will increase summer high temperatures, so too will it increase the lower winter temperatures. As illustrated in Figure 3.38, the number of observed winter days when the temperature dipped below 0°F has historically been unpredictable during the years 1960-2000. The 5-year mean trend line shows that there was quite a range where temperatures fell below 0°F, with as few as 9 days in 1999 and 13 days in 1969 and a high of 15 days in 1965. The baseline years of 1971-2000 averaged 17 days in the winter where the temperature fell below 0°F. By mid-century the median number of days where temperatures will fall below 0°F will decrease by 14 days, meaning there will only be 3 days of below 0 temperatures. By 2090 there will less than one (0.39 days) where the temperature will fall that low.[30] This will bring some relief and reduce risk to people and buildings from extreme low temperatures.

Fig. 3.38. Observed and Projected Extreme Temperatures for Farmington River Watershed



Source: NE CASC, 2017.

As described earlier in the Flood Risk Section of the plan, this change has implications for snow and ice management, with snows being heavier, snow melts more often and ice formation more often.

Vulnerability Assessment

People

All residents in the Town of Clarksburg are vulnerable to the health effects of extreme temperatures, with those who work outside directly at a greater risk. Others at greater risk are those individuals who have pre-existing medical conditions that impair their ability to regulate their body

[30] *NE CASC, 2017, https://resilientma.org/datagrapher/?c=Temp/basin/tn0/DJF/Hudson/*

temperatures, or whose homes or work places are inadequately heated or cooled. 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.

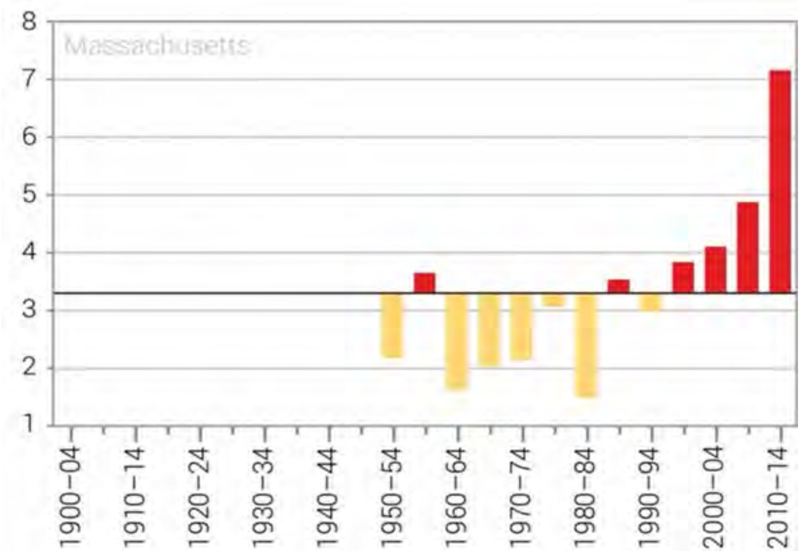
Hot temperatures can also contribute to deaths from respiratory conditions (including asthma), heart attacks, strokes, other forms of cardiovascular disease, renal disease, and respiratory diseases such as asthma and chronic obstructive pulmonary disorder. Berkshire County has a higher level of asthma-related emergency room visits than other parts of the state. 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.

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. 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.

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. 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.

What may be more concerning is the trend for higher nighttime temperatures. Warm nights are those where the minimum temperature stays above 70°F. As can be seen in Fig. 3.39, the number of nights where the temperature did not dip below 70°F has increased from a median of slightly more than three in the years 1950 – 1990, to greater than seven since the later 1990s. Historically the cooler evening temperatures in the Berkshires has allowed residents to cool their body temperatures in the night air and to cool their homes by opening windows and using fans to bring in the cooler air. Warmer nighttime temperatures will make it increasingly difficult to bring down the temperature in homes that are not equipped with air conditioning.

Fig. 3.39. Number of Nights When Temperatures Remain 70°F or Higher



https://statesummaries.ncics.org/ma

In the Berkshires, extreme cold temperatures are those that are well below zero for a sustained period of time, causing distress for vulnerable populations that are exposed to the temperatures when outside and straining home heating systems. The severity of extreme cold temperatures are generally measured through the Wind Chill Temperature Index. Wind Chill Temperature is the temperature that people and animals feel when 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 is cooled at a faster rate causing the skin's temperature to drop (MEMA, 2013)

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 three hours, using only the 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 three hours using only the sustained wind. In 2001 the NWS implemented a Wind Chill Temperature Index to more accurately calculate how cold air feels on human skin and to predict the threat of frostbite. According to the calculations, people can get frostbite in as little as 10 minutes when the temperature is -10°F degrees and winds are 15 miles per hour. (MEMA, 2013).

The Town of Clarksburg does not have in place formal protocols for opening a municipal warming or cooling shelter, because at this time there has not been an event that demanded its opening. The Town has opened up the Community Center (which has a generator) a few times during power outages in the winter, to allow people to warm up and recharge electronics, but few people have taken advantage of the service. If the Town had a town-side emergency communications system to alert residents of its opening, it may receive more use.

Built Environment

All elements of the built environment are exposed to the extreme temperature hazards. 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 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 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.

The Berkshires are currently a moderately temperate climate, but an increase in summer temperatures will create higher peak summer electricity demands for cooling, particularly with an increase in the number of air conditioning units being installed. Cooling degree days (CDD) are a measure of how much and for how long outside air temperature was higher than a specific base temperature. CDDs are the difference between the average daily temperature and 65°F, which has been determined to be a temperature that does not typically call for use of indoor cooling systems. For example, if the temperature mean is 90°F, subtract 65 from the mean and the result is 25 CCDs for that day.
In the summer, the number of CDDs was 189 in the Hudson (Hoosic) River Watershed for the baseline years of 1971-2000. The summer CDD rate is expected to increase by 94-237% (177-448 degree-days) by mid-century, and by 126-469% (238-886 degree-days) by end of century (NE CASC, 2017).[31]

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 and wetlands drying out (MCCS and DFW, 2010). Individual extreme weather events usually have a limited long-term impact on natural systems, although unusual

[31] *MA Climate Change Projections, https://eea-nescaum-dataservices-assets-prd.s3.us-east-1.amazonaws.com/resources/production/MA%20Statewide%20and%20MajorBasins%20Climate%20Projections_Guidebook%20Supplement_March2018.pdf*

frost events occurring after plants begin to bloom in the spring can cause significant damage. However, the impact on natural resources of changing average temperatures and the changing frequency of extreme climate events is likely to be massive and widespread. Climate change is anticipated to be the second-greatest contributor to this biodiversity crisis, which is predicted to change global land use. One significant impact of increasing temperatures may be the northern migration of plants and animals. Over time, shifting habitat may result in a geographic mismatch between the location of conservation land and the location of critical habitats and species the conserved land was designed to protect. Between 1999 and 2018 (fiscal years), the Commonwealth spent more than $395 million on the acquisition of more than 143,033 acres of land and has managed this land under the assumption of a stable climate. As species respond to climate change, they will likely continue to shift their ranges or change their phenologies to track optimal conditions (MCCS and DFW, 2010). As a result, climate change will have significant impacts on traditional methods of wildlife and habitat management, including land conservation and mitigation of non-climate stressors (MCCS and DFW, 2010). Changing temperatures, particularly increasing temperatures, will also have a major impact on the sustainability of our waterways and the connectivity of aquatic habitats (i.e., entire portions of major rivers will dry up, limiting fish passage down the rivers). Additional impacts of warming temperatures include the increased survival and grazing damage of white-tailed deer, increased invasion rates of invasive plants, and increased survival and productivity of insect pests, which cause damage to forests (MCCS and DFW, 2010). As temperature increases, the length of the growing season will also increase. Since the 1960s, the growing season in Massachusetts increased by approximately 10 days (CAT, n.d. as cited in MEMA & EOEEA, 2018).

Climate change is also likely to result in a shift in the timing and durations of various seasons. This change will likely have repercussions on the life cycles of both flora and fauna within the Commonwealth. While there could be economic benefits from a lengthened growing season, a lengthened season also carries a number of risks. The probability of frost damage will increase, as the earlier arrival of warm temperatures may cause many trees and flowers to blossom prematurely only to experience a subsequent frost. Additionally, pests and diseases may also have a greater impact in a drier world, as they will begin feeding and breeding earlier in the year (Land Trust Alliance, 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 invasive species (see Section 4.3.3 for additional information). Higher temperatures that result in greater concentrations of ozone negatively impact plants that are sensitive to ozone (USGCRP, 2009). Additionally, as previously described, changing temperatures can impact the phenology.

Above average, below average, and extreme temperatures are likely to impact crops—such as apples, cranberries, and maple syrup—that rely on specific temperature regimes (resilient MA, 2018). Unseasonably warm temperatures in early spring that are followed by freezing temperatures can result in crop loss of fruit-bearing trees. Farmers may have the opportunity to introduce new crops that are viable under warmer conditions and longer growing seasons; however, a transition such as this may be costly (resilient MA, 2018 as cited in MEMA & EOEEA, 2018).

Livestock are also impacted, as heat stress can make animals more vulnerable to disease, reduce their fertility, and decrease the rate of milk production. Additionally, scientists believe the use of parasiticides and other animal treatments may increase as the threat of invasive species grows. Increased use of these treatments increases the risk of pesticides entering the food chain and could result in pesticide resistance, which could result in additional economic impacts on the agricultural industry (MEMA & EOEEA, 2018).

Future Conditions

According to NOAA, global temperature data document a warming trend since the mid-1970s. Temperature changes will be gradual over the years. However, for the extremes, meteorologists can accurately forecast event development and the severity of the associated conditions with several days lead time. High, low, and average temperatures in Massachusetts are all likely to increase significantly over the next century as a result of climate change. This gradual change will put long-term stress on a variety of social and natural systems and will exacerbate the influence of discrete events (MEMA & EOEEA, 2018). Increased electricity demand for CDDs throughout the northeast could stress the New England electricity grid system and lead to brownouts or controlled blackouts, stressing or injuring the health of vulnerable populations and possibly impairing functions of government and communications systems. For the Town of Clarksburg, there will be a need to identify and maintain communications with vulnerable populations such as the elderly, people with underlying health problems, and low-income residents whose homes do not have cooling systems adequate to bring down indoor temperatures.

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

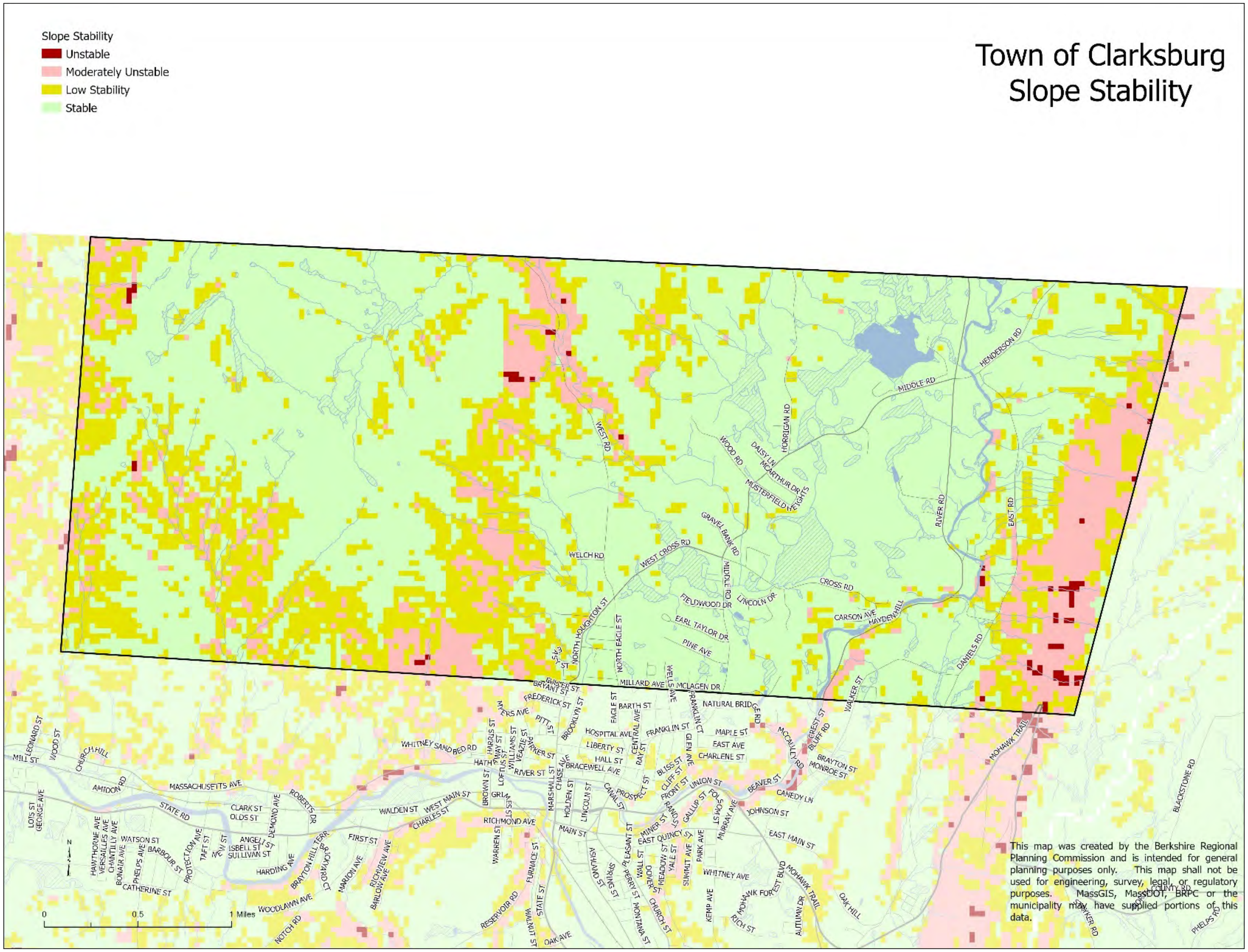
Natural variables that contribute to the overall extent of potential landslide activity in any particular area include soil properties, topographic position and slope, and historical incidence. Predicting a landslide is difficult, even under ideal conditions (MEMA & EOEEA, 2018). Estimations of the potential 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 landslides 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 for the Town of Clarksburg are illustrated Figure 3.40, with corresponding map legend on the following page.

Figure 3.40. Slope Stability Map for Clarksburg



Source: BRPC, 2021, MassGIS 2017.

[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.

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

[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).

Generally accepted warning signs for landslide activity include the following (MEMA & EOEEA, 2018):

- 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 stream 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.

Geographic Areas Likely Impacted

Landslides associated with slope saturation occur predominantly in areas with steep slopes underlain by bedrock or glacial till. 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 from organic material. 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, and becomes a plane of weakness. If conditions are favorable, failure will occur. Occasionally, landslides occur where there are lacustrine or marine clays are found, 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. (MEMA & EOEEA, 2018).

Although specific landslide events cannot be predicted like a storm, a slope stability map shows where slope movements are most likely to occur after periods of high-intensity rainfall. Unstable and Moderately Unstable slopes are found in various areas of Clarksburg. There are 33 acres of land (less than one-half of 1% of total land area) in Clarksburg that GIS has identified as being Unstable (seen as red areas in the map in Figure 3.40). There are 827 acres of land (10% of total) identified as Moderately Unstable (seen as pink areas in the map). The area with the largest acreage of Unstable slopes is in the eastern portion of the Town, along the western slopes of the Hoosac Range. Some buildings are located within Moderately Unstable areas along these slopes. Many of the Unstable areas are associated with steeper slopes, many along incised ravines of mountain streams. The ledge along the Hairpin Turn is shown as Unstable, including the site of the Eagle Restaurant. There is section of Unstable slope on the west bank of a bend in the North Branch Hoosic River. Small Unstable areas are found in the western portion of the Town, most along steeply sloped hillsides within Clarksburg State Forest, where there is no development. Although the exposed ledge along River Road along the Clarksburg/North Adams border is categorized as Moderately Unstable, rock fall is common in this area. A few years ago a section of rock came down and damaged a car. The eastern lane of the road was closed for approximately a year until MassDOT was able to clear the area and repair the roadway. A major landslide that closed the road completely would cut off a major, regional north-south route.

Historic Data

Historical landslide data for the Commonwealth suggests that most landslides are preceded by two 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).

Local news articles indicates that landslides of exposed bedrock occur periodically along the steep slopes of the Mohawk Trail in the vicinity of the Hairpin Turn. These areas are show in red in the Slope Stability Map and are located mostly in Florida. The Eagle Restaurant, which is located in Clarksburg, is located on land rated Unstable by the computer model. The most severe landslide to occur in the Berkshire region occurred along the Mohawk Trail (Route 2) in along the Florida/Savoy boundary during T.S. Irene in 2011 (Figures 3.41, 3.42). The landslide 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). The soil and tree debris covered the entire width of Route 2 and caused its closure for weeks (see bottom photo left). The landslide had a significant impact on northern Berkshire County communities because Route 2 is a major east-west transportation route in that region.

Figs. 3.41, 3.42. Landslide in Savoy, MA August 2011

Source: Top: Mabee, Stephen B., Duncan, Christopher C. 2013. Slope Stability Map of Mass., MA Geological Survey. Bottom: courtesy Stan Brown of Florida, MA

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. In Clarksburg, there are 19 residential buildings located in the areas modeled to be Moderately Unstable; there are no buildings located within the Unstable land category. Using the 2.5 people per household figure for Clarksburg, approximately 48 people are potentially at risk from landslide. Because landslide risk is not as predictable as some other hazards, such as being in floodplain, it is doubtful that all nine buildings would be impacted at one time.

Built Environment

There are no buildings located in Clarksburg in areas identified as Unstable. There are 19 buildings located within areas identified as Moderately Unstable slopes, all residential buildings. According to data extracted from assessor parcel information, the value of these nine properties is $2,397,300. Loss of these buildings could result in loss of life. There would also be significant issues with access of roads and neighborhoods.

If landslide debris where to fall into the river channel of the North Branch Hoosic at the river bend north of Daniels Road, it could alter the morphology of the river, possibly resulting in changes in downstream flow. An extreme change in river flow could flood or damage structures downstream of the landslide, especially if it were to occur during a time when the river was already flowing at flood stage such as a 100-year storm event.

Steep bedrock was carved into to create the road bed for the Mohawk Trail at the Hairpin Turn. The face of bedrock is exposed on the eastern side of the eastern section of the road, while on the western edge of the western section of the road sits atop a slope that descends steeply downward. Several trucks have been unable to make the sharp curve and have gone over the cliff of the western side of the road. A landslide on the Mohawk Trail (Route 2) at the Hairpin Turn could damage or block one or two sections of the road. If the landslide were large and heavy enough, rock and debris could not only fall onto the road and close off travel, but it could continue crashing downward and take the lower, western section of the road with it down the hillside. Reconstruction of such a devastating nature would, at a minimum, take months or years to repair, depending on severity of the damage and time of year. As the Mohawk Trail is a major east-west travel corridor for northern Berkshire County, the loss of this route would have economic consequences, as we seen during the loss of the road after T.S. Irene in 2011.

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. 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.

Electric 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, causing extended and broad area outages (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 (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. The landslide scar on the eastern slope of Mount Greylock is still largely unvegetated.

Fig. 3.43. Mount Greylock in Adams, MA. The 1990 landslide area was still void of vegetation in 1999 when this photo was taken.

Source: BRPC, 1999.

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 the region may lead to a higher likelihood for landslides as soil and vegetative cover are impacted. Special attention should be paid to the risk of landslide in permitting development in steeply sloped areas. Careful and protective use of the Town's Upland Conservation zoning bylaw would be prudent.

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.

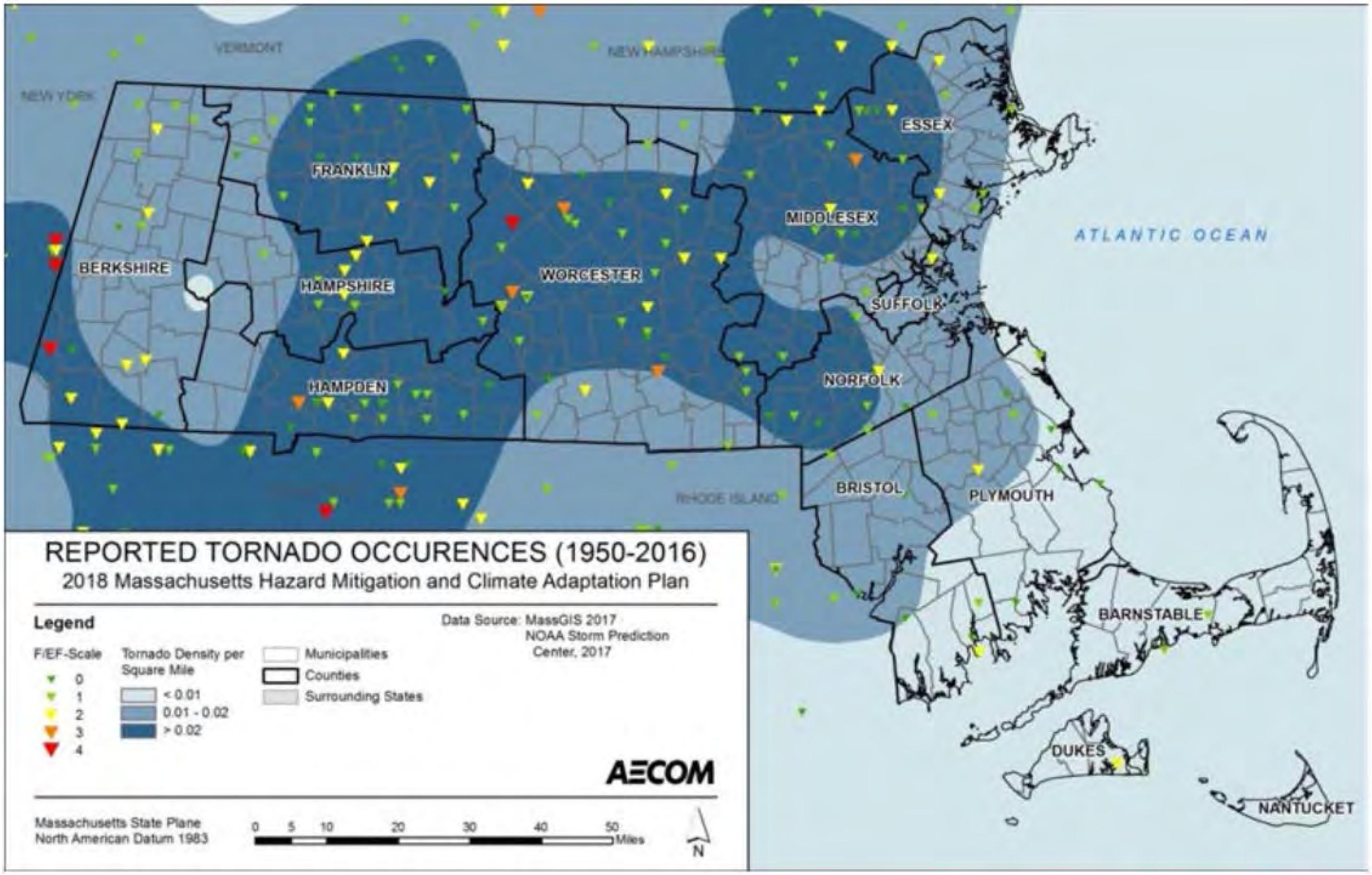
Probability

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, although the county's most devastating was in Great Barrington in May. 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 Clarksburg is susceptible. Figure 3.44 shows tornadoes reported in Massachusetts through 2016. The map shows that tornadoes were reported in the neighboring communities of North Adams and Florida, but the Town has no information about those events.

Figure 3.44. Density of Reported Tornadoes per Square Mile



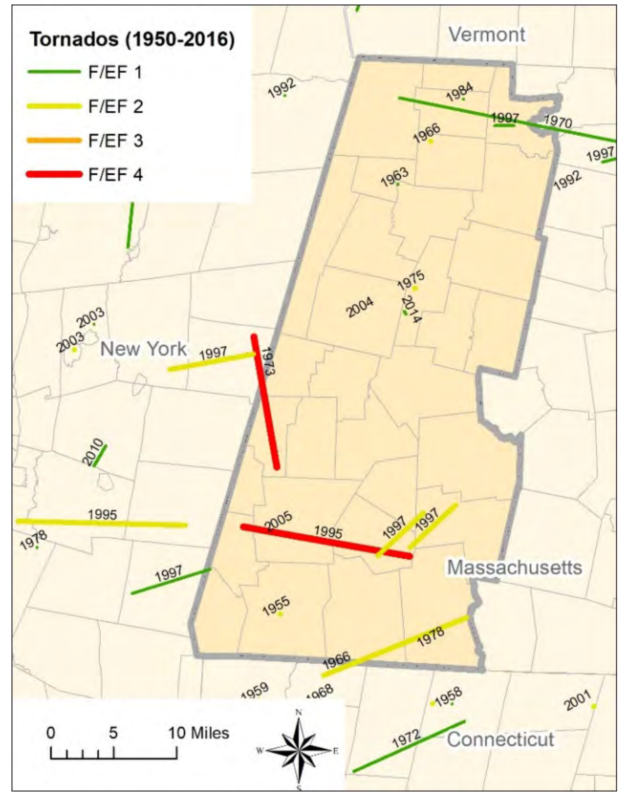
Source: MEMA, 2018, from NOAA Storm Prediction Center (SPC)

Historic Data

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

Microbursts occur throughout Berkshire County, downing trees, utility lines and sometimes causing damage to property. In the Berkshires microbursts are often very local in nature, effecting only a small area, and are often accompanied by heavy rainfall that can cause additional damage from flooding. However, because most microbursts effect small areas and damages are relatively limited, they are seldom listed by state or national agencies. One known microburst, May 29, 2012, was documented as occurring in Hopkins Forest in northwestern Williamstown by Williams College. The event, with a 4:40 p.m. maximum wind speed of 84 miles per hour on the ridge, knocked down trees of various sizes and age, and created openings in the forest. Microbursts struck in Lanesborough twice, in 2001 and in 2004, knocking down trees and powerlines for several hours. A microburst struck Cheshire in 2016. According to local news media reports, several recent thunderstorm/microburst events have also caused damages in the communities of North Adams, Adams, Cheshire, Pittsfield, Lee, and Stockbridge (Williamstown HMCAP, 2019).

Fig. 3.45. Tornados in the Berkshire Region and their Severity



Source: BRPC, 2017.

Vulnerability Assessment

People

In general, vulnerable populations include seniors, people with underlying health issues and disadvantaged populations. Individuals with limited communication capacity, such as those with limited internet or phone access, may not be aware of impending tornado warnings. The current average lead time for tornado warnings is 13 minutes. Occasionally, tornadoes develop so rapidly that little, if any, advance warning is possible. This short warning time is part of why tornados are so dangerous. Tornado watches and warnings are issued by the local NWS office. A tornado watch is released when tornadoes are possible in an area. A tornado warning means a tornado has been sighted or indicated by weather radar. (MEMA, 2018). Power outages resulting from tornado or high winds can be life-threatening to those who are dependent on electricity for life support.

In Clarksburg, these warning systems are broadcast over regional television and radio stations, which generally come out of Albany NY. Local radio stations that once were manned by local residents have switched their programming and do not always have people in the studio to issue weather alerts. The loss of local radio leaves a gap in emergency communications. The local newspaper is now owned and operated out of Vermont instead of neighboring North Adams. Summer is a time to enjoy the great outdoors for both residents and visitors alike, and it is likely that most people would not be near a TV or radio if a tornado warning is issued. This may be particularly true of campers staying in the Clarksburg State Park. In May 2021, during the development of this plan, Clarksburg residents approved funding for a CodeRED emergency and community notification system for the Town. It is expected to be in place later in 2021 and will be used send quick notifications of time-sensitive information, emergencies, and day-to-day operational updates.

Built Environment

All buildings and structures in Clarksburg are at risk from tornados. Aside from potential damage to the buildings themselves, loss of electricity would mean that well pumps would not function and residents would lack drinking and waste water. If a tornado hit a large expanse of Clarksburg and/or its neighboring towns, electricity could be out for days.

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, 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.

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 (MEMA, 2018).

Future Conditions

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). The short warning time of tornado creation increases the risk of people to tornadoes.

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 (MEMA & EOEEA, 2018).

Likely severity

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 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. 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.

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 structural 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, with accompanying descriptions of what the earthquake will feel like to people in the area. Table 3.19 describes the intensity and the equivalent Richter Scale rating.

Table 3.19. Modified Mercalli Intensity Table and Description of Impacts

Equivalent Richter Scale Magnitude	Mercalli Intensity	Abbreviated Modified Mercalli Intensity Scale Description
NA	I	Felt by very few people; barely noticeable.
< 4.2	II	Felt by few people, especially on upper floors of buildings.
NA	III	Noticeable indoors, especially on upper floors, but may not be recognized as an earthquake; vibration similar to passing of a truck.
NA	IV	Felt by many indoors, few outdoors; may feel like heavy truck striking building.
< 4.8	V	Felt by almost everyone, some people awakened; small objects move, trees and poles may shake.
< 5.4	VI	Felt by all, many frightened; some furniture moved; few instances of fallen plaster; damage slight.
< 6.1	VII	Damage negligible in buildings of good design & construction; slight-moderate in well-built ordinary buildings; considerable damage in poorly designed & constructed.
NA	VIII	Buildings suffer slight damage if well-built, severe damage if poorly built. Some walls. Chimneys, factory stacks collapse.
< 6.9	IX	Damage considerable in specially designed structures; damage great in buildings with partial collapse; buildings shifted off foundations.
< 7.3	X	Some well-built wooden structured destroyed; most masonry and frame structured destroyed with foundations.
< 8.1	XI	Few, if any (masonry) structures remain standing; bridges destroyed.
> 8.1	XII	Damage total; objects thrown into the air.

Source: MEMA & EEA, 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. 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). More noticeable in Berkshire County was a 5.1 earthquake centered near Plattsburg in upstate New York on April 21, 2002, which shook homes throughout the region.

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 Clarksburg 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).

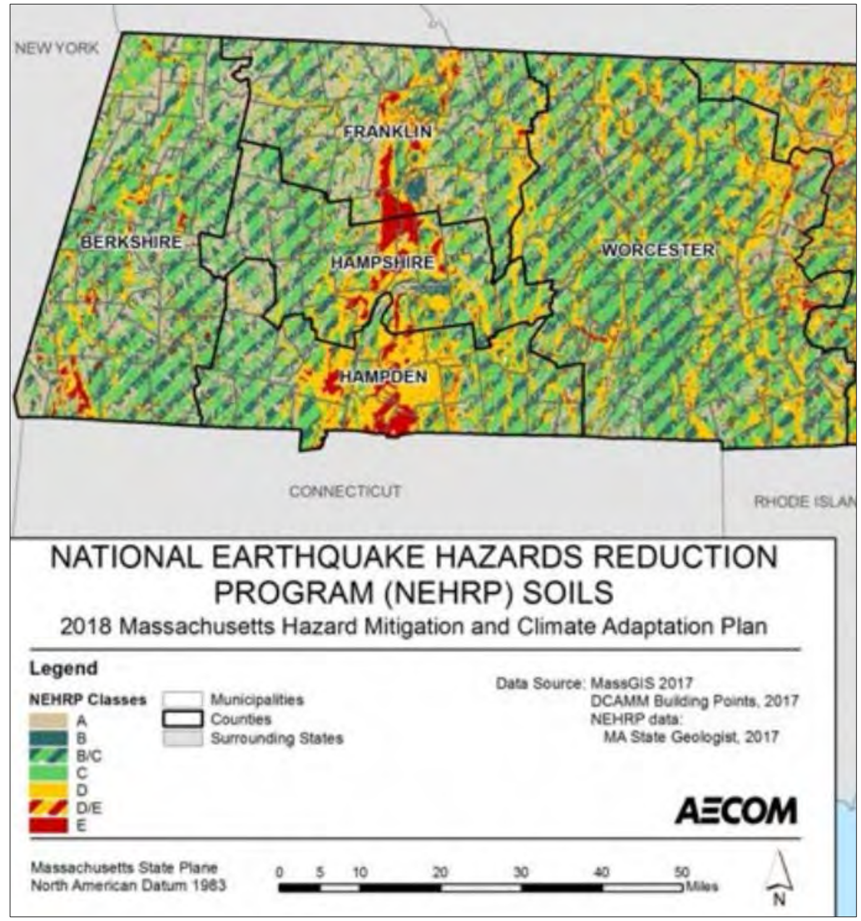
Geographic Areas Likely Impacted

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 five) 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 (MRP). The results of that analysis are discussed later in this section (MEMA & EOEEA, 2018).

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 3.46. 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).

Figure 3.46. NEHRP Soil Types in Massachusetts



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

Historic Data

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). In the morning of April 20, 2002, a 5.1-rated earthquake rattled homes and work people up throughout Berkshire County. Residents describe the affects as vibrating or shaking their homes, rattling hangings on the wall, and sounding loud like a train or large truck passing by. According to a local news article, no injuries were reported and the only local damages reported were a cracked home foundation on Houghton Street in Clarksburg.[32] Clarksburg residents who participated in the development of this plan described the same impacts in their homes. Another earthquake in Virginia on August 23, 2011 was felt in Western Massachusetts.

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

[32] *Gosselin, Lisa, 4-21-02. "Earthquake Wakes up Northeast," Berkshire Eagle.*

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).

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 *Massachusetts 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. Results were calculated on the county level. 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 a.m.; peak educational, commercial, and industrial occupancy at 2 p.m.; and peak commuter traffic at 5 p.m. Table 3.20 shows the number of injuries and casualties expected for events in Berkshire County of varying severity (based on mean return periods) and for at various times of the day. Damages and loss due to liquefaction, landslide, or surface fault rupture were not included in this analysis. Estimated damages to the general building stock were generated at the Census-tract level.

Residents may be displaced or require temporary to long-term sheltering due to the event. The number of people requiring shelter is generally less than the number displaced, as some who are displaced use hotels or stay with family or friends following a disaster event. Shelter estimates from Hazus are intended for general planning purposes and should not be assumed to be exact. It should also be noted that, in Massachusetts, the season in which an earthquake occurs could significantly impact the number of residents requiring shelter. For example, if an earthquake occurred during a winter weather event, more people might need shelter if infrastructure failure resulted in a loss of heat in their homes. These numbers should be considered as general, year-round average estimates (MEMA & EOEEA, 2018). In Clarksburg, emergency response would increase due to the increased population due to second homeowners and people at local camps.

Table 3.20. Estimated Number of Injuries, Causalities and Sheltering Needs in Berkshire County

Mean Return Period (MRP)	100-Year MRP			500-Year MRP			1,000-Year MRP			2,500-Year MRP		
Time of Event	2 am	2 pm	5 pm	2 am	2 pm	5 pm	2 am	2 pm	5 pm	2 am	2 pm	5 pm
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: MEMA & EOEEA, 2018 HAZUS

Built Environment

All elements of the built environment in the planning area are exposed to the earthquake hazard. Municipal water and sewer lines could be damages or destroyed. 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).

Table 3.19 summarizes the estimated potential building-related losses per earthquake scenario for Massachusetts. Lifeline-related losses include the direct repair cost for transportation and utility systems and are reported in terms of the probability of reaching or exceeding a specified level of damage when subjected to a given level of ground motion. Additionally, economic losses include the business interruption losses associated with the inability to operate a business due to the damage sustained during the earthquake as well as temporary living expenses for those displaced.

Table 3.19. Economic Loss Estimates, Hazus Probabilistic Scenarios based on Mean Return Period (MRP)

Economic Losses for Berkshire County	100-Year MRP	500-Year MRP	1,000-Year MRP	2,500-Year MRP
Building-Related Economic Loss Estimates	$570,000	$25,660,000	$66,220,000	$200,810,000
Transportation and Utility Losses	$170,000	$7,800,000	$23,180,000	$74,200,000

Source: MEMA & EOEEA, 2018 Hazus.

Future Conditions

Earthquakes cannot be predicted and may occur at any time. Peak Ground Acceleration 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 this 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

The Town of Clarksburg chose to examine the hazard of cybersecurity, which is defined as the defending of computers, servers, mobile devices, electronic systems, networks, and data from malicious attacks. The damage rendered by cybersecurity can be significant. Municipalities may see their entire system compromised by cyber-attacks, which in worst case scenarios could close down governmental operations. It could require the municipality to expend significant financial resources to recover files and possibly, in the event of ransomware attack, pay a ransom to the hacker for retrieval of files. The power outage in 2003 that caused a two-day blackout in much of the Northeast was a result of a cyber-attack. This outage was related to at least 11 deaths and caused an estimated $6 billion in economic damages over two days (Wagner, 2016).[33]

Probability

As computers and connectivity become more pervasive in our lives, the number of vulnerabilities increases. The frequency of attacks impacting the government has increased over the last few years, leading to a higher probability that any one entity will be attacked. In 2018, government was the 7th most targeted industry for cybercrime and experienced 8% of the total attacks. Nation-state sponsored groups are the most likely to target this sector. These groups are likely to use, sell, or deliver compromised information to their respective governments, typically for economic or political gain (IBM 2019).[34] The most likely reason for attacks on a community like Clarksburg is for ransom or to access personal information about residents.

Over the last three years, more than 42,000 vulnerabilities within software programs have been publicly disclosed. Vulnerabilities have increased over 5400% in the years 2014-2019 (IBM 2019). These vulnerabilities provide more ways that criminals can access computer networks and compromise systems.

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[33] *Wagner, Daniel, 2016. https://www.irmi.com/articles/expert-commentary/cyber-attack-critical-infrastructure*
[34] *IBM 2019 https://www.ibm.com/security/data-breach/threat-intelligence*

Like any organization, the greatest risk of cyber-attacks on municipal computer systems comes from the number and variety of people that work on these systems. There are a variety of factors that increase risk for municipalities.

- Varied computer literacy: Municipal staff are hired for the various skills needed to run the many governmental departments and operations within a Town, and the level of computer literacy is varied. New staff typically are screened and go through background and reference checks, but few are evaluated as to their computer habits or their ability to recognize potential security issues.
- Staff turnover: New staff often inherit the same desk and computer as their predecessors, and for ease in transition often inherit their usernames and passwords.
- Personal emails and devices: For a variety of reasons, municipal staff may use their own accounts and devices for work, opening risk to municipal emails and accounts.
- Non-staff access: In addition to staff, elected and appointed board and committee members are often given access to municipal computer systems, with even less security oversight than staff.
- Limited ability to act quickly: Once a security breach has been identified, municipal staff may not be able to act quickly to contain the damage. Staff may not be trained or been given the authority to shut down systems or quickly hire consultants to help deal with the situation. If the cost of containment or ransom is high, it may require a vote of the selectboard or even Town Meeting to authorize funding to address the issue.

Cybersecurity is a constantly evolving discipline. Mitigation to reduce risk includes constant vigilance, including making sure equipment and software is up to date throughout the system. Someone in municipal government should be trained and given the responsibility for staying current with malware risk and for protecting the system as needed. Training more than one staff member will add redundancy to system oversight and maintain constant coverage. Lastly, train all municipal staff and anyone else using the system to avoid scams, malicious emails and attachments to reduce the risk of someone inadvertently allowing malware to enter the system.

Geographic Areas Likely Impacted

Municipal facilities are more likely to be targeted for cybercrime, but all residents and businesses are also at risk. In addition, the electrical grid and telecommunication networks throughout the region are at risk of attacks and could result in large sections of the Town being without power or communications.

Historic Data

Cyberattacks are a human-caused hazard, often spread by users who have inadvertently allowed access to their systems. In 2015 the theft of personal information of more than 22 million government employees from the computer systems of the Office of Personnel Management has far-reaching implications (Wagner, 2016). During 2016-2019, more than 11.7 billion records and over 11 terabytes of data were leaked or stolen in publicly disclosed incidents. These compromised records contain information such as social security numbers, addresses, phone numbers, banking/payment card information, and passport data. In some cases, health data may also be stolen (IBM 2019). The recent disclosure that the U.S. Pentagon and other high-ranking federal agencies had been hacked illustrates the breadth of the danger.

Locally, at least two towns in Berkshire County and numerous municipalities across the state have been attacked with Ransomware within the last few years. One of the towns, as advised by its insurance company, paid the ransom to get its files back. In 2016, Berkshire Health Systems, the region's central health care system that includes the county's three hospitals, numerous physician practices and clinics, was attacked by malware. As recently as April 2021 the Massachusetts Auto Inspection System was shut down due to a cyber-attack. These attacks can cost the communities anywhere from tens of thousands of dollars to millions of dollars in ransom and countless hours restoring their systems and improving their resilience to a future attack.

The recent ransomware on the Colonial Pipeline forced the closure of one of the nation's key fuel pipelines. The Colonial Pipeline is a 5,500-mile-long pipeline that carries 2.5 million barrels a day of gasoline, diesel, heating oil, and jet fuel on its route from Texas to New Jersey. Closure of the pipeline for 11 days in May 2021 prompted gasoline shortages and panic buying in the southeastern U.S., including in the nation's capital. Against the advice of its consultants and that of the FBI, Colonial paid $4.4 million to foreign hackers to release its systems. Had the shutdown gone on longer, it could have affected airlines, mass transit and chemical refineries

Vulnerability Assessment

People

Cyberattacks rarely have direct, physical impacts on humans aside from the anguish caused by a breach. Personal identifiable information that may be stolen from a municipal system can cause disruption to people's lives, impacting their finances, security, and future. Municipal operations may be shut down during a breach, causing a delay in services, issuing permits or tax bills, or a host of other governmental functions. Cyber-attacks that impact the utilities may cause potential harm to those who rely on electricity for life support, heat, and water. Hospitals and medical facilities utilizing networked monitoring systems are vulnerable to hacking.

Built Environment

Cyberattacks on the built environment may result in the loss of power, communications and equipment failure in government offices. Attacks on the utilities would likely result in temporary loss of service, however utilities can also be attacked where the systems are taken control of and purposely overloaded, damaging the physical infrastructure, which will result in a costlier recovery and a longer recovery time. Government computer equipment can also be damaged or locked, preventing the use of that equipment unless a ransom is paid. This equipment can be replaced, but the data on the computers may not be recoverable, resulting in the loss of data and governmental records unless the computers have been properly backed up.

Natural Environment

Cyberattacks pose a threat to the natural environment as well. Systems such as wastewater or drinking water treatment plants are vulnerable to ransomware if they are connected to the internet, as hackers could control pumps, valves, chemical applications or many other parts of the systems. Clarksburg does not have any such computer- or internet-controlled systems TRUE? Chemical and other leaks from businesses can occur in the same manner.

Economy

The economy is susceptible to the threat of cyberattacks due to the loss of utilities and computers causing a reduction in economic output. Computerized control systems known as a Supervisory Control and Data Acquisition (SCADA) systems allow industries and utilities remote controlling and monitoring of industrial processes. An attach in these systems can disrupt production, shut down operations completely or otherwise damage the business' output. The power blackout of 2003 was an attack on the utility's SCADA system. The weakest link in these systems is employees unwittingly opening emails or some other back-door way into the system (Wagner, 2016). The U.S. government estimates that malicious cyber activity costs the U.S. economy between $57 billion and $109 billion in 2016.[35]

Future Conditions

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

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[35] *https://www.whitehouse.gov/wp-content/uploads/2018/03/The-Cost-of-Malicious-Cyber-Activity-to-the-U.S.-Economy.pdf*

CHAPTER 4: MITIGATION STRATEGY

44 CFR § 201.6(c)(3-5)

The Mitigation Strategy outlines how the Town of Clarksburg intends to reduce potential losses identified in the Risk Assessment chapter. The goals and objectives of the Town guide the selection of actions to mitigate and reduce potential losses. A prioritized list of cost-effective, environmentally sound, and technically feasible mitigation actions is the product of reviewing benefits and costs of each proposed project.

Existing Protections and Authorities

The Town of Clarksburg is fortunate in having natural mitigative infrastructure in the contiguous forests and wetland resources that dominate the landscape. The Town'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[36]. 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.

The Town participates in the National Flood Insurance Program, which enables homeowners, business owners and renters in participating communities to purchase federally backed flood insurance. In general, having flood insurance is required for mortgage or loan seekers whose buildings are located in floodplains or flood zones.

The Town of Clarksburg has policies and regulations in place to direct development away from hazardous areas, including construction in floodplain and on upper elevations. In general, large commercial and industrial projects must apply for a Special Permit, with the Planning Board being the Special Permit Grant Authority (SPGA) for most development, with the exception of windmill electric generating, for which the Zoning Board of Appeals is the SPGA.

Before granting a Special Permit, the SPGA shall find that the purposed use "will not overload any public water, drainage or sewer system or any other Municipal facility to such an extent that the proposed use or any existing use in the immediate area or in any other area of the town will be unduly subjected to hazards affecting public health, safety or general welfare… and will not constitute a nuisance due to air or water pollution, flood, dust, noise, vibration, lights or visually offensive structures and accessories." A Site Plan for the proposal is required, in which is shown existing and proposed topography including contours, location of wetlands streams, water bodies, drainage swales, 100-year floodplain, and unique natural features. All site plans shall be prepared by a registered architect, landscape architect, professional engineer or registered land surveyor, as appropriate, and certified by same with their seal stamp and signature. To obtain a special permit, the project must

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

demonstrate protection of unique or important natural features and show the adequacy of the proposed drainage system within and adjacent to the site to handle the increased runoff resulting from the project. It must also show the adequacy of the soil erosion plan and any plan for the protection of steep slopes, both during and after construction and the protection of wetlands by building in accordance with the state Wetlands Protection Act.

The Town has enacted an overlay district and accompanying zoning bylaw to specifically restrict new development in the 100-year floodplain. The purposes of the Floodplain District are to protect public health, safety, and welfare, to protect human life and property from the hazards of periodic flooding, to preserve natural flood control characteristics and the flood storage capacity of the floodplain, and to preserve and maintain the groundwater table and water recharge area within the floodplain. The general boundaries of the Floodplain District are shown on the Clarksburg Flood Insurance Rate Map (FIRM), dated July 5, 1982 as Zones A, I-30 to indicate the 100-year floodplain. The exact boundaries of the district are defined by the 100-year surface elevations shown on the FIRM, and further defined by the Flood Profiles contained in the Flood Insurance Study dated July 5, 1982. These two maps as well as the accompanying Study, are incorporated herein by reference and are on file with the Town Clerk, Planning Board, and Building Inspector. In general, the only uses allowed by-right within this district are buildings lawfully existing prior to the adoption of the district, agricultural, and outdoor recreational uses. The Planning Board may issue a special permit if the project complies with the following provisions: all encroachments including fill, new construction, substantial development improvements to existing structures, and other development are prohibited unless there is a certification by a registered professional engineer provided by the applicant demonstrating that such encroachment shall not result in any increase in flood levels during the occurrence of the 100-year flood; and the land is shown to be neither subject to flooding produced by the 100-year occurrence, nor unsuitable for the proposed use because of hydrological and/or topographical conditions (Sec. 8.1, Zoning Bylaws of the Town of Clarksburg MA, 2017).

In addition to the Floodplain District, floodplains and areas subject to flooding in Clarksburg are partially protected from adverse development impacts through the Massachusetts Wetlands Protection Act (310 CMR 10.00), one of the most protective wetlands laws in the U.S. In the Act the 100-year floodplain is one of several types of wetland resource and is termed Bordering Land Subject to Flooding. In the Act, “the boundary of Bordering Land Subject to Flooding is the estimated maximum lateral extent of flood water which will theoretically result from the statistical 100-year frequency storm. Said boundary shall be that determined by reference to the most recently available flood profile data prepared for the community within which the work is proposed under the National Flood Insurance Program.” The floodplain boundary is presumed accurate, but this “presumption is rebuttable and may be overcome only by credible evidence from a registered professional engineer or other professional competent in such matters. Where NFIP Profile data is unavailable, the boundary of Bordering Land Subject to Flooding shall be the maximum lateral extent of flood water which has been observed or recorded (310 Mass. Reg. 10.57).

Under the Wetlands Protection Act no one may “remove, fill, dredge, or alter” any wetland, floodplain, bank, land under a water body, land within 100 feet of a wetland, or land within 200 feet of a perennial stream or river, without a permit from the local Conservation Commission. The Act identifies several presumed “interests” or values to be protected: flood control, prevention of storm damage, prevention of pollution, and protection of fisheries, shellfish, groundwater, public or private water supply, and wildlife habitat. The term “alter” is defined to include any destruction of vegetation, or change in drainage characteristics or water flow patterns, or any change in the water table or water quality. The wetland regulations prohibit most destruction of wetlands and naturally vegetated riverfront areas, and require replacement of flood storage loss when floodplains are filled. Most activities, such as construction, landscaping, and grading, require a permit from the Conservation Commission. Where development is proposed that would impact floodplains, a civil engineer or hydrologist should calculate the flood elevation.

Clarksburg has also established an Upland Conservation zoning by-law to govern construction along the upper elevations of hillsides on the east and west side of the Town. The minimum lot size for construction is five acres, with a minimum of 250 feet of frontage along a roadway. The maximum development footprint allowed is 10% of the lot. In general, the by-law restricts or prohibits most commercial development in this zone. Development allowed by-right include single family homes and a few larger developments, including nursing/assisted living homes, daycare/nursery schools, senior care centers, and construction of a private street with approval under the subdivision laws. Multi-family and townhouses are prohibited. Uses allowed by special permit include forestry of greater than25,000 board feet or 50 cords of wood, resorts and clubs, small scale solar photovoltaic installations and windmill electric generation facilities. The Special Permitting Authority for most special permits in the Upland Conservation area is the Clarksburg Planning Board, with the exception of public utility facility, including windmills, which is permitted by the Zoning Board of Appeals.

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 Clarksburg as its minimum building standards. The Town is also a state-designated Green Community, which involved the adoption of a building code that requires that new buildings meet higher energy conservation and efficiency standards, leading to reductions in long-term building-related greenhouse gas emissions from within Clarksburg. Local municipal building inspectors must be certified by the state to be eligible for the position.

The Clarksburg Department of Public Works is a small but dedicated crew that works 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 because small streams can become swollen quickly during heavy rain events. 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 Clarksburg 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. The Cross Road bridge is slightly too large for the state Small Bridge Program but not significant enough of a regional project to rank highly on the TIP. The fact that the road remains open and detours are available makes the project even less competitive when compared to other TIP projects.

Using Town funds or its small Chapter 90 allocation, the Clarksburg Highway Department has undertaken several road projects in recent years to reduce the risk of flooding in various areas of the Town. As noted in the Flooding section of this plan, T.S. Irene caused severe flood damages throughout the Town, damaging and/or completely destroying culverts and sections of roadbed. Since this event, it is the Town's policy to upsize culverts and small bridges and add wing walls where feasible during repairs or restoration of roadways. Examples of such improvement projects include those at Cross Road / Lincoln Drive, East Road, Daniels Road, and Gates Avenue. It is expected that the replacement of the bridge on Cross Road will be upsized and that the new crossing on upper Middle Road will be upsized to an open bottom culvert.

In Clarksburg the Police Chief serves as the Town's Emergency Management Director. He has recently advocated for and gotten approval from Annual Town Meeting to establish a CodeRed emergency communications system in order to keep residents safe and informed with quick notifications of time-sensitive information, emergencies, and day-to-day operational updates.

The Briggsville Water District has purchased a residential property adjacent to its Spring House facility. Currently all water is distributed to customers through gravity-fed pressure. The District is demolishing the house and will erect a holding tank at the site for storage and to maintain water pressure.

Generators are located at the Community Center (local designated shelter) and the Clarksburg Fire Station. The Community Center is handicap accessible and has a kitchen if the need to use it as a shelter were to arise. The capacity of the shelter is approximately 100 people.

The Clarksburg Volunteer Fire Company is an all-volunteer organization with approximately 30 current members. Although the Town does not have paid or full-time firefighters, it is proud of its firefighting heritage. Several of its members have gone on to become professional firefighters in the neighboring City of North Adams, and one of its members has become the Fire Chief for the City of Springfield (the 3rd largest city in the state). Although the Town does not have its own ambulance service, the Fire Company does have EMTs within its ranks. Approximately 80% of the company's calls are medical calls. As with most volunteer fire companies in the region, there is little coverage during the work week when its members are working, so the Town relies on mutual aid during these times. As with other volunteer companies in the region, it is difficult to recruit and retain members.

The Fire Company is very active in pursuing grant funding for equipment and supplies. This is especially important as the Fire Company Station serves as the Town's Emergency Operations Center (EOC). Although the Company has always conducted forest fire trainings, it gained invaluable experience in incident commend and in adapting to new on-the-ground firefighting techniques during the forest fire of 2015. Weaknesses identified during debrief meetings after this fire helped the Company focus on equipment needs and become more competitive when applying for grant funding. Communication gaps identified during the debrief have been addressed with the addition of a new repeater tower in the area.

One of Clarksburg's greatest strengths is the good working relationship and tight coordination between the Police, Fire and Highway crews. There are no turf wars. The Town has experienced two severe hazard events within 10 years, that of T. S. Irene in 2011 and the forest fire of 2015, and during those incidents it was a coordinated "all hands on deck." In addition to the Town's first responders, local citizens step in to help where possible.

As with much of life in small towns, funding is a constant battle. Firefighting and EOC equipment is costly: from the personal gear needed for each member, to the generator and equipment needed for the EOC, on up to the vehicles needed for response. Providing full gear for one new fire fighter costs more than $5,000. The community actively and financially supports the Fire Company and the Town provides a small stipend and funds the purchasing of new fire trucks when needed. A new generator for the station and a new fire truck (estimated cost $350,000-450,000) is needed at this time.

Clarksburg is an active member of the Northern Berkshire Regional Emergency Planning Committee (REPC), an all-hazards regional planning committee that focuses on emergency and incident planning and response. The REPC's strength is the shared coordinated efforts and expertise of its nine member communities, all of which are located in northern Berkshire County and southern Vermont. All member towns of the REPC benefit from the coordinated efforts undertaken by the REPC, which includes formal mutual aid agreements, shared equipment and supplies, coordinated communications and public outreach programs, trainings and drill exercises. The REPC has developed a regional shelter plan that identifies shelters and their amenities within each municipality, along with a central, regional shelter (located in neighboring North Adams) in the event that one is needed for the region. The REPC was a key resource in securing and distributing needed supplies during the COVID 19 Pandemic.

Clarksburg has begun to address the issue of cybersecurity. It has procured the professional services of an IT consultant to evaluate and improve the protectiveness of its computer system. New protections and software updates have been placed within the system, and a small grant was just awarded to support employee training in recognizing potential security issues. The drafting of a Cyber Incident Response Plan is in its early stages. This plan, based on guidelines drafted by the Commonwealth, outlines step by step what the Town should do in the event of a cybersecurity breach. This is just the beginning of what should be an ongoing and evolving cybersecurity protection program.

Resident Concerns

As part of the public planning process for the development of this plan, the Town of Clarksburg issued a public survey for residents and business owners to respond to. The survey was open for 60 days and was offered online via Survey Monkey and via paper copies in Town Hall and the Community Center. The survey was promoted heavily through inserts in tax bills, letters sent to business owners, and reminders issued on the Town website and Facebook accounts. It was also promoted through the Elementary School's social media system. The Town received 59 surveys. The responses received through the public survey has aided Town officials and first responders to develop and prioritize hazard mitigation and adaptation strategies.

The survey asked respondents to list where and when they had witnessed the occurrence of severe natural hazards in Clarksburg. This question was open-ended to allow residents to answer without any prompts. Flooding was overwhelmingly the hazard that respondents described in almost every response. T.S. Irene was mentioned by name in 36% of responses. Washed out / closed road and flooding of property were common responses, along with calls for better maintenance of culverts and drains. A "word cloud" of the responses helps to illustrate concerns voiced by respondents (see Fig. 4.1).

The survey also asked respondents to choose and rank the top three natural hazards that concern them the most. The list of hazards included all the hazards evaluated in this hazard mitigation and climate adaptation plan, with the exception of Cyber Attacks. Flooding was broken out into two hazards – that of roads and of property – to aid the town in understanding how much private property impacts might be occurring in Clarksburg. Flooding/washout of roads was chosen as the hazard of most concern, with 37% of respondents ranking it #1 (of greatest concern) and 29% ranking it #2 (second greatest concern). Flooding of their property, severe winter storms, and other severe storms (tropical storms/hurricanes, high winds, etc.) also received high "top 3" rankings.

Fig. 4.1. Most Common Responses to Severe Natural Hazards Witnessed in Clarksburg

Source: Survey Monkey, 2021.

Lastly the survey asked respondents to choose and rank the top three impacts that are caused by the hazards of concern that they choose. The highest ranked impact was Injury or Loss of Life (27%), closely followed by Loss of Electricity and Loss of Property.

Prioritizing Actions

In general, the greatest risk to people and property in Clarksburg is a severe flood event. Safe and effective emergency response and evacuations during severe flood events is threatened by damaging flooding along the North Branch Hoosic River and Hudson Brook. T.S. Irene clearly demonstrated these vulnerabilities. River Road and Cross Road are key emergency response routes and both were damaged and/or closed, as were other connectors such as Daniels Road. Although the Fire Station / EOC is located on high ground, it could be isolated if River and Cross Roads were closed. Residents on Carson Avenue are at risk of being cut off during flood events. Adding to risk is the lack of a community-wide emergency communications system that could alert residents and business owners to hazardous conditions and direct them to safety.

The mitigation projects listed in table 4.1 fall within the primary *Categories of Actions*: The column containing *Description of Action* is a brief summary of the mitigation action the community has identified to reduce their vulnerability to a hazard or more broadly increase resilience.

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

The *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

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

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.

Timeframe is listed at Short, Long, and Ongoing to reflect the timeframe identified for projects. A project that has been identified as short term is one that can and needs to be implemented immediately. These projects are likely to pass a benefit-cost analysis, have the political and community support necessary, and are practicable. Long term projects still require multiple steps before implementation, including studies, engineering, and gaining community support. 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.

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

Those actions listed in italic font in Table 4.1 were listed as action items in the Town's previous hazard mitigation plan, when it was included in the 2015 *Berkshire County Hazard Mitigation Plan Addendum*, the county-wide plan that included 23 Berkshire communities. Actions listed in regular font are new actions identified through the current hazard mitigation planning process.

Table 4.1 provides a roadmap for the Town of Clarksburg to increase resiliency and will be updated with the new plan in five years.

Table 4.1. Mitigation Action Plan for the Town of Clarksburg

Category of Action	Description of Action	Benefit	Implementation Responsibility	Timeframe / Priority	Resources / Funding	Notes/Updates from 2012
Structural Project - Flooding	*School Street Culvert structural replacement*	*Reduce the risk of flooding in area and potential road closure*	Dept. Public Works (DPW)	Ongoing / Low	Gen. Funds, DPW budget, Chapter 90, FEMA	Pipe is old but functioning – continue to monitor and replace when feasible
Structural Project - Flooding	*Monitor flooding along Houghton Street culverts and determine if replacement is needed*	*Reduce the risk of flooding in area and potential road closure*	DPW	Ongoing / Low	Gen. Funds, DPW budget, Chapter 90, FEMA	Gates Ave. upsized; 40' of pipe replaced on Gleason St., but all 200' underground also needs replacing
Structural Project - Flooding	*Monitor flooding along River Road's culverts and work with MassDOT to determine if replacement is needed*	*Reduce the risk of flooding in area and potential road closure*	DPW, MassDOT	Ongoing/ High	DPW budget staff time, MassDOT implement	Ongoing in coordination with MassDOT
Structural Project - Flooding	*Monitor flooding along the area of Cross Road/Lincoln Drive determine if replacement needed*	*Reduce the risk of flooding in area and potential road closure*	DPW	Ongoing / High	Gen. Funds, DPW budget, Chapter 90, FEMA	Addressed: culvert was upsized and replaced with open bottom span; flooding of properties adjacent to stream occurs due to sedimentation in channel
Structural Project - Flooding	*Monitor flooding along upper Middle Road to determine if replacement needed*; implement Foresight Land Services engineering design by re-applying for grant funds	*Reduce the risk of flooding in area and potential road closure*	DPW	Short / High	Gen. Funds, DPW budget, Chapter 90, FEMA	Engineering secured with Town funds; applied for MassWorks grant but not successful; Town expects to re-apply

Category of Action	Description of Action	Benefit	Implementation Responsibility	Timeframe / Priority	Resources / Funding	Notes/Updates from 2012
Structural Project – flooding	Implement Foresight Land Services engineering design recommendation for upper West Road over Bear Swamp Brook	Reduce risk of flooding of road	DPW	Short / High		Grant-funded engineering recommends open bottom metal box culvert
Local Plans – All Hazards	*Incorporate hazard mitigation planning into future community plans (i.e. Capital Improvements, Master Plans, Open Space & Recreation Plans)*	*Ensure that the community considers hazard mitigation for all municipal projects*	Planning Board, DPW	Ongoing / High	Gen. Funds, State Funds	Hazard concerns were considered when Complete Streets Plan was drafted
Natural Systems Protection – All Hazards	*Establish an education program for landowners on the benefits of having a forest management plan for hazard reduction through a working group of municipal, state and large private landowners*	*Mitigate hazards by reducing runoff and wildfire risk*	Select board, DCR, Private landowners, school news	Long / Low	Gen. Funds, DCR, Private funds	No action taken but issue still valid
Education – All Hazards	*Distribute educational material to residents on hazards of highest concern in town and how to mitigate them for existing and new construction*	*Educate residents on location and risk of hazards to obtain buy-in for expensive structural mitigation activities and ensure new development is not susceptible to hazards*	EMD	Long / Low	Gen. Funds, Free materials	No action taken but issue still valid
Local Plans - Flooding	*Pursue new floodplain maps*	*Improve identification of flood-prone areas and allow town to more effectively prevent development within floodplain*	FEMA, Planning Board	Long / High	FEMA Map Modernization Program	Being undertaken by federal and state agencies

Category of Action	Description of Action	Benefit	Implementation Responsibility	Timeframe / Priority	Resources / Funding	Notes/Updates from 2012
Local Plans - Flooding	*Join the Community Rating System*	*Allow homeowners to reduce insurance while better preparing the town for hazards and reducing risk*	EMD	NA	Gen. Funds	No action taken; Town does not feel need to pursue this
Preparedness – Severe Storms	*Identify trees new power lines for trimming; determine whether the Town and/or National Grid will do the work; trim trees as needed*	*Reduce risk of power failure during storms*	Tree Warden, National Grid	Ongoing / Medium	National Grid	Town and National Grid have been more proactive in tree trimming; still valid
Preparedness – Fire	*Identify debris in the Clarksburg State Forest and have DCR remove debris as needed; work with DCR to maintain access*	*Reduce chance of wildfire*	DCR	Ongoing / Low	DCR	No Action taken; still valid
Preparedness – Fire	Clear and re-establish fire access paths	Improve wildfire fire response time	Fire Company, DCR	Long / Low	DCR, AT Council	New Action
Structural Projects – Flooding, Preparedness	Pursue funding to construct new bridge at Cross Road, which is currently in preliminary design/cost estimate phase	Restore safe, 2-way travel on this critical route	DPW, MassDOT	Short/ High	Town, Ch. 90, MassDOT, MVP Program	New Action
Structural Projects – Flooding	Evaluate storm runoff and management above Carson Ave. area to determine causes and possible solutions	Reduce risk of injury and property damages; maintain safe travel for this emergency response route	DPW, MassDOT, EMD	Short / High	Town, Ch. 90, MassDOT	New Action

Category of Action	Description of Action	Benefit	Implementation Responsibility	Timeframe / Priority	Resources / Funding	Notes/Updates from 2012
Structural Projects – Flooding, Preparedness	Implement engineering solution to the failure of the retaining wall Cross Road below Fire Station and above Gordon Garage	Protect road, residences and local businesses; protect response time from Fire Station	DPW, BOS, EMD	Short / High	Town, Ch. 90	New Action
Preparedness - Flooding	Monitor the bank erosion on the North Branch Hoosic River – above and below Mary Baker Bridge; retain engineering services to evaluate	Protect properties along Carson Avenue/Cross Road	DPW, EMD, CC, MassDOT, property owners	Ongoing /High	Town, Ch. 90, MassDOT, MassWorks, MVP	New Action
Preparedness – All Hazards	Implement the recently approved Code Red communications system	Improve communications warning system to residents, businesses and school populations	EMD	Short / High	Town	New Action; cost approved by Annual Town Meeting May 2021
Preparedness - Landslide	Monitor the rock outcrop along River Road for potential landslide	Maintain critical north-south travel and emergency route open	DPW, EMD, MassDOT	Ongoing / Low	MassDOT	New Action
Preparedness - Flooding	Elevate or relocate critical records and equipment in the Police Station / Town Hall first floor / basement	Reduce risk of loss of governmental operations, continuity of government and archives	IT, BOS, EMD	Short / Low	Town, Green Communities	New Action

CHAPTER 5: PLAN ADOPTION

44 CFR § 201.6(c)(5)

This Plan received official Approval Pending Adoption from FEMA on DATE and was formally adopted by the Clarksburg Select Board on DATE. Subsequently it received final approval from FEMA 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 Clarksburg 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 Clarksburg will officially review needed updates for the plan on an annual basis. Specifically the Hazard Mitigation Planning Committee, stakeholders, and partners 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, research and document new disaster information, and participate in resiliency- and mitigation-related initiatives available to the region.

Annual review is scheduled to occur prior to the annual budgeting process. Under the joint leadership of the Emergency Management Director and the Town Administrator, tracking of actions will be done based on completed mitigation actions, new development, changing problem areas, and input from public involvement.

In reaching out the residents and neighbors of Clarksburg, the Hazard Mitigation Planning 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, Clarksburg Adams will begin the process of organizing and identifying funding for the plan update every 3.5 years. Recommendations listed in the FEMA Review Tool (following page) will be considered.

Integration in Future Planning

§201.6(c)(4)(ii)

This HMCAP will be used in all future planning efforts in Clarksburg including comprehensive plan updates, transportation plans, and zoning changes.

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

FROM SECTION 2 OF THE LOCAL MITIGATION PLAN REVIEW TOOL ISSUED BY FEMA, Dated

PLAN ASSESSMENT – INSERT FEAM FINAL COMMENTS HERE

A. Plan Strengths and Opportunities for Improvement. This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Recommended Corrections:

- N/A

References:

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

BRPC, 2015. *Berkshire County Hazard Mitigation Plan*, *Addendum*, Pittsfield, MA.

BRPC, 2017. *Clarksburg Complete Streets Report*, Pittsfield, MA.

Commonwealth of Mass., 2021. Resilient MA Climate Clearinghouse website, https://resilientma.org/. This website hosts relevant data used throughout this plan, including the NE CASC data.

Federal Emergency Management Agency (FEMA), 2013, *Local Mitigation Planning Handbook*.

Mass. Emergency Management Agency (MEMA) & the Exec. Office of Energy and Environmental Affairs (EOEEA), 2013. *Massachusetts State Hazard Mitigation Plan (SHMP),* Boston, MA.

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

APPENDICES:

APPENDIX A: PLANNING MEETING DOCUMENTATION

APPENDIX B: PUBLIC PARTICIPATION DOCUMENTATION

Insert public presentation

Insert survey results

Document posting of the *Draft Clarksburg Hazard Mitigation and Climate Adaptation Plan* on the Town of Clarksburg website homepage DATES.

Solicitation to comment on plan - correspondence sent to neighboring communities and the Northern Berkshire REPC

Natural Hazard Mitigation and Climate Adaptation Plan

Town of Clarksburg
May 12, 2021

What is Hazard Mitigation?

- Natural hazards pose a risk to people, property and the environment
- Examples: floods, hurricanes, tornadoes, drought, heat waves
- Identify activities that can be done to mitigate the hazards *before* they occur
- Mitigation: *pro-active*, rather than reactive; action taken to solve a problem on a *permanent, long-term basis*
- Mitigation Plan is a requirement for eligibility for some FEMA funds
- Updating Plan – Clarksburg was part of the Berkshire Regional Hazard Mitigation Plan of 2012

What Risks Are We Evaluating?

Hazards Evaluated
Flooding (incl. Dam Failure, Ice Jam, Beaver Activity)
Severe Winter Events (Ice Storm, Blizzard, Nor'easter)
Hurricane & Tropical Storm
High Wind & Thunderstorm
Drought
Invasive Species / Pests / Vector-borne Diseases
Wildfire
Annual & Extreme Temperature Changes
Landslide
Tornado
Earthquake

Will Climate Change Effect Hazards and Human Health?

Already we see altered weather patterns:

- More frequent and more intense precipitation; damages and repairs more costly
- Longer growing season, more airborne allergens
- More heat waves (>90°F); more in spring and fall
- Warmer winters with heavier snow and more ice
- Higher survival rates for pests (ticks, mosquitos, forest pests)
- Increased risk for algae blooms on lakes/ponds (recent ex. = Stockbridge, Pittsfield)

Observed Number of Extreme Precipitation Events

- 55% increase 1958-2016 in heavy rain/snow ranked top 1% of daily events
- 55% increase in extreme precipitation includes 9-year drought
- ~30% increase in precipitation events >2" in 1 day (see right)
- >2"/day often = flooding, especially if rain on snow/frozen ground

Number of Events w/ Precipitation > 2" in 1 day

https://statesummaries.ncics.org/ma

Observed Number of Warm Nights

Projected In Hudson Watershed:

- Day temps. >90°F increase from 1 per yr. to 9 by 2050s
- Increase to 18 by 2090s**

Observed In MA:

- Number of nights where minimum temp. >70°F increases in MA*

Seniors and those with medical conditions more vulnerable to heat and humidity

** https://statesummaries.ncics.org/ma*
*** MA Climate Change Clearinghouse*

Winter Weather Changes

Cycles of cold and warm will increase, alter risks

- **Warmer temps:**
  - **More rain-on-snow events** = Increased runoff, risk of winter floods and ice jams
  - **More Ice Storms** = 2008: >1 million w/out power
  - **Less snowpack = less groundwater recharge** = lower baseflow in streams, rivers, reservoirs
  - **Loss of snow insulation** = risk of freeze/thaw = increased risk of frozen pipes, drains
  - **Dryer spring soils**

Don't take Water for Granted

- Drought cycles due to increased temperatures and evaporation
- Lower groundwater recharge
- More water in summer/fall in extreme storm events with higher, earlier peak flows and more runoff
- Berkshires got off lightly 2016-17

T.S. Irene 2011

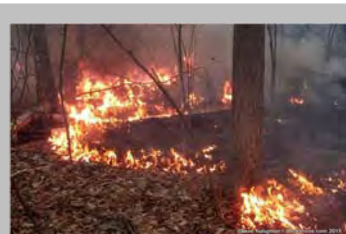
- 3”-9” in 12-hour period + high winds
- 100+ year flood in Hoosic River
- 500,000+ MA residents w/out electricity
- Dubbed the “costliest Category 1 storm” ($15.8 billion in damages in US)
- $35 million in damages in Berk. Co.; $23 million alone for Mohawk Trail
- Permanent loss of The Spruces, Wmstn.

T.S. Irene 2011 in Clarksburg

- River Road collapses
- Several road damages & closures
- Flooding of property & basements
- Fire Dept. receives >50 calls
- Some evacuations
- Floodwaters approach Town Hall
- Conduit for travel for Vermonters
- T.S. Lee Sept. 2011

Clarksburg Forest Fire April 2015

- 272 acres burned – record for county
- 376 firemen fought the fire over 3 days
- Bad News: site inaccessible to trucks, tankers
- Good News: no buildings nearby
- Experience gained



Areas of Concern

Floodplain Vulnerabilities

- 58 homes in 100-year floodplain
- 4 businesses in floodplain
- Road flooding:
  - Cross/Carson
  - E. Cross/Lincoln

Areas of Concern

- Erosion of the bank on N. Branch Hoosic River
- Just above and below the Mary Baker bridge

Mitigation Example: Benton Hill Rd., Becket

3 culvert bridge replacements in 7 years

New full span bridge reduces risk of repeated failure

Clockwise from top left:
First replacement crossing (2009); catastrophic culvert failure due to Tropical Storm Irene (2011); "emergency temporary replacement" crossing (2011); replacement bridge (2016).

Mitigation Example: Bank Stabilization, New Marlborough:

To reduce flooding and possible loss of road

Are You Ready for Electricity Outages?

Observed: household summer peak demand up 3-fold from 1960-2000

The energy sector's three major climate change concerns:

- Flooding (increased precipitation, flooding)
- Extreme events (hurricanes, snow, ice); 2008 some customers lost power for 2+ weeks
- Increased temperature (demand surge, damage to distribution system, controlled brownouts)

Are you prepared to open warming or cooling shelters?

Public Survey Results

- 51 surveys completed – **and it's still open!**
- Respondents from across Town
- Hazard cited most often is T.S. Irene: 61% mention it by name
- Washed out / closed roads and flooded property repeated often
- Need for more culvert & drain maintenance often mentioned

Public Survey Results

Rankings: natural hazards that concern residents the most

1. Flooding/washout of roads & Flooding of resident property
2. Flooding/washout of roads & Severe winter weather
3. Other Severe storms & Vector-borne diseases

Rankings: why residents are concerned about hazards

1. Injury or loss of life & Not being informed of impending disaster
2. Loss of electricity & Being isolated (rd. washout, no communication)
3. Being isolated & Loss of property

Natural Hazards Themes

- **Flooding and Vulnerable Infrastructure**
  - Several culverts were enlarged post-Irene; more need to be done
  - Cross-town emergency routes vulnerable: River Rd., Cross Rd.
  - N. Branch Hoosic River bank erosion
- **Emergency Preparedness**
  - Need for town-wide emergency notification system
  - Protect governmental operations

Major Recommended Actions

- **Pursue road improvements with flooding in mind:**
  - Replace Cross Rd. bridge - high priority (currently in design)
  - Reconstruct upper Middle Rd. (currently in design)
  - Repair retaining wall Cross Rd.
  - Investigate causes of chronic flooding at Cross Rd./Carson Ave.

Major Recommended Actions

- Establish a town-wide emergency notification system
- Floodproof ground floor of Town Hall for continuity of government operations
- Monitor riverbank erosion in area of Mary Baker bridge

Now it's Your Turn!

Help town officials, first responders and fellow residents prioritize the most important actions

Seeking Public Comments

- **Fill out the public survey if you haven't done so through May 21: https://www.surveymonkey.com/r/ClarksburgHM**
- **Provide comments about tonight's presentation**
- **Review / comment on the Draft Hazard Mitigation and Climate Adaptation Plan when it's posted June 11-30**
- **Send comments to: lauren@berkshireplanning.org**