



Windsor Hazard Mitigation & Climate Adaptation Plan

June 2020

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Cover Photo Credit: Glenn Roy, Windsor resident, Conservation
Commissioner, MVP Committee member

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 Windsor, Massachusetts Hazard Mitigation & Climate Adaptation Plan (HMCAP) is prepared to meet the requirements of 44 CFR § 201.6 pertaining to local hazard mitigation plans. 44 CFR § 201.6(a)(1) states that “a local government must have a mitigation plan approved pursuant to this section in order to receive HMGP project grants. Furthermore, a local government must have a mitigation plan approved pursuant to this section in order to apply for and receive mitigation project grants under all other mitigation grant programs.” As the HMCAP will illustrate, Windsor’s eligibility for FEMA’s hazard mitigation grants is crucial.

In addition to legal requirements, the Town of Windsor has laid out the following **Mission Statement** for their hazard mitigation and climate adaptation planning process:

Mission Statement: To identify risks and sustainable cost-effective actions to mitigate the impact of natural hazards in order to protect life, property and the environment in Windsor, MA. The following goals are set forth in order to achieve this mission:

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

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

Background

Mitigation Planning

The Town of Windsor was not included in the Regional Hazard Mitigation Plan that was approved by FEMA Region I in 2012. Therefore, this **Hazard Mitigation & Climate Adaptation Plan (HMCAP)** is a new, single-jurisdiction plan.



Locus

The Town of Windsor is a small, rural community located in east-central Berkshire County in western Massachusetts. It borders the towns of Cheshire and Dalton to the west, Savoy to the north, Peru and Hinsdale to the south and Cummington, in Hampshire County, to the east.

CHAPTER 2: PLANNING PROCESS

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

Introduction

This chapter outlines the development of the Town of Windsor 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 engagement 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 and implementation process (44 CFR § 201.6(c)(4)(iii)) will be discussed in Chapter 6.

The Town of Windsor retained the Berkshire Regional Planning Commission, an MVP and HM Provider, to aid them in developing a new, combined Hazard Mitigation and Climate Adaptation Plan that will meet the requirements of both MEMA for Hazard Mitigation Planning and the EOOEA for the Municipal Vulnerability Preparedness process. The goal of the Windsor Municipal Vulnerability Preparedness Committee's work was to develop a set of Actions for addressing Priority Hazards, using the Community Resilience Building (CRB) Workshop process and methodology as a key stakeholder tool. In addition, the Windsor MVP Committee met over the period of several months, to outline the major issue areas, utilizing the Hazard Mitigation Guidance documents. Berkshire Regional Planning Commission serves the 32 municipalities to guide planning and development across multiple disciplines for Berkshire County. BRPC also works with state and federal agencies to coordinate efforts to benefit the region. This Windsor Hazard Mitigation and Climate Adaptation Plan is a compilation of data collected by BRPC, information gathered from the planning committee during meetings and the MVP workshop and from public feedback at Public Review sessions, as well as one-on-one interviews conducted with key stakeholders outside of working meetings.

Planning Meetings and Participation

44 CFR § 201.6(c)(1)

During the HMCAP planning process, there was opportunity for public comment and participation in the planning process by Windsor's residents, as well as officials in neighboring communities, local and regional agencies and nonprofit partners involved in hazard mitigation activities, and state agencies that have the authority to regulate development, as well as businesses and other private and non-profit interests.

Windsor is a small town, where committees may be comprised of one or two people, and many people serve on multiple committees, most often on a volunteer basis. The following groups and representatives listed in Table 2.1 were active on the Windsor Municipal Vulnerability Preparedness Committee:

Table 2.1 Town of Windsor Municipal Vulnerability Preparedness Committee

Name	Affiliation
Doug McNally – Committee Co-chair	Windsor Select Board, Windsor Planning Board, Windsor Broadband Committee, Berkshire Transportation Advisory Committee
Jim Caffrey – Committee Co-chair	The Trustees of Reservations, Westfield Wild & Scenic Committee
Glenn Roy	Windsor Conservation Commission
John Denno	Superintendent, Windsor Highway Dept.
Kip Buoymaster	Sergeant, Windsor Police Dept.
Scott Eastwood	Chief, Windsor Volunteer Fire Dept. & EMT Windsor Ambulance Service
Michael Tirrell	Resident, Police & Fire Depts. (Retired)
Marc Volk	Resident, Civil Engineer
Allison Egan, Senior Planner	Berkshire Regional Planning Commission, MVP Consultant
Carolyn Massa, Senior Planner	Berkshire Regional Planning Commission, MVP Consultant

Justin Gilmore, Transportation Planner	Berkshire Regional Planning Commission, MVP Consultant team
Peg McDonough, Planner	Berkshire Regional Planning Commission, MVP Consultant team

The central objective of the Community Resilience Building (MVP) Workshop process was to first review regional weather events from the past and climate change data and projections, then collect local data from attendees, and create a climate-related Natural Hazard Risk Matrix for the town, including a written Summary Climate Adaptation Report that:

1. Defined top local natural and climate-related hazards of concern;
2. Identified existing and future strengths and vulnerabilities;
3. Developed prioritized actions for the Community;
4. Identified immediate opportunities to collaboratively advance actions to increase resilience.

Top Natural and Climate-Related Hazards

Ice/Ice Storms, High Winds, Severe Storms, Heavy Rains, Extreme Temperature Fluctuations, Drought, Invasive Species

The Community Resilience Building MVP workshops revealed that all Windsor residents are affected by and aware of how severe weather impacts the community. The discussions were detailed and wide-ranging, with many stories told about particularly severe storm and hazardous events that occurred over the past years. These discussions are summarized below.

Categories of Concerns and Challenges

Flooding & Damage to Roads, Bridges & Culverts

MVP workshop participants universally cited the need for well-maintained roads, culverts and bridges to keep up with the impacts of severe weather. Flooding that washes over roads and makes them impassible, icy, muddy and rutted is a constant for many months of the year. Coordination with MA DOT was mentioned for State Rte. 9, since that main thoroughfare is so critical for circulation and is the main evacuation route for the Town and adjacent communities. Rte. 9's heavy truck traffic, speeding and ongoing maintenance by the MA DOT is a concern. There are many miles of unpaved road in town, which are a continuous source of work for the Highway dept. Those roads that are private are not well-maintained. Recommendations were to encourage property owners to maintain roads or consider paving, when appropriate. Enacting flood hazard zoning and the need for education for property owners to reduce flooding was mentioned as being important to protect life and property.

Emergency Preparedness and Response

Preparations for power outages for prolonged periods lead to much discussion about “sheltering in place.” While Windsor does have a short-term, warming/cooling shelter at Town Hall, there is no full sheltering capability available at any municipal property. Workshop attendees and the MVP Committee want to create a full shelter at Town Hall and a secondary shelter site at Notchview or other location. Most attendees at the workshop were unaware of the regional shelters in adjacent communities. The need for public education on a range of issues around preparedness for multiple hazards was identified as a priority. In addition, the Volunteer Fire Department and Ambulance Service is in need of additional Volunteers particularly for the EMT squad. This is a pressing concern both in Windsor as well as the rest of Berkshire County.

Vulnerable Populations

Windsor’s sparse, aging population, separated from one another by large swaths of woodland, is a concern. Establishing a more “formal” system of outreach and regular communications with residents about emergency preparedness, transportation, group buying opportunities for home back-up generators and home safety and sanitary system upgrades, were identified as needed to increase resilience.

Power & Communications Infrastructure

Harsh weather of many kinds makes power outages a regular part of life in Windsor. Stability in the power grid, good communications infrastructure and increased functionality are a priority. The new town-financed high-speed Broadband network is seen as key to building a robust platform. Cell service is still spotty and problematic. Taking advantage of the state-owned radio tower and encouraging adding additional cell towers in Windsor might be another way to shore-up communications with residents and neighboring communities. Vulnerabilities to the power grid and lack of backup generators – both at Town owned properties and in private residences was cited as an area of focused priority. National Grid should also be engaged regularly to update residents and town leadership on what maintenance and upgrades are expected to be completed.

Transportation

The lack of a regular bus service through town and the growing elder population who may eventually have to give up driving is a concern. Priority should be given to communicating with neighboring towns that have COA or other rides programs that Windsor might tap into. In addition, the Town might make greater use of the Volunteer Fire Dept’s rescue vehicle (4 wheel drive) for reaching the vulnerable during harsh weather.

Economic Vitality

While Windsor’s natural environment is a key economic engine including farms and farm products, forestry and forest products, outdoor recreation including camping, skiing, hunting, snowmobiling, and etc., it is a concern that climate change may negatively affect those businesses. While many people in Windsor work from home, the Town only has 2 retail establishments – both small convenience stores, one of which sells

fuel. Encouraging new startup businesses to locate in Windsor, was cited as being a priority. Economic Development Planning was identified as a need and a high priority, as was supporting Mohawk Trail Woodlands Partnership and the MA Forest Stewardship program. Also the need to coordinate with the MA DCR, Forestry and Wildlife Divisions, Westfield River Watershed Assn. and other agencies on management of properties located in Windsor.

Combatting Invasive Species & Vector borne Disease

The presence of invasive insects, especially the Emerald Ash borer and plants, including phragmites, and many others has been noted all over Windsor, potentially decimating woodlands and water bodies. An increase in the tick population is widely noted with concomitant increase in tick-borne illness, has been reported by the MA Public Health Department, in Windsor as well as the rest of Berkshire County. Increased public education for prevention and protection and the formal establishment of monitoring and maintenance procedures, spearheaded by Windsor Health and Recreation departments, in partnership with state agencies, The Trustees of Reservations and homeowners/landowners to work cooperatively to keep invasives in check, is an important priority.

Water Resources, Supply & Quality

While Windsor is water rich, concern was expressed about Septic Systems throughout town not being monitored or pumped regularly. With loss of power, well pumps and sump pumps are out of commission, increasing risk for residents. The dependence on private wells was a concern because the Town has no backup water supply for forest fire, nor potable water, in the event that residential or town wells are contaminated or run dry. Invasive species could also impact surface water quality as well as runoff from residential properties of fertilizers, oil or other contaminants.

Landfill

Windsor has an old, uncapped landfill that currently has two test wells drilled for monitoring purposes. However, the Town has yet to come up with a plan to cap the landfill and finance same, to protect life and properties into the future.

Historic Properties

The rich history of Windsor which is as an asset, is also a vulnerability. The Town has to develop a long-term Capital Improvement Plan to assess, preserve and utilize Town properties to their fullest capabilities.

Every meeting of the Windsor Municipal Vulnerability Preparedness Committee was posted and open to the public. The Windsor Hazard Mitigation & Climate Adaptation Plan Draft was available for review and comment at the Windsor Town Offices, as well as posted to the Town of Windsor and BRPC websites. Making the document available to the public for review meets requirements of 44 CFR § 201.6(b)(1). Additionally, the Town of Windsor solicited feedback from neighboring towns by emailing the plan and requesting comments. In addition, requests for comment from regional committees that Town staff and HMCAP Committee members serve on, meets requirements of 44 CFR § 201.6(b)(2),

pertaining to involvement of regional partners in the planning process. A copy of the letter of solicitation of comments, can be found in Appendix D.

Technical Assistance for the development of this plan were provided by the Berkshire Regional Planning Commission (BRPC). BRPC assists all Berkshire County municipalities to achieve their goals, including community and economic development, community planning, data and information services, emergency preparedness planning, environmental and energy planning, regional services, public health planning and services and transportation planning and coordination. The Windsor Hazard Mitigation & Climate Adaptation Plan is a compilation of data collected by BRPC, information gathered from the HMCAP Committee during meetings and the Community Resilience Building Workshops, the public CRB Workshop Results session and interviews conducted with key stakeholders outside of working meetings.

This Plan reflects comments provided by the above participants and by MEMA and FEMA.

Incorporation of Existing Information

44 CFR § 201.6(b)(3)



No plan is ever created in a silo, particularly a Hazard Mitigation and Climate Adaptation Plan, because of its applicability to infrastructure, land use, town services and the protection of vulnerable residents and environments. The Town of Windsor reviewed and incorporated existing plans, studies, reports and technical information into this hazard mitigation plan, including the following:

- ❖ Town of Windsor Zoning Bylaws
- ❖ Mohawk Trail Woodlands Partnership - Forest-based Economic Development & Conservation Partnership (date?)
- ❖ Forest Stewardship Plan, Notchview Reservation (Trustees of Reservations, 2018)
- ❖ Westfield River Five Year Watershed Action Plan (Pioneer Valley Planning Commission, 2006)

Existing studies, plans and guidance were also solicited from the Massachusetts Department of Conservation & Recreation, Forestry Division. Plans referenced include: Landscape Designations for DCR Parks & Forests: Selection Criteria and Management Guidelines and the Central Berkshire District Forest Resource Management Plan. All documents provided important insight into the value of natural resources in Windsor, providing a long-term vision for the Town and a path toward protecting the community's many natural assets.

Other hazard mitigation plans consulted during the development of this plan included the Town of Dalton's, the town immediately adjacent to Windsor, which plan was approved by FEMA Region I in January, 2019.

The next chapter of this Plan explains the risk assessment process, profiling each hazard and its potential to affect the Town of Windsor. Table 2.1 below, illustrates prioritizing hazards by order of magnitude, frequency and the establishment of a ranked priority, per the Town of Windsor Municipal Vulnerability Preparedness Committee and the information received during the MVP Workshop. The method of prioritization meets requirements of 44 CFR § 201.6(c)(3)(iii).

Plan Structure

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

Hazard Mitigation Goals

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

1. To preserve the natural areas that provide hazard mitigation ecosystem services to the community
2. To plan, design, and construct sustainable, cost-effective, and environmentally sound mitigation projects
3. To protect life and property from the impacts of hazardous conditions
4. To enhance communication and education of hazards for community residents, particularly those most vulnerable and isolated.

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 Windsor 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 Windsor several resources were utilized. The 2012 Berkshire County Hazard Mitigation Plan served as a foundation to build from. The hazards identified in the 2012 plan were Flooding, Structurally Deficient Bridges over Waterways, Dam Failure, Wildfire, Snow, High Wind, and Other Natural hazards (i.e. severe storms and tornadoes). In order to build upon this list, the 2018 State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) for the Commonwealth of Massachusetts was consulted. Accounting for the location, natural and built environments, history, and scientific studies of the area, it was determined that Windsor must plan for the following hazardous conditions:

- **Inland Flooding**
- **Severe Winter Storms**
- **Droughts**
- **Change in Average Temperatures/Extreme Temperatures**
- **Tornadoes/High Wind**
- **Landslides**
- **Wildfires**
- **Hurricanes/Tropical Storms**
- **Other Severe Weather**
- **Invasive Species**
- **Earthquakes**
- **Dam failure**
- **Vector-borne Diseases**
- **Cyber Security**

People

Windsor’s population of 879 gives the Town a low density of people/square mile. Windsor’s population is expected to decrease slightly, with the percentage of older adults expected to increase as a proportion of the population, mirroring a similar trend throughout Berkshire County. In 2010, there were 375 occupied housing units, resulting in a household size of 2.9 people per household (US Census Bureau). In 2018 there are now an estimated 454 occupied housing units including seasonally-occupied properties. Full time residences are estimated at 359 housing units. In 2018, the average household size reduced to 2.35.

Natural Environment

Windsor is located in east-central Berkshire County, in the southern Hoosac Mountain range, in the area known as the Berkshire Hills, or the Berkshire Plateau. Windsor’s elevation at 2031 feet, makes it especially susceptible to the effects of harsh weather. It is generally accepted that Windsor has its own micro-climate, as temperatures are several degrees lower, with more regular precipitation and fog conditions present, than is experienced by the adjacent communities of Cummington or Dalton, at lower elevations. The climactic conditions that support Windsor’s Eastern Hemlock-Spruce-Northern Hardwood Forest cover - steep slopes and sheltered ravines, kept cool by high-gradient streams - are well-documented. ¹ In addition to steep and hilly terrain, the soils in Windsor are mostly clays, with a high water table and slow percolation rates

creating wet conditions for many months of the year. Road maintenance for this small community is a constant and costly challenge.

Table 3.1: Hazard Prioritization for the Town of Windsor

Hazard	Area of Impact Rate	Frequency of Occurrence Rate	Magnitude / Severity Rate	Hazard Ranking
	1=small 2=medium 3=large	0 = Very low frequency 1 = Low 2 = Medium 3 = High Frequency	1=limited 2=significant 3=critical 4=catastrophic	
Dam Failure	1	1	1	3

¹ Classification of Natural Communities in Massachusetts, <http://www.mass.gov/nhesp>, 2016.

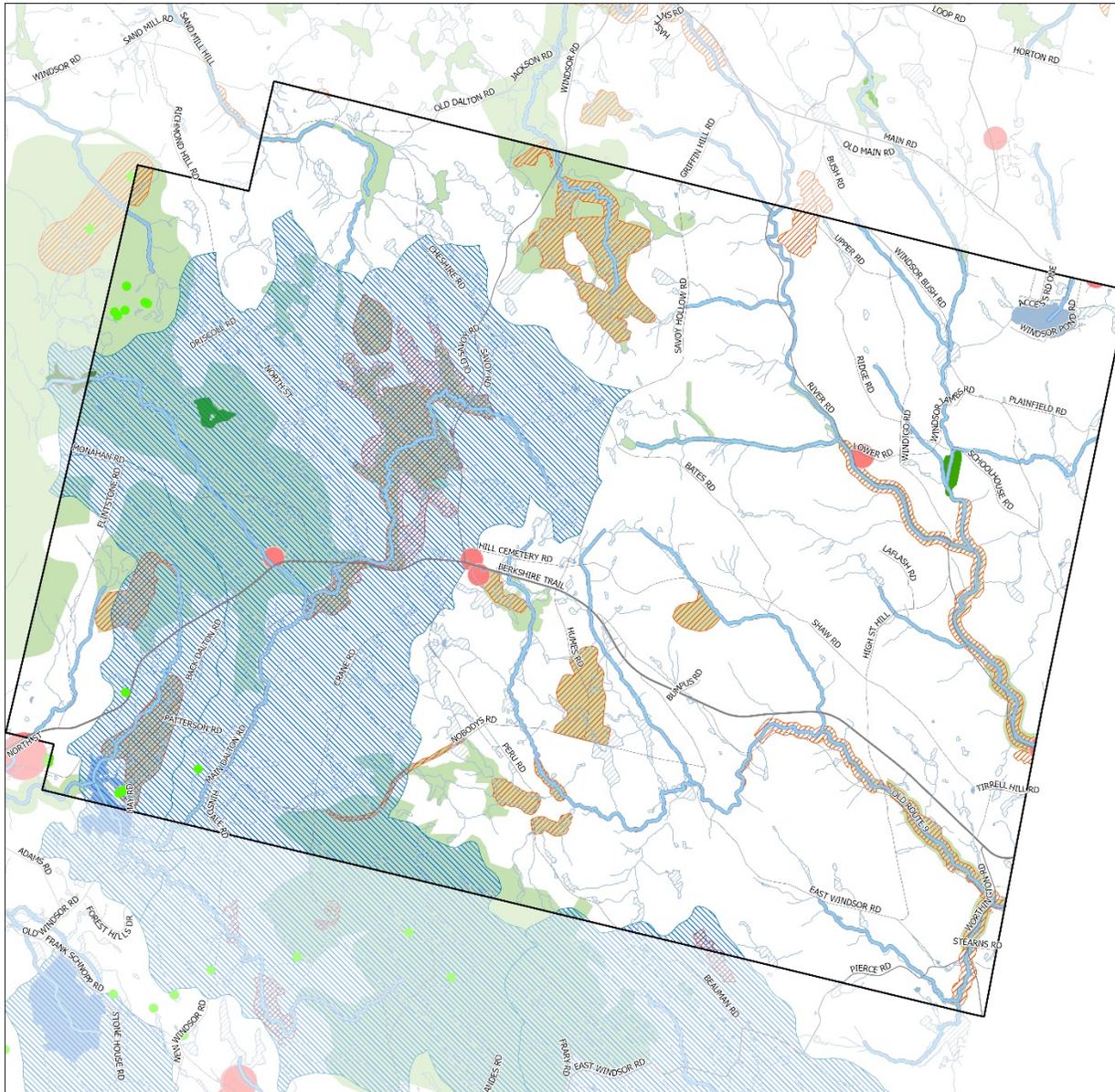
Flooding (include Ice Jam, Beaver Activity)	3	3	2	8
Severe Winter Event (Ice Storm, Blizzard, Nor'easter)	3	3	3	9
Severe Storms (high winds, microbursts, Thunderstorms)	3	3	2	8
Hurricane & Tropical Storms	3	3	2	8
Drought	2	2	2	6
Tornado	1	1	1	3
Earthquake	1	1	1	3
Wildfire	3	2	1	6
Landslide	2	1	1	4
Change in Avg./Extreme Temperatures	3	3	2	8
Invasive Species	3	3	1	7
Pests/Vector-borne Diseases	3	3	3	9
Cyber Security threats to operations	1	1	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 frequency	events that have not occurred in recorded history of the town, or that occur less than once in 1,000 years (less than 0.1% per year)			
1=Low frequency	events that occur from once in 100 years to once in 1,000 years (0.1% to 1% per year)			
2=Medium frequency	events that occur from once in 10 years to once in 100 years (1% to 10% per year)			
3=High frequency	events that occur more frequently than once in 10 years (greater than 10% per year)			
Magnitude/Severity				
1=limited	injuries and/or illnesses are treatable with first aid; minor" quality or life" loss; shutdown of critical facilities and services for 24 hours or less; property severely damaged < 10%			
2=significant	injuries and/or illnesses do not result in permanent disability; shutdown of several critical facilities and services for more than one week; property severely damaged < 25% and > 10%			
3=critical	injuries and/or illnesses result in permanent disability; complete shutdown of critical facilities for at least two weeks; property severely damaged < 50% and > 25%			
4=catastrophic	multiple deaths; complete shutdown of facilities for 30 days or more; property severely damaged > 50%			

Windsor enjoys the distinction of being the only community in the Commonwealth of Massachusetts that is located in three River's watersheds – the Housatonic, the Hoosic (part of the Hudson River watershed) and the Westfield (part of the Connecticut River watershed). The upland areas of Windsor are designated as Outstanding Resource Watershed for both the Housatonic and Westfield Rivers. Some of Windsor's streams and ponds areas are identified as Priority Habitats for Rare & Endangered Species and the Westfield and its' tributaries are Outstanding Cold Water Fisheries. The Westfield River is also designated a National Wild & Scenic River. Figure 3.2, below, shows the Environmental features to be found in town.

The Town of Windsor is heavily forested, with forest stewardship provided by a mix of private, state government and nonprofit organizations. The Trustees of Reservations manages over 3000 acres at Notchview Reservation, while the Massachusetts Dept. of Conservation & Recreation's Forestry Division manages 1845 acres, in Windsor State Forest. These preserve lands are also designated as a Wildlife Management Areas by the Commonwealth, as well as watershed protection areas for the adjacent Town of Dalton. These preserved lands provide invaluable watershed protection and natural buffer for the built environment in Windsor. **Figure 3.3** below, shows Land Cover in the Town of Windsor.

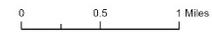
The natural environment provides benefits to a community that are not always quantifiable. However, clean air, carbon sequestration, clean water, wildlife habitat, ground water retention, wind and heat mitigation, increased real estate values and mental/physical well-being of residents can accrue from good stewardship of natural resources and careful development practices that preserve ecological functioning.

Figure 3.2: Town of Windsor Environmental Concerns



Town of Windsor Environmental Concerns

- Certified Vernal Pools
- Interim Wellhead Protection Area
- Outstanding Resource Watershed
- Priority Habitats of Rare Species
- Cold Water Fisheries
- Natural Communities
- BioMap2 Core Habitat
- Stream
- Wetland
- Open Water

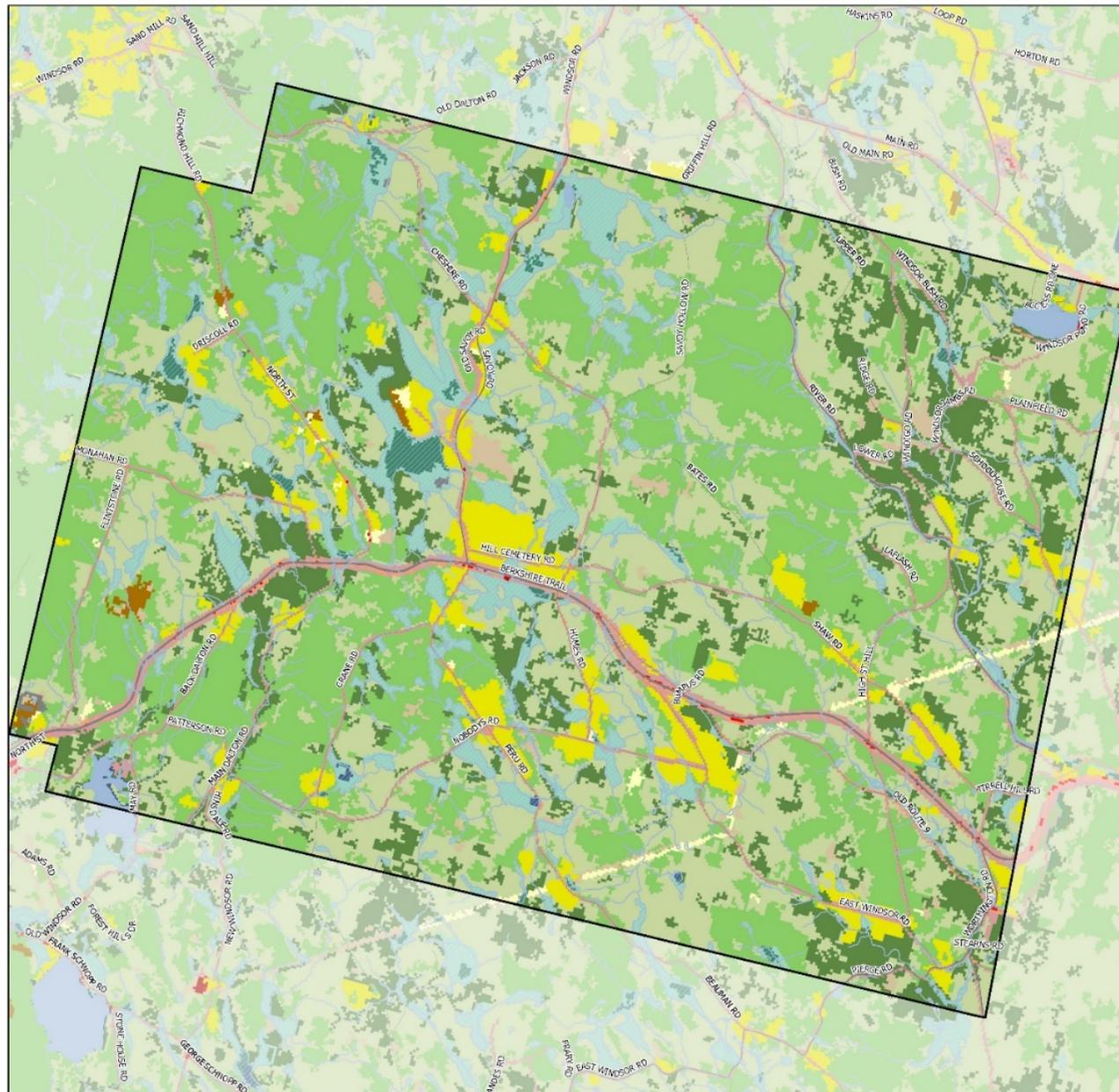


This map was created by the Berkshire Regional Planning Commission and is intended for general planning purposes only. This map shall not be used for engineering, survey, legal, or regulatory purposes. MassGIS, MassDOT, BRPC or the municipality may have supplied portions of this data.

Built Environment

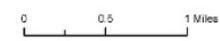
44 CFR § 201.6 (c)(2)(ii)(C) asks that vulnerability in the risk assessment be addressed in terms of land uses and development trends within the community so that mitigation options can be considered in future land use decisions. As a general description for all hazards assessed in the hazard mitigation planning process, the Town of Windsor is almost exclusively a residential community with a modest 1% to 2% annual growth rate. Homes are scattered along main roads in the community, especially State Route 9, North and Savoy Roads, with others isolated from their neighbors by large tracts of forested land. However, the Town of Windsor adopted several new bylaws to allow for Ground-Mounted Solar Photovoltaic Arrays and Marijuana establishments – both to comply with State mandates for designated Green Communities (which Windsor became in 2019) and following the 2016 passage of the statewide Legalization, Regulation, and Taxation of Marijuana regulations that went into effect in 2018. In January, 2020, the Windsor Select Board voted to adopt a Large-scale Industrial and Commercial Facilities zoning bylaw, to protect residents and homes from the effects of more intensive land uses of 10 acres or more, as would be required for building a clustered assisted-living or nursing home facility, a forest-products processing facility or, a marijuana manufacturing facility, among other possible land uses. Figure 3.3 below, shows the Land cover to be found in the Town of Windsor.

Figure 3.3: Town of Windsor Land Cover



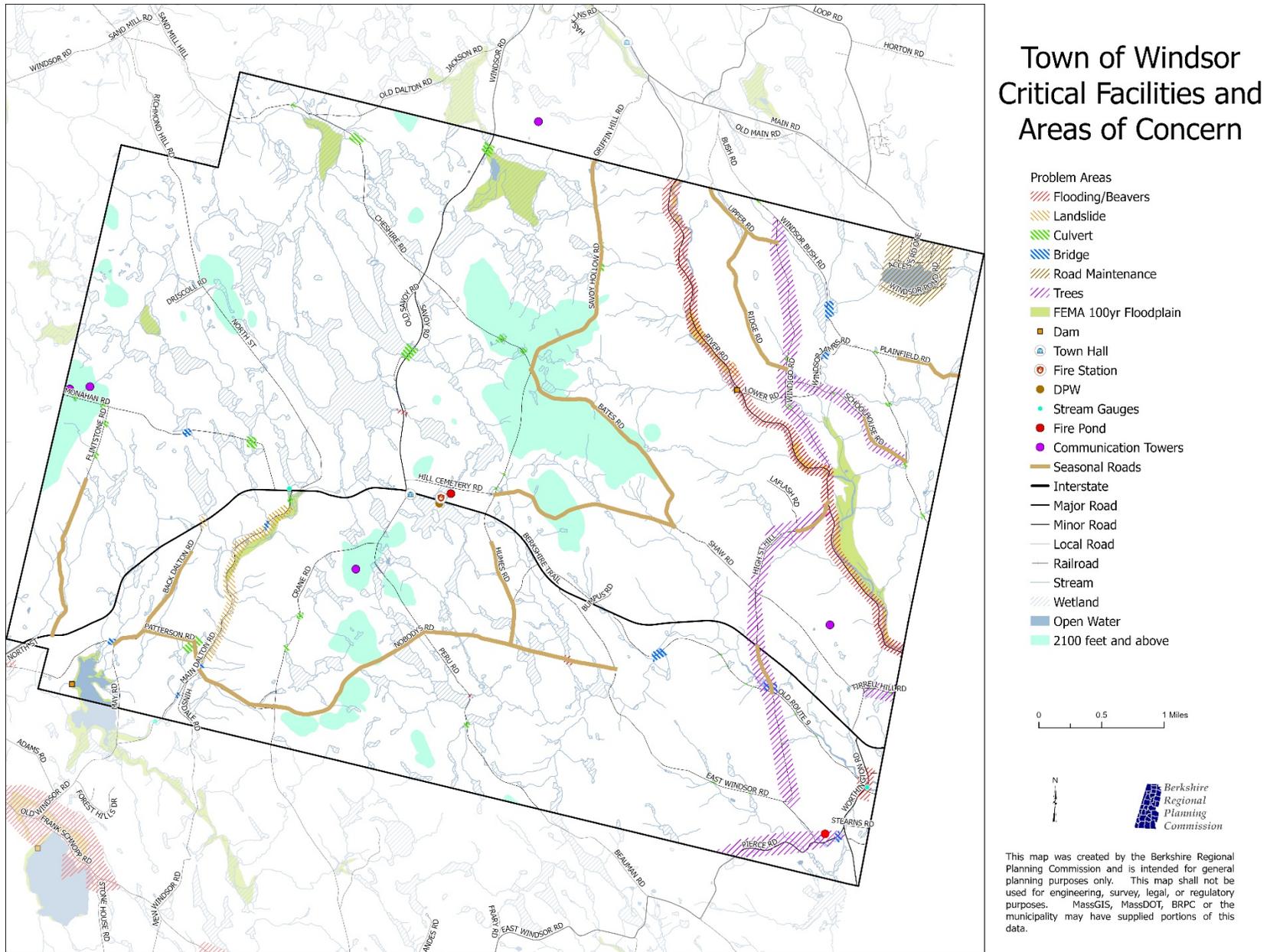
Town of Windsor NLCD Land Cover

- Open Water
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land (Rock, Sand, Clay)
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands



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Figure 3.4: Windsor Critical Facilities Map



Critical Facilities are the buildings and infrastructure hubs that are necessary for continued operation during a hazardous event. Windsor has critical facilities housed in three buildings, most operating out of the Volunteer Fire Dept. and Town Offices at the Town Hall Annex at 1890 Route 9. Table 3.2 shows Windsor’s Critical Facilities and figure 3.4 (above) provides a map of the critical facilities and areas of concern.

Table 3.2: Windsor Critical Facilities

<i>Type</i>	<i>Name</i>	<i>Address</i>
Police	Police Department	1890 Route 9, Windsor, MA 01270
Town Offices	Town Offices	1890 Route 9, Windsor, MA 01270
Volunteer Fire Department & Emergency Operations Center	Fire Station	2025 Route 9, Windsor, MA 01270
Warming/Cooling Shelter	Town Hall	1927 Route 9, Windsor, MA 01270
Alternate Emergency Operations Center	Highway Department Garage	2024 Route 9, Windsor, MA 01270

Economy

As noted above, the predominant land uses in Windsor are forests (82%), agriculture (6 %) and residential (.03%) (MassGIS 2016 data). The town belongs to the Central Berkshire Regional School District, sending its elementary students to Craneville School and its middle and high school students to Nessacus Middle and Wahconah High Schools, respectively – all in Dalton, MA.

The following is a summary of sources of income and industry for residents in the Town of Windsor that could potentially be impacted by natural hazards. According to the U.S. Census Bureau’s American Community Survey’s (ACS) 5-year Estimates for 2018, 41.4% of the population over 16 have an occupation in management, business, science, and arts occupations; 20.6% in sales and office occupations; 16.1% in service occupations; 5.7% in production, transportation, and material moving occupations; and 16.1% in natural resources, construction, and maintenance occupations. The percentages of the working age population by industry are as follows: 27.1% in educational services, and health care and social assistance; 10.2% in professional, scientific, and management, and administrative and waste management services; 10.0% Construction; 13.5% Retail trade; 4.5% Arts, entertainment, and recreation, and accommodation and food services; 7.8% in manufacturing; 2.0% in transportation and warehousing, and utilities; 0.8% in information; 4.5% in public administration; 6.1% in finance and insurance, or real estate, rental and leasing; 9.0% in other services, except public administration; 3.3% in agriculture, forestry, fishing and hunting, and mining; and 1.2% in wholesale trade. Additionally, the ACS tells us that 81.3% of households have earnings, 39.3% have social security income, and 27.3% have retirement income. The population receiving Supplemental Security Income is 3.3%, cash public assistance income is 0%, and Supplementary Nutrition Assistance Program (SNAP) benefits go to 5.3%.

Inland Flooding

Hazard Profile

Inland flooding is the result of moderate precipitation over several days, intense precipitation over a short period, or melting snowpack (U.S. Climate Resilience Toolkit, 2017). Developed, impervious areas can contribute to inland flooding (U.S. Climate Resilience Toolkit, 2017). Common types of local or regional flooding are categorized as inland flooding including riverine, ground failures, ice jams, dam overtopping, beaver activity (tree removal, dam construction, and dam failure), levee failure, and urban drainage, though the latter is not an issue for the rural Town of Windsor. Overbank flooding occurs when water in rivers and streams flows into the surrounding floodplain or into “any area of land susceptible to being inundated by floodwaters from any source.” Flash floods are characterized by “rapid and extreme flow of high water into a normally dry area, or a rapid rise in a stream or creek above a predetermined flood level.” (FEMA, 2011b as cited in MEMA & EOEEA, 2018²). The hazards that produce these flooding events in the region include hurricanes, tropical storms, heavy rain events, winter rain-on-snow, thunderstorms, and a recovering beaver population.

Likely severity

In general, the severity level of flood damage is affected by flood depth and flood velocity. The deeper and faster flood flows become, the more power they have and the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment. (MEMA, 2013) However, flood damage to homes and buildings can occur even during shallow, low velocity flows that inundate the structure, its mechanical system and furnishings.

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

² Massachusetts Emergency Management Agency & the Executive Office of Energy and Environmental Affairs developed the MA State Hazard Mitigation and Climate Adaptation Plan, 2018 <https://www.mass.gov/service-details/massachusetts-integrated-state-hazard-mitigation-and-climate-adaptation-plan>

understood, however, that these measurements reflect statistical averages only; it is possible for two or more floods with a 100-year flood discharge to occur in a short time period.

Probability

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

Table 3.2: Recurrence Intervals and Probabilities of Occurances

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

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

Geographic areas likely impacted

There are 427 acres of 100 - year floodplain within the town of Windsor, according to the MA DCR Office of Water Resources. This amounts to 1.9% of the acres in town. Based on additional analysis, 10.3 acres (2.4%) of the floodplain are developed with residential structures or outbuildings. This leaves 416.7 acres that are potentially developable under current zoning.

Historic data

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

Table 3.3. Previous Flooding Occurrences in the Berkshire County Region

Year	Description of Event
1936	Widespread flooding occurs along the northern Atlantic in March 1936. Widespread loss of life and infrastructure. Many flood stages are discharges highest of record at many USGS stream gages, including Coltsville in Pittsfield. ³
1938	Large rain storm hit the area. This storm was considered a 1% annual chance flood event in several communities and a .2% annual chance flood event in Cheshire. The Hoosic River flooded downtown areas of densely-developed Adams and North Adams, with loss of life and extensive damage to buildings. Other communities were not as severely impacted by it.
December 31, 1948 - January 1, 1949	The New Year's Flood hit our region with many of our areas registering the flood as a 1% annual chance flood event.
1955	Hurricanes Connie and Diane combined to flood many of the communities in the region and registering in 1% -0.2% annual chance flood event (100-500-year flood event) (FEMA 1977-1991).
May 1984	A multi-day storm left up to 9" of rain throughout the region and 20" of rain in localized areas. This was reported as an 80-year flood for most of the area and higher where the rainfall was greater (USGS, 1989).
September 1999	The remnants from Hurricane Floyd brought over between 2.5-5" of rain throughout the region and produced significant flooding throughout the region. Due to the significant amount of rain and the accompanying wind, there were numerous reports of trees down.
December 2000	A complex storm system brought 2-4" of rain with some areas receiving an inch an hour. The region had numerous reports of flooding.

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

March 2003	An area of low pressure brought 1-2" of rain, however this and the unseasonable temperatures caused a rapid melting of the snow pack.
August 2003	Isolated thunderstorms developed that were slow moving and prolific rainmakers. These brought flooding to the area and caused the evacuation of the residents of the trailer park along Wahconah Falls Road in neighboring Dalton.
September 2004	The remnants from Hurricane Ivan brought 3-6" of rain. This, combined with saturated soils from previous storms, caused flooding throughout the region.
October 2005	A stationary cold front brought over 6" of rain and caused widespread flooding throughout the region.
November 2005	Widespread rainfall across the region of 1-1.5", which was preceded by 1-2 feet of snow, resulted in widespread minor flooding.
September 2007	Moderate to heavy rainfall occurred, which lead to localized flooding.
March 2008	Heavy rainfall ranging from 1-3" impact the area. Combined with frozen ground and snowmelt, this led to flooding across the region.
August 2008	A storm brought very heavy rainfall and resulted in flash flooding across parts of the region.
December 2008	A storm brought 1-4" of rain to the region, with some areas reporting ¼ to 1/3 of an inch an hour of freezing rain., before changing to snow. Moderate flooding and ponding occurred throughout the region.
June 2009	Numerous slow-moving thunderstorms developed across the region, bringing very intense rainfalls and upwards of 6" of hail. This led to flash flooding in the region.
July 2009	Thunderstorms across the region caused heavy rainfall and flash flooding.
August 2009	An upper level disturbance moved across the region during the afternoon hours and triggered isolated thunderstorms which resulted in roads flooding.
October 2009	A low-pressure system moved across region bringing a widespread heavy rainfall to the area; 2-3" of rain was reported across the region.
March 2010	A storm brought heavy rainfall of 1.5-3" across the region, with roads closed due to flooding.
October 2010	The remnants from Tropical Storm Nicole brought 50-60 mph winds and 4-6" of rain resulting in urban flooding.
March 2011	Heavy rainfall, combined with runoff from snowmelt due to mild temperatures, resulted in flooding of rivers, streams, creeks, roads, and basements.
July 2011	Scattered strong to severe thunderstorms spread across the region resulting in small stream and urban flooding.
August 2011	Two distinct rounds of thunderstorms occurred producing heavy rainfall and localized flooding of roads.
August 2011	Tropical Storm Irene tracked over the region bringing widespread flooding and damaging winds. Riverine and flash flooding resulted from an average of 3-6 inches of rain and upwards of 9", within a 12-hour period. Widespread road closures occurred throughout the region. In Williamstown this event was a 1% annual chance flood event.
September 2011	Remnants of Tropical Storm Lee brought 4-9" of heavy rainfall to the region. Due to the saturated soils from Tropical Storm Irene, this rainfall lead to widespread minor to moderate flooding on rivers as well as small streams and creeks.

August 2012	Remnants from Hurricane Sandy brought thunderstorms developed repeatedly bringing heavy rains over areas of the region. Upwards of 4-5" of rain occurred and flash flooding caused the closure of numerous roads.
May 2013	Thunderstorms brought wind and heavy rainfall caused flash flooding and road closures in areas.
August 2013	Heavy rainfall repeatedly moved across the region causing more than 3 inches of rain in just a few hours resulting in streams and creeks to overflow their banks and resulting in flash flooding. Roads were closed as a result of the flooding and water rushed into some basements.
September 2013	Showers and thunderstorms tracked over the same locations and resulted in persistent heavy rain, flash flooding and road closures.
June 2014	Slow moving showers and thunderstorms developed producing very heavy rain over a short period of time. This led to some flash flooding and road closures, especially in urban and poor drainage areas.
June 2014	Showers and thunderstorms repeatedly passed over the same locations, leading to heavy rainfall and significant runoff, which caused flash flooding in some areas. Many roads were closed due to the flooding and some homes were affected by water as well.
July 2014	A cluster of strong to severe thunderstorms broke out causing heavy rainfall and flash flooding with 3-6" of rainfall occurring.
May 2016	Bands of slow-moving showers and thunderstorms broke out over the region. Due to the slow movement of these thunderstorms, heavy rainfall repeatedly fell over the area resulting in flash flooding and some roads were temporarily closed.
August 2017	Widespread rain moved through the area resulting in isolated flash flooding.
August 2017	Severe thunderstorms developed resulting in flash flooding.

Source: BRPC 2018 (unless otherwise noted)

Bolded events are in the top 15 events that caused the Housatonic River to flow above flood stage at the Coltsville USGS gage (5')

Vulnerability Assessment

People

The impact of flooding on life, health, and safety is dependent upon several factors, including the severity of the event and whether or not adequate warning time is provided to residents. Populations living in or near floodplain areas may be impacted during a flood event. People may also be impacted when transportation infrastructure is compromised from flooding.

Of the population exposed, the most vulnerable include people with lower socioeconomic status, people over the age of 65, young children, people with medical or functional needs, and those with low English language fluency. People with low socioeconomic status are more

vulnerable because they are likely to consider the economic impacts when deciding whether or not to evacuate. The population over the age of 65 is more vulnerable because some of them may require assistance to evacuate, due to health or mobility impairments, and/or the medical or residential community in which they live may be flooded, creating dangerous conditions. Those who have low English language fluency may not receive or understand the warnings to evacuate. All of these vulnerable populations may be less likely to have adequate resources to recover from the loss of their homes and or places of employment.

The total number of injuries and casualties resulting from typical riverine flooding is generally limited due to advance weather forecasting, blockades, and warnings. The historical record from 1993 to 2017 indicates that there have been two fatalities associated with flooding (occurring in May 2006) and five injuries associated with two flood events (occurring within 2 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. Carbon monoxide results from improper location and operation of cooking and heating devices (grills, stoves), damaged chimneys, or generators.

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

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

Built Environment

The Town of Windsor has several areas of focused concern in terms of flooding. Flooding in Windsor is most often the result of undersized culverts causing road washouts or flooding caused by beaver activity. Flintstone Road is a persistent area of concern due to several undersized culverts located at the first bridge crossing, heading north from Rte 9. If this road crossing bridge were to fail completely, over thirty homes in Windsor would have their access completely cut off, as there is no alternate road into/out of the neighborhood. In recent history, flood waters have overtopped the road, undermining the road bed during heavy rains and seasonal snow melt. The severity of the problem makes replacing the culvert the first priority for Windsor Highway Department.

Unpaved Cheshire Road has a 4' culvert that crosses under the road, that requires attention in the near future (1-2 year horizon). That culvert is completely submerged, which keeps the road constantly wet and muddy. See ([Latitude: 42.555855](#) / [Longitude: -73.076986](#)).

On Peru Road, the first culvert where Windsor Brook crosses the road (heading southeast toward Peru – approximately at #1075 Peru Road.) Beaver deceiver was installed near culvert, but is not operational. Since beaver deceiver was installed, this crossing has been overtopped by the stream more than once. Town expects the structure would be overtopped again with any subsequent rain or heavy snow storm.

Figure 3.6: Flintstone Road



Figure 3.7: River Road



River Road, immediately adjacent to the Westfield River, is also an area of high concern. Its entire length is often flooded, due to constant beaver activity. North Street, at a higher elevation, is frequently icy, rutted and hard to keep open and passable all winter. Main Dalton Road too, cuts through a FEMA-designated 100-year floodplain, and is often muddy and prone to landslides.

Savoy Hollow Road, Bates Road, sections of Old Rte. 9 and Shaw Roads, Humes Road, Nobody's Road and Flintstone Road are designated as "seasonal" roads that are not maintained during the heaviest snow months.

Berkshire County's rivers and streams are dynamic systems, with stream channel and bank erosion common in both headwater streams and in the level, meandering floodplains of the Housatonic and Westfield Rivers. Fluvial Erosion is the process where the river undercuts a bank, usually on the outside bend of a meander, causing sloughing and collapse of the riverbank. Fluvial erosion of stream and riverbanks can creep towards the built environment and threaten to undercut and wash away buildings, roads, and bridges. Many roads throughout the region follow streams and rivers, having been laid in the floodplain or carved along the slopes above the bank. Older homes, barns and other structures were also built in floodplain or just upgradient of stream channels in both rural and urban areas. Fluvial erosion can also scour and 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).

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

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

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.

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

There is no municipal wastewater treatment plant in Windsor because all waste is treated in onsite septic systems. This eliminates the vulnerability of wastewater treatment facilities during a flood. However septic systems can flood as well, contaminating the surrounding areas,

posing health risks, and damaging the environment. A common effect of septic overflows due to flooding is nitrogen overloads in nearby bodies of water that can kill native wildlife and cause eutrophication in water bodies. At the 48-acre Windsor Pond (a/k/a Duke’s Pond), which is ringed by private homes, health warnings have been issued during the summer of 2017, when low water levels and warmer temperatures caused an outbreak of “Swimmer’s Itch” – a rash caused by an allergic reaction to a parasite that thrives in warmer freshwater lakes and ponds. The parasite does not live on human hosts, but is carried by snails and in the feces of waterfowl to freshwater bodies.

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.

When the floodplain data is overlaid with building footprints using ArcMap GIS, there are six buildings in floodplain areas in Windsor, five (5) on private property and one (1) publicly owned. Table 3.4 shows total values broken down by ownership type (derived from Assessor data, in the absence of FIRM maps for this municipality.) For map, see Figure 3.5, above.

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

Type	Building Value	Other Value
Private	\$769,100	\$170,400
Public	\$47,000	\$0

The Town of Windsor is not (yet) an NFIP community. Since 44 CFR § 201.6(c)(2)(ii) requires all plans approved after October 1, 2008 to address NFIP insured structures that have been repetitively damaged by floods, Windsor has taken the initiative to apply to the NFIP as of February, 2020. The Town of Windsor has no repetitive loss properties, nor does it have any Critical Facility located in flood hazard areas.

Natural Environment

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

Economy

In addition to the value of buildings potentially lost during a flood event, there may be economic losses due to an inability to commute to work, purchase food or fuel, or communicate. Many Windsor homeowners have home-based businesses. In addition, there are two small retail convenience stores in Windsor, including the only gas station, upon which many rely. Additional losses of Farms crops, livestock and forest products would also be negatively affected.

Future Conditions

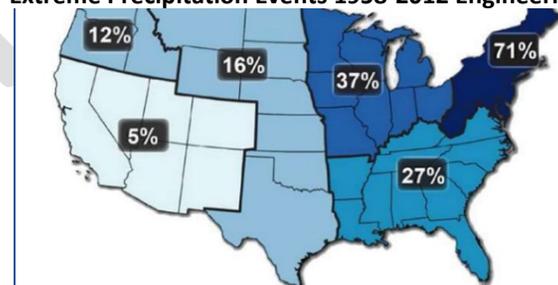
Based on data gathered from the Northeast Climate Science Center (NECSC), the yearly precipitation total for Berkshire County has been experiencing a gradual rise over the last 70 years, rising from 40.1 inches in the 1960's to 48.6 inches in the 2000's. According to projections from the NECSC, the county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

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

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

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

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



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

Climate change will likely alter how the region receives its precipitation, with an increase of it falling in the form of severe or heavy events. The observed amount of precipitation falling in very heavy events, defined as the heaviest one percent of all daily events, has increased 71% in the Northeast between 1958-2012.⁴

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

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

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 greatest increase in the past decade (see Fig. 3.9)⁵.

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

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



⁴ NOAA - <https://toolkit.climate.gov/image/762>, adapted from Karl et al.

⁵ <https://statesummaries.ncics.org/ma>

Severe Winter Storms

Hazard Profile

Severe winter storms in Windsor 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 20°F. A severe blizzard is categorized as having temperatures near or below 10 °F, winds exceeding 45 mph, and visibility reduced by snow to near zero (MEMA, 2013).

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

Ice storm conditions are defined by liquid rain falling and freezing on contact with cold objects creating ice build-ups of ¼ inch or more that can cause severe damage. An ice storm warning, now included in the criteria for a winter storm warning, is for severe icing. This is issued when ½ - inch or more of accretion of freezing rain is expected. This may lead to dangerous walking or driving conditions and the pulling down of power lines and trees. (MEMA, 2013)

Likely Severity

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

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

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

Table 3.5 Regional Snowfall Index Ranking Categories

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

Source: MEMA 2013.

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

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

While severe winter weather declarations have become more prominent in the 1990s, we do not believe that this reflects more severe weather conditions than the Berkshires experienced in the years 40+ years prior to the 1990s. Respected elders across Berkshire County comment that snow depths prior to the 1990s were consistently deeper than 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 a expected drain on municipal budgets. Residents and town staff expect to deal with several snow storms and a few Nor'easters each winter. According to the NOAA-NCDC storm database, over 200 winter storm events occurred in the Commonwealth between 2000 and 2012. Therefore, the subset of severe winter storms are likely to continue to occur annually (MEMA, 2013). The Town of Windsor's elevation and micro-climate places it at a high-risk for impacts from severe storms that the county normally gets, compared to the neighboring counties in the Connecticut River and Hudson River Valleys.

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

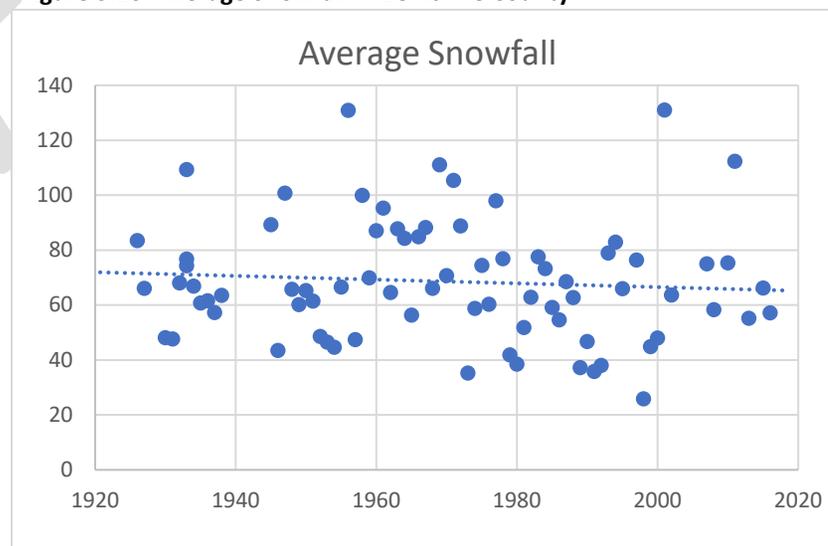
Geographic Areas Likely Impacted

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 Windsor, although higher elevations have slightly higher snow depths.

Historic Data

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

Figure 3.10: Average Snowfall in Berkshire County



one during 2006 to 18 during 2008. Snow and other winter precipitation occur very frequently across the entire region. Snowfall in the region can vary between 26 and 131 inches a year, however it averages around 65 inches a year, down from around 75 inches a year in 1920. Another tracking system is the one- and three-day record snowfall totals.

According to data from the Northeast States Consortium, 99% of the one-day record snowfall events in the region typically yield snow depths in the range of 12"-24", while the majority of three-day record snowfall events yield snow depths of 24"-36" (Table 3.6).

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

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

Source: (Northeast States Emergency Consortium, 2010).

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

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

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

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

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

Source: FEMA 2017.

Vulnerability Assessment

People

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

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

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

their homes. Rural populations may become isolated by downed trees, blocked roadways, and power outages. The ability of emergency responders to respond to calls may be impaired by heavy snowfall, icy roads, and downed trees (MEMA & EOEEA, 2018).

Built Environment with Infrastructure and Systems

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

Natural environment

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

Economy

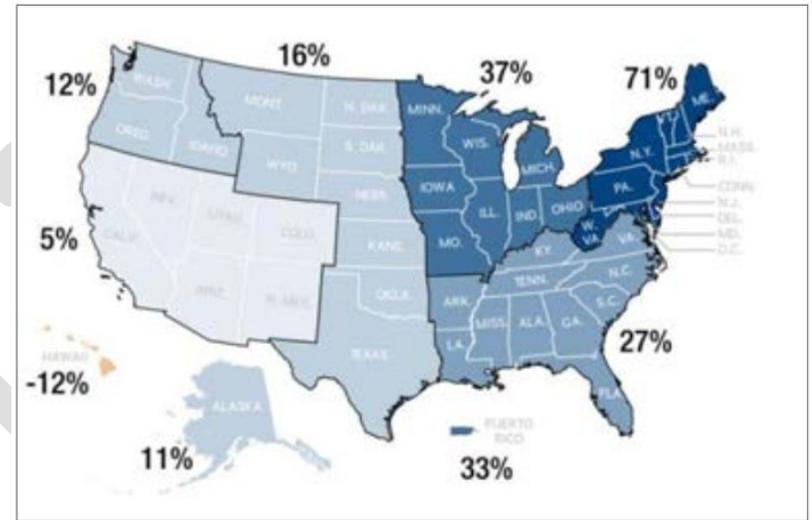
The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain municipal and state financial resources due to the cost of staff overtime, snow removal and wear on equipment. Rescheduling of schools and other municipal programs and meetings can also be costly. The potential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

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

Future Conditions

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

Figure 3.11: Observed Changes in Heavy Precipitation



Source: NCA, 2014 as cited in MEMA & EOEEA

Droughts

Hazard Profile

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

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

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

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

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

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

Likely severity

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

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

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

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

Probability

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

Geographic Areas Likely Impacted

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

Historic Data

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

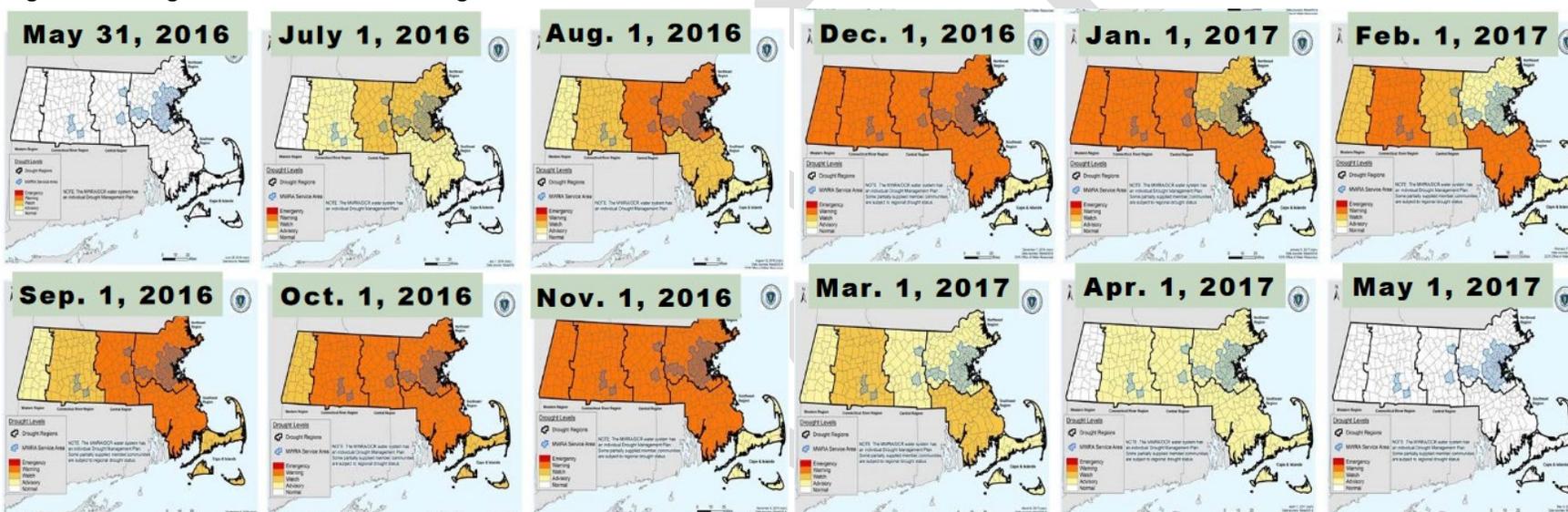
Table 3.8: Estimated Droughts Based on the Mass. Standardized Precipitation Index

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

Source: MEMA, 2013

Additional information indicates that droughts occurred in the state 2007-08 and in 2010, although neither of these involved drought conditions in Berkshire County (Western Drought Region). The most recent drought in Massachusetts occurred during a 10-month span in 2016-17. In July 2016 Advisory and Watch drought levels began to be issued for the eastern and central portions of the state, worsening in severity until the entire state was under a Drought Warning status for the months of November-December 2016. Water levels began to recover in February 2017, with the entire state determined to be back to normal water levels in May 2017. The Massachusetts Water Resources Commission stated that the drought was the worst since the state’s Drought Management Plan was first issued in 2001, and the most severe since the 1960s drought of record.⁶

Figure 3.12: Progression of the 2016-17 Drought



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

In general, the central portion of the state fared the worse and Berkshire County fared 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.

⁶ MA Water Resources Commission, 2017. Annual Report, Fiscal Year 2017. Boston, MA.

Vulnerability Assessment

People

The Berkshire region has not suffered a severe, Emergency-level drought since the 1960s. However, with changing precipitation patterns and warming temperatures, it is unclear how well private wells will serve the demands of Windsor residents during a prolonged drought.

For the purposes of this HMCAP, the entire population of Windsor is exposed and vulnerable to drought. Those with access and functional needs are at greatest risk, if they are unable to travel to, or afford, alternative water sources. It has been reported that a percentage of Windsor's residents have had wells run dry in years past. The Town has no official backup water source, at present, but does own Spring that might be able to serve that function, if it can be appropriately protected. As of 2018, 20.2% of Windsor's population was age 65 or older, an age group predicted to increase as a percentage of total population in the coming years. Older adults may be at heightened risk during drought periods.

Due to the great expanses of state and preserved forest land and pristine wildlife habitat in Windsor that attracts outdoor enthusiasts year 'round, the risk to people from wildfire is likely to increase in the years ahead, during severe drought. Drought would negatively impact the capacity of local firefighting efforts to control wildfires. A more detailed discussion of wildfire and the Town's vulnerability is found in that section of the report.

Built Environment with Infrastructure and Systems

Drought does not threaten the physical stability of critical facilities in the same manner as other hazards such as wind-based or flood-related events. However, if drought led to wildfire the entire Town, including homes and historic town-owned buildings, would be at risk. Additionally, as a result of wildfire, electrical and communication systems would be at significant risk. Surface water bodies would also be at risk of contamination.

Natural Environment

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

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

- Reduced water availability, specifically, but not limited to, habitat for aquatic species
- Decreased plant growth and productivity
- Increased wildfires
- Greater insect outbreaks
- Increased local species extinctions
- Lower stream flows and freshwater delivery to downstream estuarine habitats
- Changes in the timing, magnitude, and strength of mixing (stratification) in coastal waters
- Increased potential for hypoxia (low oxygen) events
- Reduced forest productivity
- Direct and indirect effects on goods and services provided by habitats (such as timber, carbon sequestration, recreation, and water quality from forests)
- Limited fish migration or breeding due to dry streambeds or fish mortality caused by dry streambeds

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

Economy

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

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

Future Conditions

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

For drought conditions to occur, soil moisture is limited or lacking, forest duff is dried out and standing vegetation is dry and possibly dead, providing the fuel needed for a wildfire. Given that the Town of Windsor is 90.4% forested, the risk of wildfire during drought conditions is a serious concern.

DRAFT

Change in Average Temperatures/ Extreme Temperatures

Hazard Profile

Likely severity

Relative to the rest of the Commonwealth, the Town of Windsor is protected from extreme heat by the higher elevation. At the same time however, the lack of many extreme heat events has left most unprepared. Homes being constructed to keep in warmth, and a dearth of centralized or shared cooling centers, has left the Town of Windsor vulnerable to extreme heat.

Considering the higher elevation and consequent wind, Windsor does have an average colder climate when compared to the central and eastern part of Massachusetts. The environment and people have adapted to these conditions; however extremes still pose a risk.

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

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

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

Probability

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

The change in average temperatures has already affected the Town of Windsor. Figure 3.13 shows the projected annual average temperature, increasing through the next century.

Geographic Areas Likely Impacted

For the purposes of this HMCAP, the entire population of the Windsor is considered exposed to extreme temperatures, due to the Town's high elevation. Extreme temperature events occur more frequently and vary more in the inland regions where temperatures are not moderated by the Atlantic Ocean.

According to NOAA, the annual average temperatures in the Western Division of Massachusetts, encompassing the Town of Windsor, are around 46°F.

Historic Data

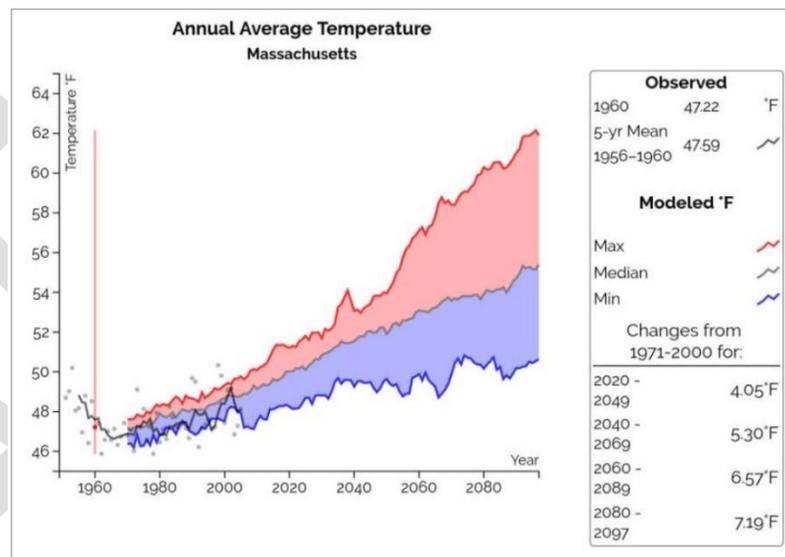
The following are some of the lowest temperatures recorded in the Berkshire region for the period from 1895 to present. (National Climatic Data Center, 2017)

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

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

- Boston, MA 102°F
- Great Barrington, MA 99°F

Figure 3.13: Projected Annual Average Temperature



Source: Resilient MA, 2018

- Adams, MA 95°F

- Pittsfield, MA 95°F

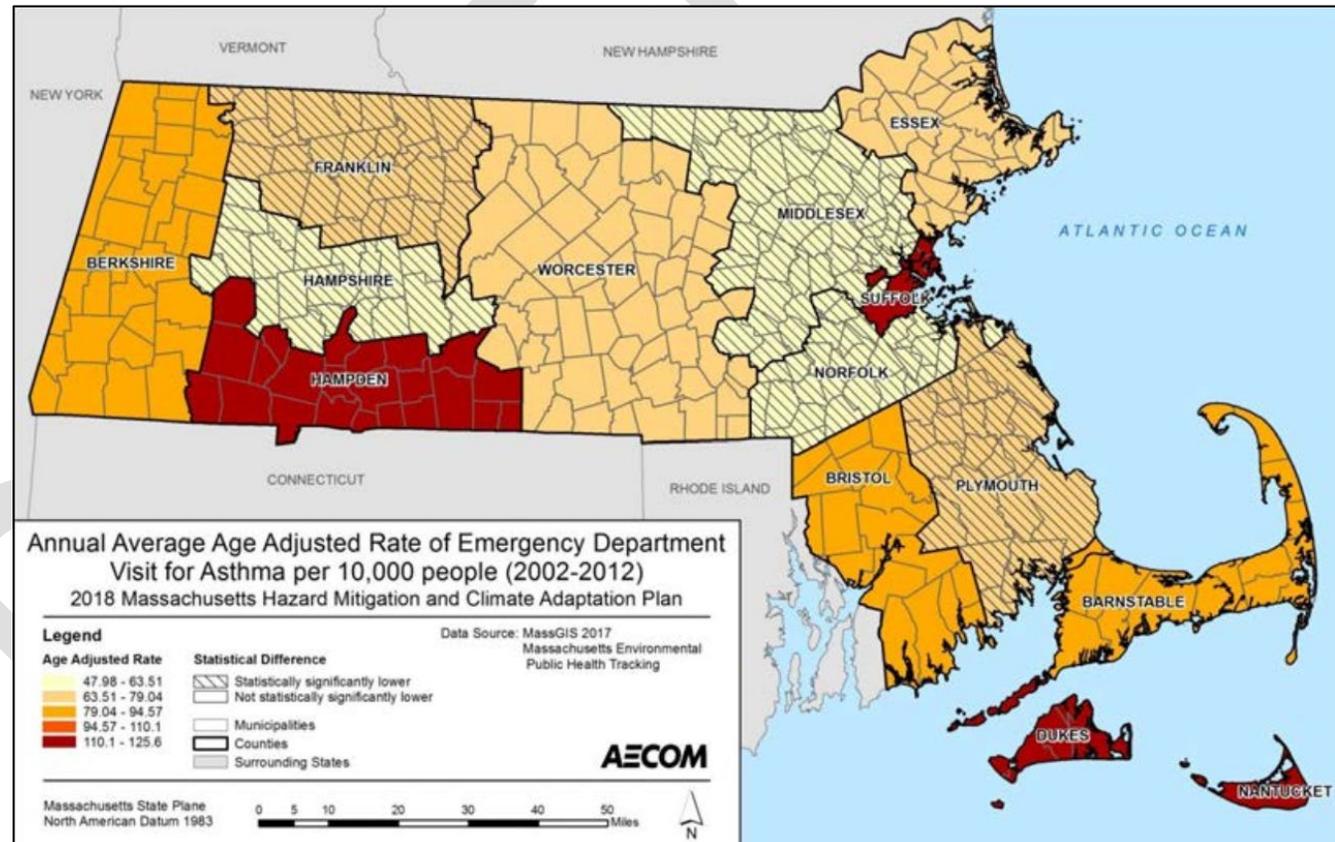
It should be noted that temperature alone does not define the stress that heat can have on the human body – humidity plays a powerful role in human health impacts, particularly for those with pre-existing pulmonary or cardio-vascular conditions. The NWS issues a Heat Advisory when the Heat Index is forecast to reach 100°-104°F for two or more hours. The NWS issues an Excessive Heat Warning if the Heat Index is forecast to reach 105°F or more for two or more hours.

Vulnerability Assessment

People

According to the Centers for Disease Control and Prevention, populations most at risk to extreme cold and heat events include the following: (1) people over the age of 65, who are less able to withstand temperatures extremes due to their age, health conditions, and limited mobility to access shelters; (2) infants and children under 5 years of age; (3) individuals with pre-existing medical conditions that impair heat tolerance (e.g., heart disease or kidney disease); (4) low-income individuals who cannot afford proper heating and cooling; (5) people with respiratory conditions, such as asthma or chronic obstructive pulmonary disease; and (6) the general public who may overexert themselves when working or exercising during extreme heat events or who may experience hypothermia during

Figure 3.14: Rates of Emergency Department Visits Due to Asthma by County



extreme cold events. Additionally, people who live alone—particularly the elderly and individuals with disabilities—are at higher risk of heat-related illness due to their isolation and reluctance to relocate to cooler environments.

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

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

Built Environment

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

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

Extreme heat has potential impacts on the design and operation of the transportation system. Impacts on the design include the instability of materials, particularly pavement, exposed to high temperatures over longer periods of time, which can cause buckling and lead to increased failures (MassDOT, 2017). High heat can cause pavement to soften and expand, creating ruts, potholes, and jarring, and placing additional stress on bridge joints. Extreme heat may cause heat stress in materials such as asphalt and increase the frequency of repairs and replacements (resilient MA, 2018). While Windsor does not have a railroad running through its boundaries, railroad tracks can expand in extreme heat, causing the track to “kink” and derail trains. Higher temperatures inside the enclosure-encased equipment, such as traffic control devices and signal control systems for rail service, may result in equipment failure (MEMA & EOEEA, 2018).

Natural Environment

There are numerous ways in which changing temperatures will impact the natural environment. Because the species that exist in a given area have adapted to survive within a specific temperature range, extreme temperature events can place significant stress both on individual species and the ecosystems in which they function. High-elevation spruce-fir forests, forested boreal swamp, and higher-elevation northern hardwoods are likely to be highly vulnerable to climate change (MCCS and DFW, 2010). Higher summer temperatures will disrupt wetland hydrology. Paired with a higher incidence and severity of droughts, high temperatures and evapo-transpiration rates could lead to habitat loss and wetlands drying out (MCCS and DFW, 2010). Individual extreme weather events usually have a limited long-term impact on natural systems, although unusual frost events occurring after plants begin to bloom in the spring can cause significant damage. However, the impact on natural resources of changing average temperatures and the changing frequency of extreme climate events is likely to be massive and widespread.

Climate change is anticipated to be the second-greatest contributor to this biodiversity crisis, which is predicted to change global land use. One significant impact of increasing temperatures may be the northern migration of plants and animals. Over time, shifting habitat may result in a geographic mismatch between the location of conservation land and the location of critical habitats and species the conserved land was designed to protect. Between 1999 and 2018 (fiscal years), the Commonwealth spent more than \$395 million on the acquisition of more than 143,033 acres of land and has managed this land under the assumption of a stable climate. As species respond to climate change, they will likely continue to shift their ranges or change their phenologies to track optimal conditions (MCCS and DFW, 2010). As a result, climate change will have significant impacts on traditional methods of wildlife and habitat management, including land conservation and mitigation of non-climate stressors (MCCS and DFW, 2010). Changing temperatures, particularly increasing temperatures, will also have a major impact on the sustainability of our waterways and the connectivity of aquatic habitats (i.e., entire portions of major rivers will dry up, limiting fish passage down the rivers). Additional impacts of warming temperatures include the increased survival and grazing damage of white-tailed deer, increased invasion rates of invasive plants, and increased survival and productivity of insect pests, which cause damage to forests (MCCS and

DFW, 2010). As temperature increases, the length of the growing season will also increase. Since the 1960s, the growing season in Massachusetts increased by approximately 10 days (CAT, n.d. as cited in MEMA & EOEEA, 2018).

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

Economy 44 CFR § 201.6(c)(2)(i)(B)

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

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

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

Future Conditions

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

Tornadoes/High Wind

Hazard Profile

Likely Severity

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

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

Probability

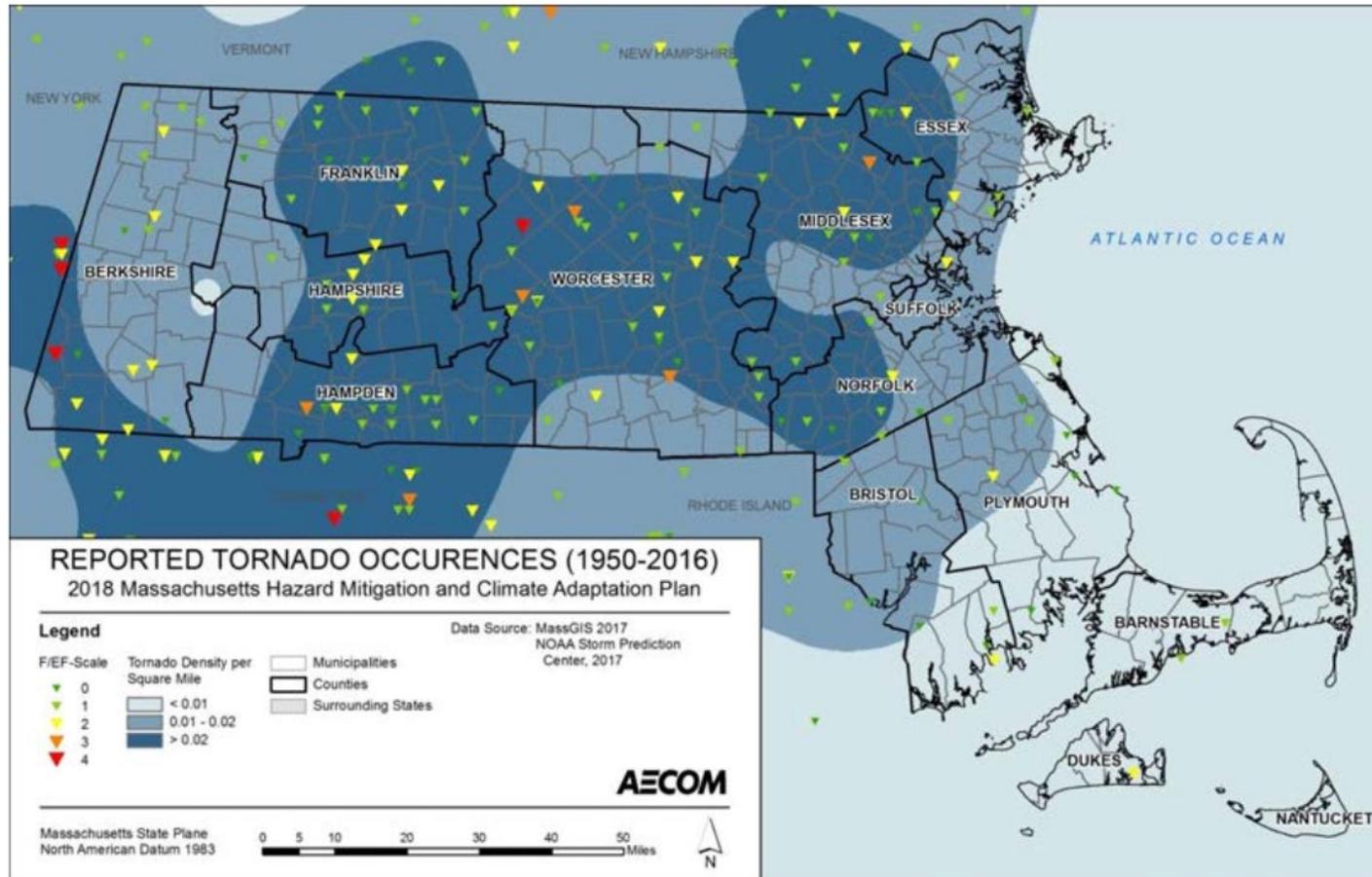
The location of tornado impact is totally unpredictable. Tornadoes are fierce phenomena which generate wind funnels of up to 200 MPH or more, and occur in Massachusetts usually during June, July, and August. Worcester County, and areas just to its west have been dubbed the “tornado alley” of the state,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

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

Geographic Areas Likely Impacted

While the area impacted by a tornado will be limited at the time of the event, anywhere in Windsor is susceptible. Figure 3.15 is show tornadoes reported in Massachusetts.

Figure 3.15: Density of Reported Tornadoes per Square Mile



Historic Data

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

people died and 24 were injured. The signs of the tornado's destruction are still visible today in Great Barrington from Rt. 7. The hill to the east is scarred where the tornado uprooted and toppled trees (MEMA & EOEEA, 2018).

Vulnerability Assessment

People

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

Built Environment

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

Natural environment

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

Economy

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

Future Conditions

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

Landslides

Hazard Profile

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

Likely Severity

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

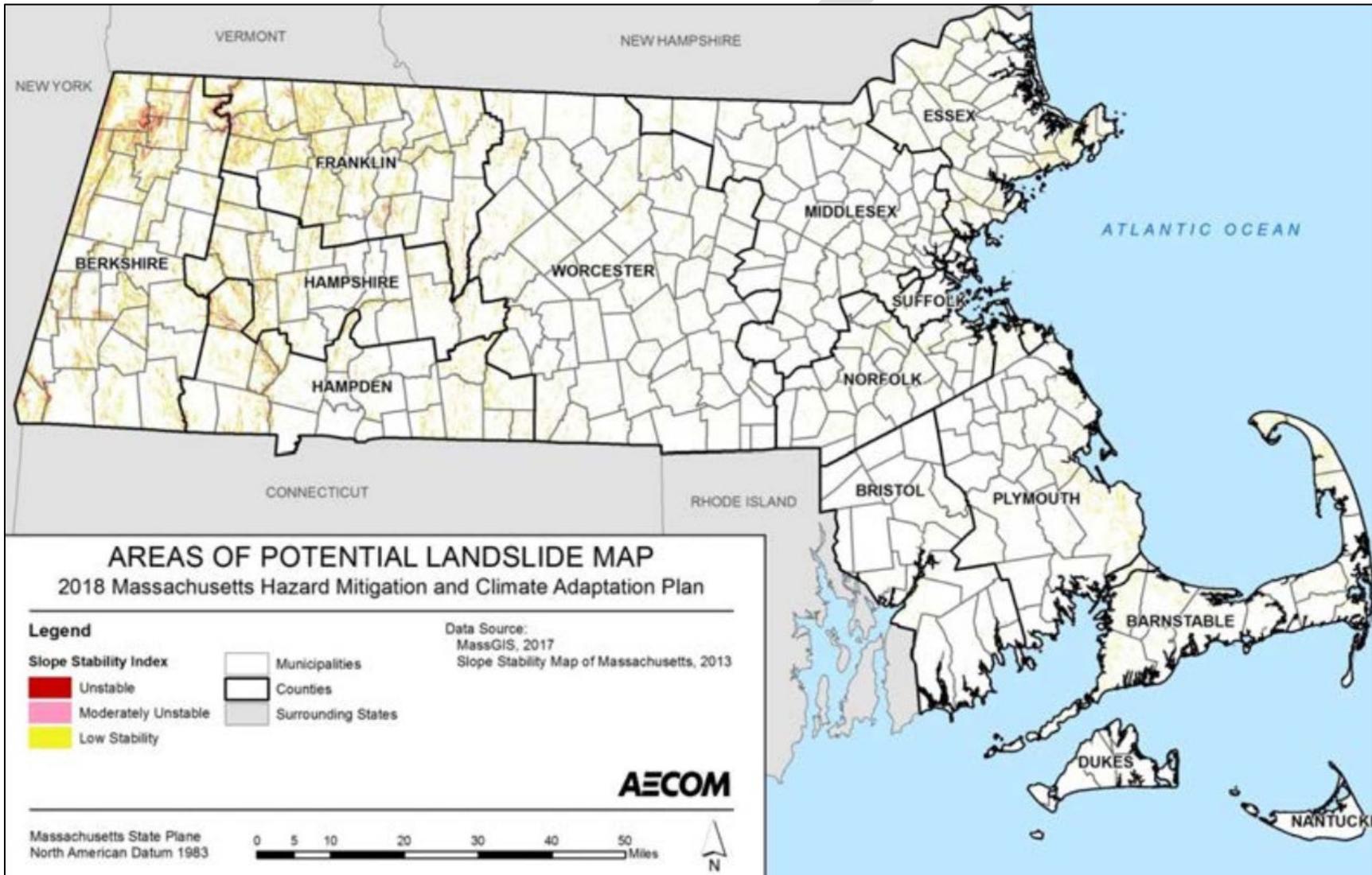
Probability

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

The probability of instability metric indicates how likely each area is to be unstable. In 2013, the Massachusetts Geological Survey prepared an updated map of potential landslide hazards for the Commonwealth (funded by FEMA's Hazard Mitigation Grant Program) to provide the public, local governments, and emergency management agencies with the location of areas where slope movements have occurred or may possibly

occur in the future under conditions of prolonged moisture and high-intensity rainfall (MEMA & EOEEA, 2018). The results of this study are shown in figure 3.16.

Figure 3.16: Slope Stability Map



¹Relative Slide Ranking—This column designates the relative hazard ranking for the initiation of shallow slides on unmodified slopes. **²Stability 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.

³Factors 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. **⁴Probability 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.

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
Red	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 $FS \leq 1$	>50%	Optimistic half of range required for stability	Stabilizing factors may be responsible for stability
Pink	Lower Threshold of Instability	Moderate	0.5 - 1	$\geq 50\%$ of $FS > 1$	<50%	Pessimistic half of range required for instability	Destabilizing factors are not required for instability
Yellow-Green	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
Green	Stable	Very Low	>1.5	Minimum $FS = 1.5$	–	Cannot model instability with most conservative parameters specified	Significant destabilizing factors are required for instability

⁵Possible 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:

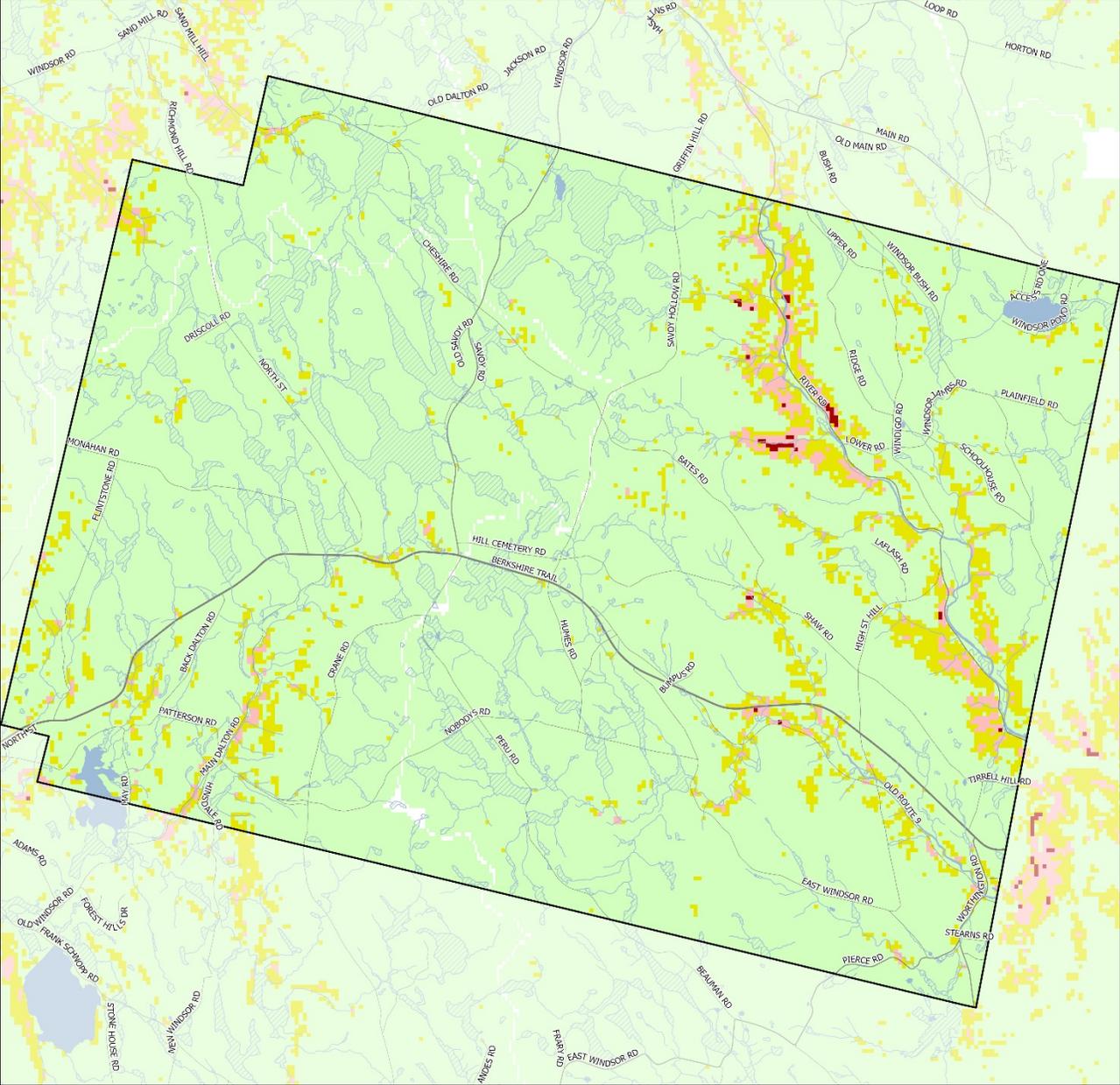
- Springs, seeps, or saturated ground in previously dry areas
- New cracks or unusual bulges in the ground
- Soil moving away from foundations
- Ancillary structures, such as decks and patios, tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
-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

Geographic Areas Likely Impacted

Although specific landslide events cannot be predicted, a slope stability map shows where slope movements are most likely to occur after periods of high-intensity rainfall. Unstable areas are located throughout the Commonwealth. However, the highest prevalence of unstable slopes is generally found in the western portion of the Commonwealth, including the area around Mount Greylock and the nearby portion of the Deerfield River, the U.S. Highway 20 corridor near Chester, as well as the main branches of the Westfield River (MEMA & EOEEA, 2018). Figure 3.17 shows the area in Windsor that are at risk of landslide.

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

Figure 3.17: Town of Windsor Landslide Map



Town of Windsor Slope Stability

- Slope Stability
- Unstable
 - Moderately Unstable
 - Low Stability
 - Stable



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

Historic Data

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

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

Vulnerability Assessment

People

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

Built Environment

In the Town of Windsor, only Main Dalton Road, which runs along the course of Windsor Brook, is identified as having unstable slopes which could lead to landslides. Though not heavily developed, this road is the location of several homes and farms, which could be impacted.

Landslides can result in direct losses as well as indirect socioeconomic losses related to damaged infrastructure. Infrastructure located within areas shown as unstable on the Slope Stability Map should be considered to be exposed to the landslide hazard. Highly vulnerable areas include mountain roads and transportation infrastructure, both because of their exposure to this hazard and the fact that there may be limited

transportation alternatives if this infrastructure becomes unusable. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use. Access to major roads is crucial to life safety after a disaster event and to response and recovery operations. The ability of emergency responders to reach people and property impacted by landslides can be impaired by roads that have been buried or washed out by landslides. The instability of areas where landslides have occurred can also limit the ability of emergency responders to reach survivors.

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

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

Natural Environment

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

Economy

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

Future Conditions

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

Wildfires

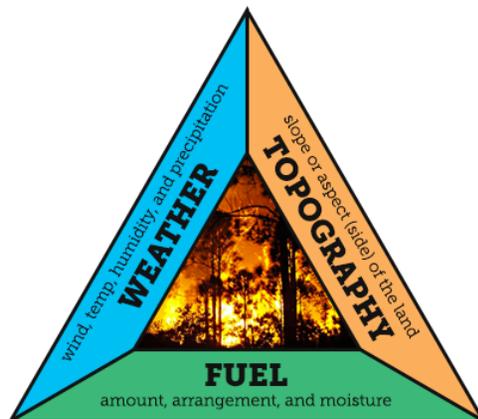
Hazard Profile

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

Likely severity

The Town of Windsor Volunteer Fire Department provides fire protection to residents and participates with other municipal FD's to provide mutual aid to its municipal neighbors. In the event of a significant forest fire, the mutual aid system would be utilized, plus MA DCR's Bureau of Forest Fire Control and Forestry located in Amherst, MA would also be involved. However, the travel time to Windsor from other areas could cause an increase in any fire's severity.

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.



Fire Behavior Triangle

Source:

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

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.

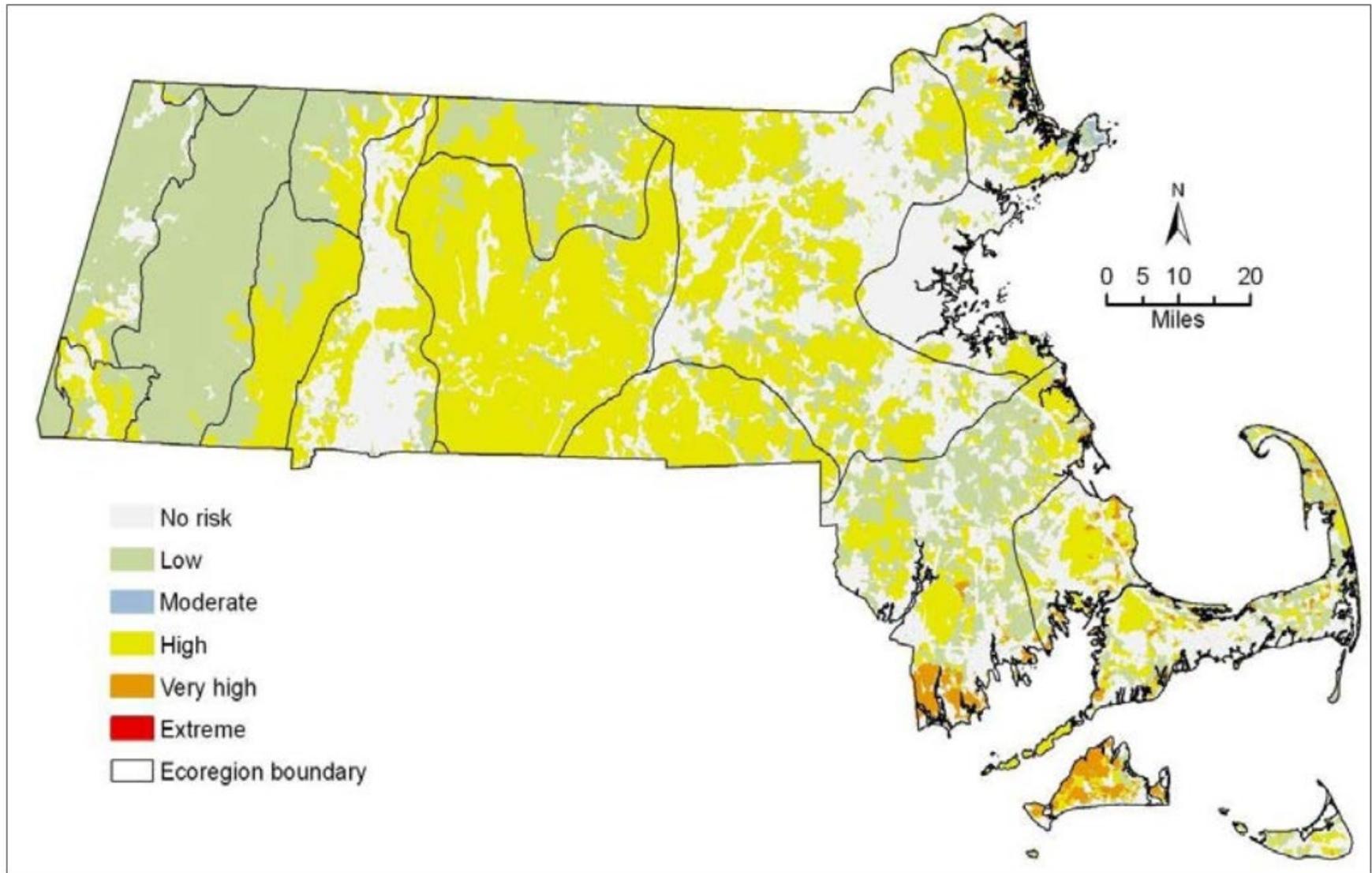
Probability

It is difficult to predict the likelihood of wildfires because a number of factors affect fire potential and because some conditions (e.g., drought, land use development patterns, location, and fuel sources) exert changing pressure on the wildland-urban interface zone. However, based on the frequency of past occurrences, it is reasonable to anticipate at least one notable wildfire in the state of Massachusetts each year, lowering the probability that Windsor will be affected.

Geographic Areas Likely Impacted

Most of the land in Windsor is vulnerable to wildfire. While the risk of fire is relatively low for the Town of Windsor compared to the Commonwealth, there is some hazard still posed by wildfire. Figure 3.18 shows the results of a geospatial analysis of fire risk by the Northeast Wildfire Risk Assessment Geospatial Work Group.

Figure 3.18: Wildfire Risk Areas for the Commonwealth of Massachusetts



Source: Northeast Wildfire Risk Assessment Geospatial Work Group, 2009

Historic Data

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

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

Vulnerability Assessment

People

As demonstrated by historical wildfire events, potential losses from wildfire include the lives of residents and responders and negative impacts to human health. The analysis of populations within interface or intermix areas (where buildings intermingle with forest) is not useful for Windsor because of low population density. Instead it can be assumed that the entire population of Windsor is vulnerable to wildfire due to the fact that all homes are surrounded by forest. All individuals whose homes or workplaces are located in wildfire hazard zones are exposed to this hazard, as wildfire behavior can be unpredictable and dynamic. However, the most vulnerable members of this population are those who would be unable to evacuate quickly, including those over the age of 65, households with young children under the age of 5, people with mobility limitations, and people with low socioeconomic status. Landowners with pets or livestock may face additional challenges in evacuating if they cannot easily transport their animals. Outside of the area of immediate impact, sensitive populations, such as those with compromised immune systems or cardiovascular or respiratory diseases, can suffer health impacts from smoke inhalation. Individuals with asthma are more vulnerable to the poor air quality associated with wildfire. Finally, firefighters and first responders are vulnerable to this hazard if they are deployed to fight a fire in an area they would not otherwise be in.

Smoke and air pollution from wildfires can be a severe health hazard. Smoke generated by wildfire consists of visible and invisible emissions containing particulate matter (soot, tar, and minerals), gases (water vapor, carbon monoxide, carbon dioxide (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, municipal, residential, ancillary and utility are vulnerable to wildfire. Communications and electrical systems would be cut off by wildfire if affected at portion of the system. Drinking water for Windsor and Pittsfield would also be at risk of contamination. 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 in this heavily-wooded community, wildfires could create conditions in which bridges are damaged or obstructed (MEMA & EOEEA, 2018).

Natural environment

Fire is a natural part of many ecosystems and serves important ecological purposes, including facilitating the nutrient cycling from dead and decaying matter, removing diseased plants and pests, and regenerating seeds or stimulating germination of certain plants. However, many wildfires, particularly man-made wildfires, can also have significant negative impacts on the environment. In addition to direct mortality, wildfires and the ash they generate can distort the flow of nutrients through an ecosystem, reducing the biodiversity that can be supported. Frequent wildfires can eradicate native plant species and encourage the growth of fire-resistant invasive species. Some of these invasive species are highly flammable; therefore, their establishment in an area increases the risk of future wildfires. There are other possible feedback loops associated with this hazard. For example, every wildfire contributes to atmospheric CO₂ accumulation, thereby contributing to global warming and increasing the probability of future wildfires (as well as other hazards). There are also risks related to hazardous material releases during a wildfire. During wildfires, containers storing hazardous materials could rupture due to excessive heat and act as fuel for the fire, causing rapid spreading of the wildfire and escalating it to unmanageable levels. In addition, these materials could leak into surrounding areas, saturating soils and seeping into surface waters to cause severe and lasting environmental damage (MEMA & EOEEA, 2018).

Economy

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

Future Conditions

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

- Without an increase in summer precipitation (greater than any predicted by climate models), future areas burned is very likely to increase.
- Infestation from insects is also a concern as it may affect forest health. Potential insect populations may increase with warmer temperatures and infested trees may increase fuel amount.
- Tree species composition will change as species respond uniquely to a changing climate.
- Wildfires cause both short-term and long-term losses. Short-term losses can include destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and the destruction of cultural and economic resources and community infrastructure (MEMA, 2013).

Hurricanes/Tropical Storms

Hazard Profile

Likely Severity

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

- A tropical depression is declared when there is a low-pressure center in the tropics with sustained winds of 25 to 33 mph.
- A tropical storm is a named event defined as having sustained winds from 34 to 73 mph.
- If sustained winds reach 74 mph or greater, the storm becomes a hurricane. The Saffir-Simpson scale ranks hurricanes based on sustained wind speeds—from Category 1 (74 to 95 mph) to Category 5 (156 mph or more). Category 3, 4, and 5 hurricanes are considered “major” hurricanes. Hurricanes are categorized based on sustained winds; wind gusts associated with hurricanes may exceed the sustained winds and cause more severe localized damage (NOAA, n.d.[b]).

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

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

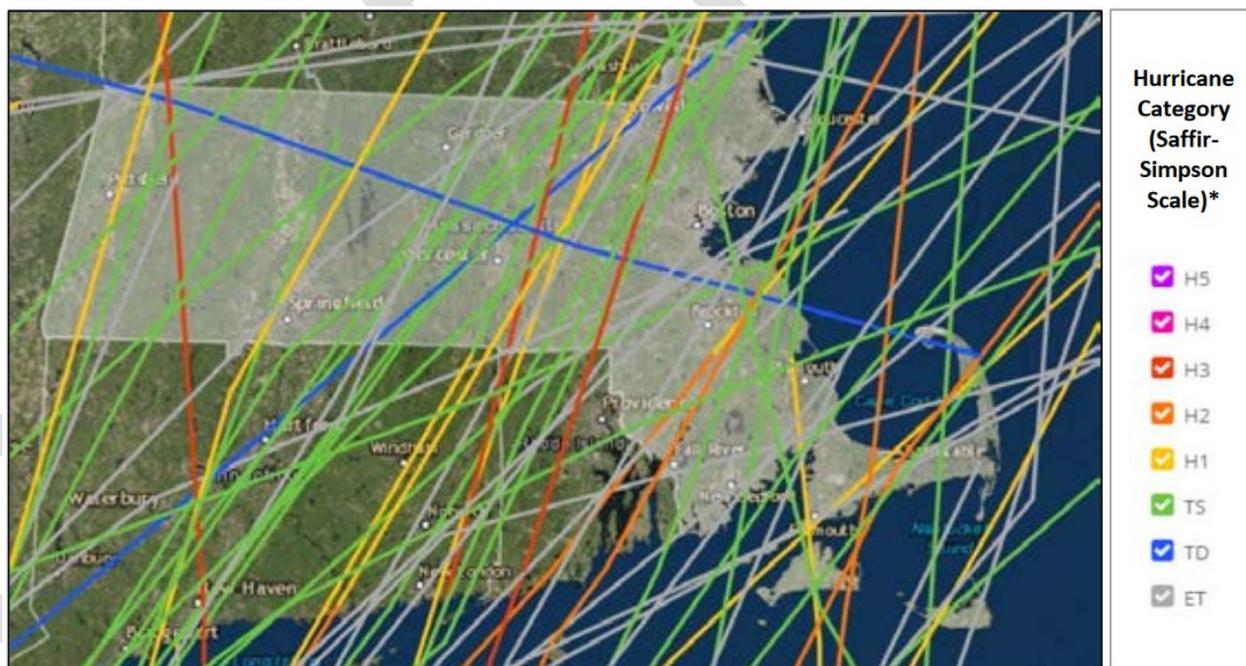
Probability

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

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

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.

Figure 3.19: Historical Hurricane Paths within 65 miles of Massachusetts



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

Geographic Areas Likely Impacted

The entire Commonwealth is vulnerable to hurricanes and tropical storms, depending on each storm’s track. The coastal areas are more susceptible to damage due to the combination of both high winds and tidal surge, as depicted on the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) maps. Inland areas, especially those in floodplains, are also at risk for flooding from heavy rain and wind damage. The majority of the damage following hurricanes and tropical storms often results from residual wind damage and inland flooding, as was demonstrated during recent tropical storms. Historic storm tracks can be seen in the NOAA graphic, figure 3.18. The graphic shows tracks that have cut through Windsor.

Historic Data

The National Oceanic and Atmospheric Administration (NOAA) has been keeping records of hurricanes since 1842 (Table 3.9). From 1842 to 2018, there have been five (5)

Tropical Depressions, five (5) Tropical Storms, one (1) Category 1 Hurricane and one (1) Category 2 Hurricane pass directly through Berkshire County.

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

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

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

Hurricane Gloria caused extensive damage along the east coast of the U.S. and heavy rains and flooding in western Massachusetts in 1985. This event resulted in a federal disaster declaration (FEMA DR-751). In October 2005 the remnants of Tropical Storm Tammy followed by a

subtropical depression produced significant rain and flooding across western Massachusetts. It was reported that between nine and 11 inches of rain fell. The heavy rainfall washed out many roads in Hampshire and Franklin Counties. The Green River flooded a mobile home park in Greenfield, with at least 70 people left homeless. Following these events, the mobile home park was demolished, and the site was turned into a town park. Localized flooding in Berkshire County was widespread, with several road washouts. This series of storms resulted in a federal disaster declaration (FEMA DR-1614) and Massachusetts received over \$13 million in individual and public assistance. (MEMA, 2013)

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

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

Vulnerability Assessment

People

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

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

Built Environment

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

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

Natural Environment

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

Economy

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

Future conditions

The Northeast has been experiencing more frequent days with temperatures above 90°F, increasing sea surface temperatures and sea levels, changes in precipitation patterns and amounts, and alterations in hydrological patterns. According to the Massachusetts Climate Change Adaptation Report, large storm events are becoming more frequent. Although there is still some level of uncertainty, research indicates the warming climate may double the frequency of Category 4 and 5 hurricanes by the end of the century and decrease the frequency of less severe

hurricane events. More frequent and intense storm events will cause an increase in damage to the built environment and could have devastating effects on the economy and environment. As stated earlier, cooler water temperatures along the Northeast Atlantic Ocean help to temper the strength of tropical storms, but if the ocean continues to warm, this tempering force could be lessened, leading to greater intensity of storms that make landfall in New England.

DRAFT

Other Severe Weather

Hazard Profile

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

Likely Severity

HIGH WINDS

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

THUNDERSTORMS

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

Force	Wind (Knots)	WMO Classification	Appearance of Wind Effects On Land
0	Less than 1	Calm	Calm, smoke rises vertically

Table 3.10: Beaufort Wind Scale – Effects on Land

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

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

Probability

HIGH WINDS

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

THUNDERSTORMS

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

Geographic Areas Likely Impacted

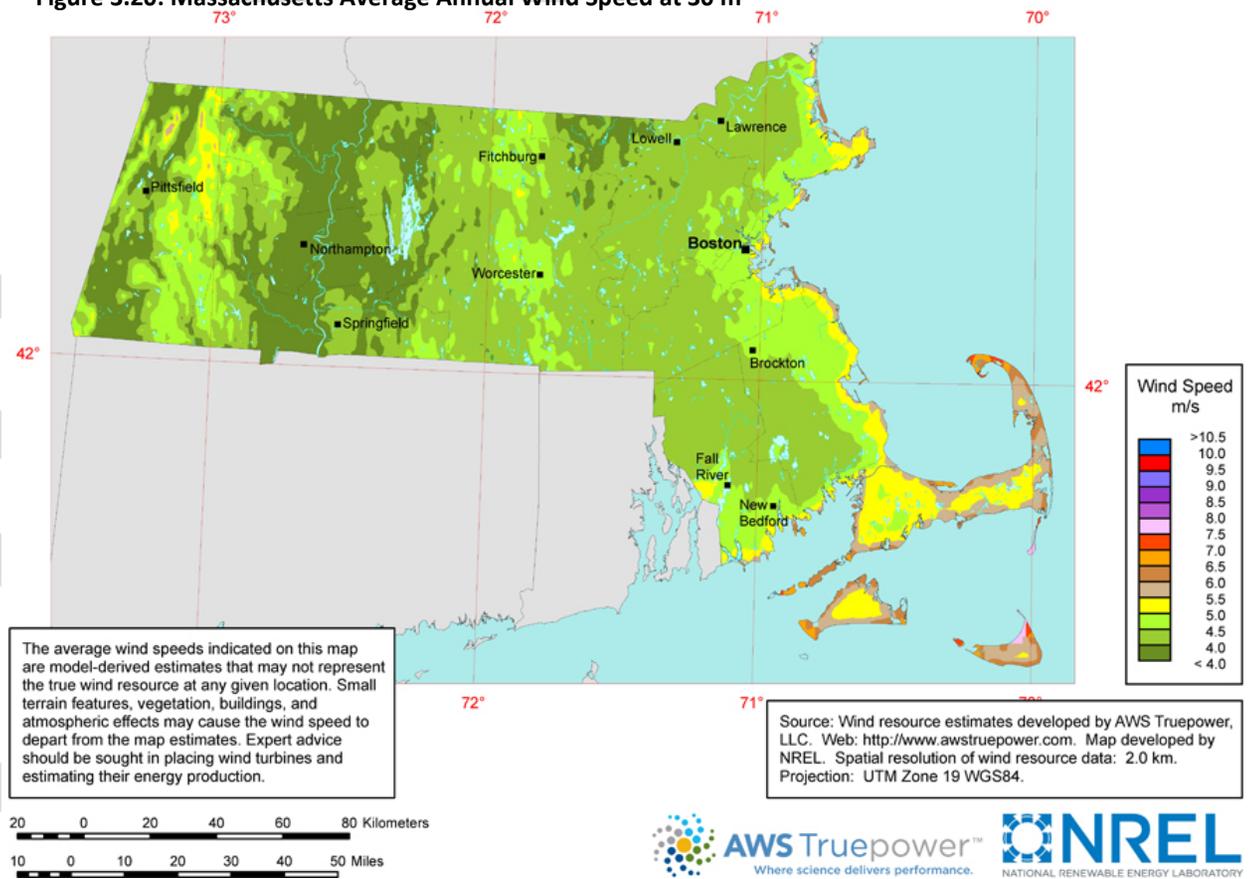
HIGH WINDS

The entire Town of Windsor is vulnerable to high winds that can cause extensive damage. Relative to the rest of the Commonwealth and surrounding areas of Berkshire county, wind speeds on average are typically higher in Windsor as shown in figure 3.20. Some areas are more susceptible to wind than others.

THUNDERSTORMS

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

Figure 3.20: Massachusetts Average Annual Wind Speed at 30 m



Historic Data

It is difficult to define the number of other severe weather events experienced by Windsor each year. Figure 3.21 shows number of annual thunderstorm days across the United States. Massachusetts experiences 20 to 30 thunderstorm days each year.

Vulnerability Assessment

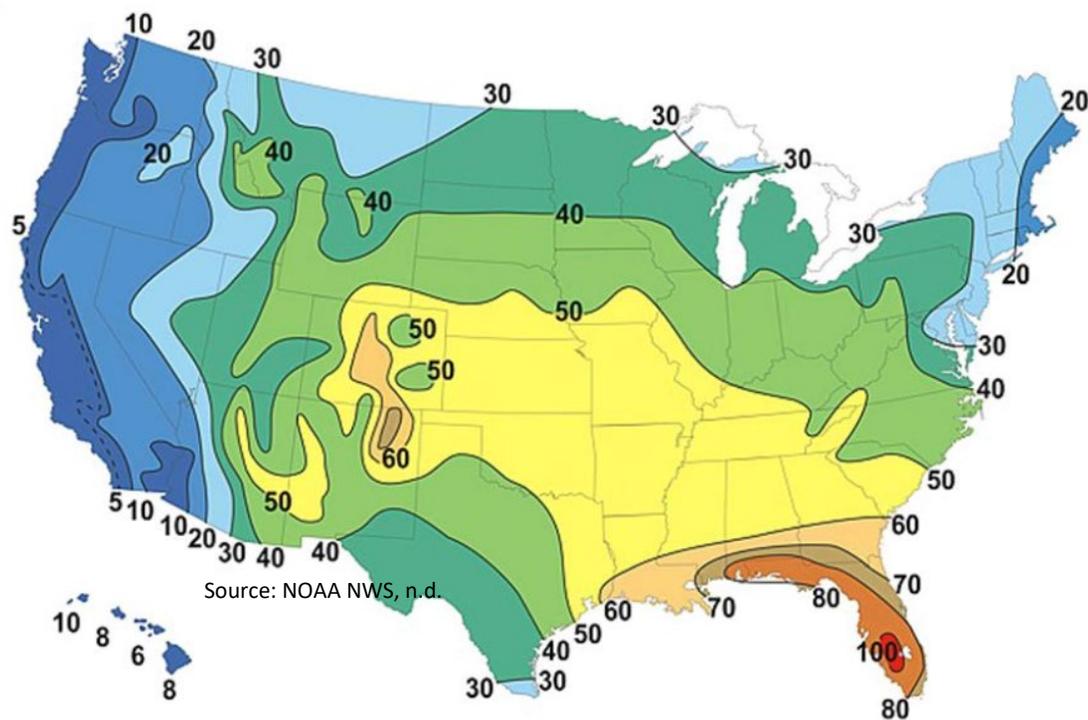
People

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

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

Both high winds and thunderstorms present potential safety impacts for individuals without access to shelter during these events. Extreme rainfall events can also affect raw water quality by increasing turbidity and bacteriological contaminants leading to gastrointestinal illness. Additionally, research has found that thunderstorms may cause the rate of emergency room visits for asthma to increase to 5 to 10 times the normal rate (Andrews, 2012). Much of this phenomenon is attributed to the stress and anxiety that many individuals, particularly children, experience during severe thunderstorms. The combination of wind, rain, and lightning from thunderstorms with pollen and mold spores can

Figure 3.21: Annual Average Number of Thunderstorm Days in the U.S.



exacerbate asthma (UG, 2017). The rapidly falling air temperatures characteristic of a thunderstorm as well as the production of nitrogen oxide gas during lightning strikes have also both been correlated with asthma (SKMCAP, 2018).

Built Environment

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

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

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

Natural Environment

As described under other hazards, such as hurricanes and nor'easters, high winds can defoliate forest canopies and cause structural changes within an ecosystem that can destabilize food webs and cause widespread repercussions. Direct damage to plant species can include uprooting or total destruction of trees and an increased threat of wildfire in areas of tree debris. High winds can also erode soils, which can damage both the ecosystem from which soil is removed as well as the system on which the sediment is ultimately deposited. Environmental impacts of extreme precipitation events are discussed in depth in Section 4.1.1 and often include soil erosion, the growth of excess fungus or bacteria, and direct impacts to wildlife. For example, research by the Butterfly Conservation Foundation shows that above-average rainfall events have

prevented butterflies from successfully completing their mating rituals, causing population numbers to decline. Harmful algal blooms and associated neurotoxins can also be a secondary hazard of extreme precipitation events as well as heat. Public drinking water reservoirs may also be damaged by widespread winds uprooting watershed forests and creating serious water quality disturbances (MEMA & EOEEA, 2018).

Economy

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

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

Future Conditions

Increased frequency of severe weather events in general is an effect of climate change, and thus we can expect to see more severe wind event and thunderstorms in Windsor in the future.

Invasive Species

Hazard Profile

Likely Severity

The Town of Windsor chose to examine the hazard of both plant and animal invasive species. Invasive species are defined as non-native species that cause or are likely to cause harm to ecosystems, economies, and/or public health (NISC 2006).

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

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

Probability

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

Geographic Areas Likely Impacted

The Town of Windsor Forest Management and Stewardship Plan identified Japanese barberry observed during field inspection of a 43-acre property off of South Windsor State Road (Route 8). The invasive Japanese barberry was not established throughout the property however, and the Massachusetts Department of Conservation and Recreation (DCR) recommended that an invasive control program should be developed and implemented before the population get higher. Additionally, areas that do not have nonnative species should be monitored to prevent invasive establishment.

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

Invasive insects are a significant threat, particularly to trees and everything that depends on those trees from wildlife to people.

Historic Data

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

The terrestrial, freshwater, and marine species listed on the MIPAG website as “Invasive” (last updated April 2016) are listed in Table 3.11. The table also includes details on the nature of the ecological and economic challenges presented by each species as well as information on when and where the species was first detected in Massachusetts (MEMA & EOEEA, 2018).

Table 3.11: Invasive Plants in Massachusetts

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

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

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

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

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

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

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

The Emerald Ash Borer was first discovered in Massachusetts in Berkshire County. The Emerald Ash Borer kills ash trees quickly, by drilling holes through the trunks. This pest has already killed a large numbers of trees in Windsor and is seen as the most pressing invasive species problem in this heavily-forested community (as well as surrounding communities.) Windsor has taken a proactive stance, removing infected trees as soon as positive identification is made.



Vulnerability Assessment

People

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

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

Built Environment

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

Invasive species like water chestnut or milfoil, may impair surface water quality, that has implications for drinking water supplies and the cost of ongoing water treatment.

Natural Environment

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

- Reduced diversity of native plants and animals
- Impairment of recreational uses, such as swimming, boating, and fishing
- Degradation of water quality
- Degradation of wildlife habitat
- Increased threats to public health and safety
- Diminished property values
- Declines in fin and shellfish populations
- Loss of coastal infrastructure due to the habits of fouling and boring organisms
- Local and complete extinction of rare and endangered species (EOEEA, 2002 as cited by MEMA & EOEEA, 2018)

Economy

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

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

Future Conditions

Temperature, concentration of CO₂ in the atmosphere, frequency and intensity of hazardous events, atmospheric concentration of CO₂, and available nutrients are key factors in determining species survival. It is likely that climate change will alter all of these variables. As a result, climate change is likely to stress native ecosystems and increase the chances of a successful invasion. Additionally, some research suggests that elevated atmospheric 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 of successful establishment or expansion. Other climate change impacts that could increase the severity of the invasive species hazard include

the following (Bryan and Bradley, 2016; Mineur et al., 2012; Schwartz, 2014; Sorte, 2014; Stachowicz et al., 2002 as cited in MEMA & EOEEA, 2018):

- Elevated atmospheric CO₂ levels could increase some organisms' photosynthetic rates, improving the competitive advantage of those species.
- Changes in atmospheric conditions could decrease the transpiration rates of some plants, 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 forest 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).

Earthquakes

Hazard Profile

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

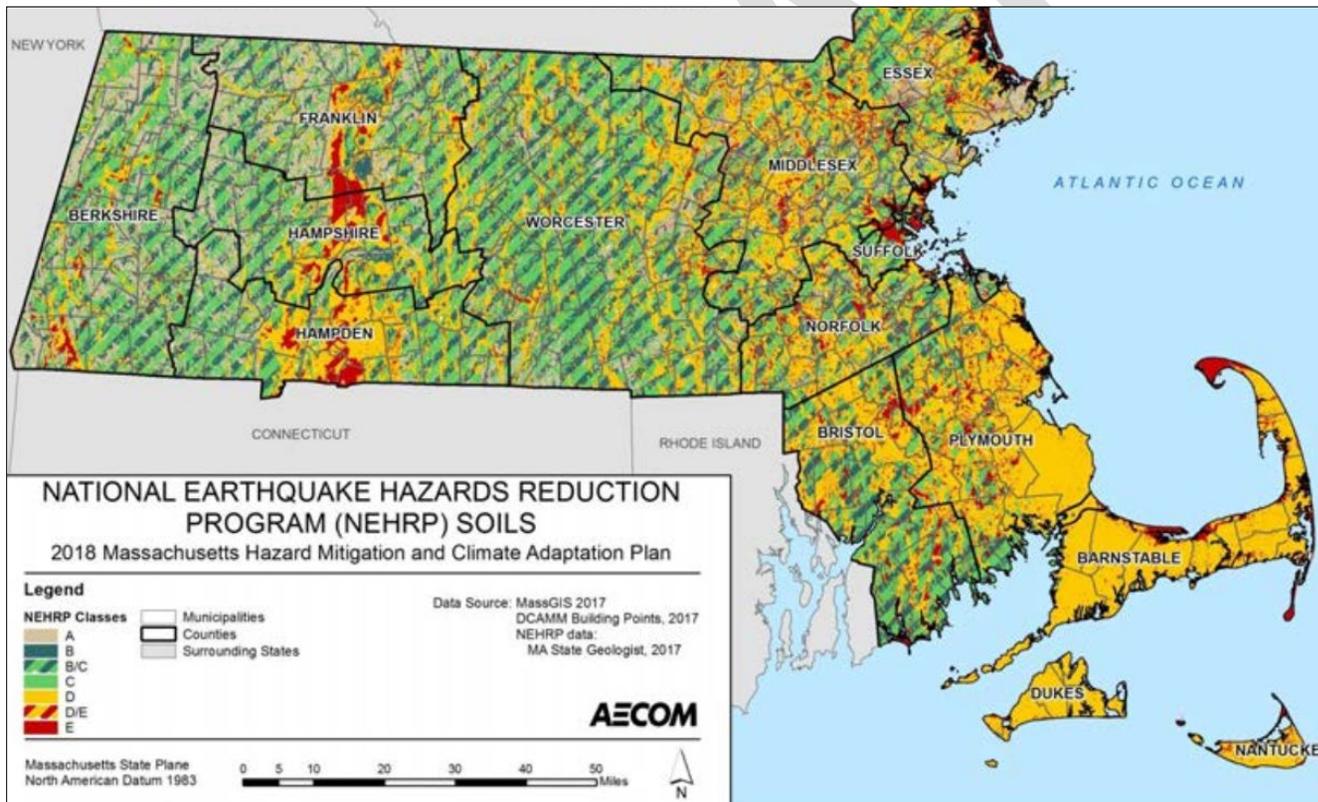
Likely severity

Ground shaking is the primary cause of earthquake damage to man-made structures. This damage can be increased due to the fact that soft soils amplify ground shaking. A contributor to site amplification is the velocity at which

the rock or soil transmits shear waves (S waves). The National Earthquake Hazards Reduction Program (NEHRP) developed five soil classifications, which are defined by their S-wave velocity, that impact the severity of an earthquake. The soil classification system ranges from A to E, where A represents hard rock that reduces ground motions from an earthquake and E represents soft soils that amplify and magnify ground shaking and increase building

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

damage and losses. These soil



types are shown in Figure 3.22. Soil types A, B, C, and D are reflected in the Hazus analysis that generated the exposure and vulnerability results later in the section (MEMA & EOEEA, 2018).

The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth. The focal depth of an earthquake is the depth from the surface to the region where the earthquake's energy originates (the focus). Earthquakes with focal depths up to about 43.5 miles are classified as shallow. Earthquakes with focal depths of 43.5 to 186 miles are classified as intermediate. The focus of deep earthquakes may reach depths of more than 435 miles. The focus of most earthquakes is concentrated in the upper 20 miles of the Earth's crust. The depth to the Earth's core is about 3,960 miles, so even the deepest earthquakes originate in relatively shallow parts of the Earth's interior. The epicenter of an earthquake is the point on the Earth's surface directly above the focus. Seismic waves are the vibrations from earthquakes that travel through the Earth and are recorded on instruments called seismographs. The magnitude or extent of an earthquake is a seismograph-measured value of the amplitude of the seismic waves. The Richter magnitude scale (Richter scale) was developed in 1932 as a mathematical device to compare the sizes of earthquakes. The Richter scale is the most widely known scale for measuring earthquake magnitude. It has no upper limit and is not used to express damage. An earthquake in a densely populated area, which results in many deaths and considerable damage, can have the same magnitude as an earthquake in a remote area that causes no damage. The perceived severity of an earthquake is based on the observed effects of ground shaking on people, buildings, and natural features, and severity varies with location. Intensity is expressed by the Modified Mercalli Scale, which describes how strongly an earthquake was felt at a particular location. The Modified Mercalli Scale expresses the intensity of an earthquake's effects in a given locality in values ranging from I to XII. Seismic hazards are also expressed in terms of PGA, which is defined by USGS as "what is experienced by a particle on the ground" in terms of percent of acceleration force of gravity. More precisely, seismic hazards are described in terms of Spectral Acceleration, which is defined by USGS as "approximately what is experienced by a building, as modeled by a particle on a massless vertical rod having the same natural period of vibration as the building" in terms of percent of acceleration force of gravity (percent g).

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

Probability

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

A 1994 report by the USGS, based on a meeting of experts at the Massachusetts Institute of Technology, provides an overall probability of occurrence. Earthquakes above about magnitude 5.0 have the potential for causing damage near their epicenters, and larger magnitude

earthquakes have the potential for causing damage over larger areas. This report found that the probability of a magnitude 5.0 or greater earthquake centered somewhere in New England in a 10-year period is about 10 percent to 15 percent. This probability rises to about 41 percent to 56 percent for a 50-year period. The last earthquake with a magnitude above 5.0 that was centered in New England took place in the Ossipee Mountains of New Hampshire in 1940 (MEMA & EOEEA, 2018).

Geographic Areas Likely Impacted

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

Historic Data

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

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

Vulnerability Assessment

People

The entire population of Massachusetts is potentially exposed to direct and indirect impacts from earthquakes. The degree of exposure depends on many factors, including the age and construction type of the structures where people live, work, and go to school; the soil type these buildings are constructed on; and the proximity of these building to the fault location. In addition, the time of day also exposes different sectors of the community to the hazard. There are many ways in which earthquakes could impact the lives of individuals across the Commonwealth. Business interruptions could keep people from working, road closures could isolate populations, and loss of utilities could impact populations that suffered no direct damage from an event itself. People who reside or work in unreinforced masonry buildings are vulnerable to liquefaction.

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

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

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

<i>Severity</i>	<i>100-Year MRP</i>			<i>500-Year MRP</i>			<i>1,000-Year MRP</i>			<i>2,500-Year MRP</i>		
	<i>2am</i>	<i>2pm</i>	<i>5pm</i>	<i>2am</i>	<i>2pm</i>	<i>5pm</i>	<i>2am</i>	<i>2pm</i>	<i>5pm</i>	<i>2am</i>	<i>2pm</i>	<i>5pm</i>
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: SCMCA, 2018 HAZUS

MRP= Mean Return Period

Built Environment

All elements of the built environment in the planning area are exposed to the earthquake hazard. In addition to direct impacts, there is increased risk associated

with hazardous materials releases, which have the potential to occur during an earthquake from fixed facilities, transportation-related incidents (vehicle transportation), and pipeline distribution. These failures can lead to the release of materials to the surrounding environment, including potentially catastrophic discharges into the atmosphere or nearby waterways, and can disrupt services well beyond the primary area of impact (MEMA & EOEEA, 2018).

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

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

Natural Environment

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

Economy

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

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

Future Conditions

Earthquakes cannot be predicted and may occur at any time. Peak Ground Acceleration (PGA) maps are used as tools to determine the likelihood that an earthquake of a given Modified Mercalli Intensity may be exceeded over a period of time, but they are not useful for predicting the occurrence of individual events. Therefore, geospatial information about the expected frequency of earthquakes throughout Massachusetts is not available. Unlike previous hazards analyzed in the Windsor Hazard Mitigation 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.

DRAFT

Dam Failure

Hazard Profile

Likely severity

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

Table 3.14: Dam Size Classification

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

Table 3.15: Dam Hazard Potential Classification

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

The classification for potential hazard shall be in accordance with table 3.15. The hazards pertain to potential loss of human life or property damage in the event of failure or improper operation of the dam or appurtenant works. Probable future development of the area downstream

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

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

Probability

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

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

There are a number of ways in which climate change could alter the flow behavior of a river, causing conditions to deviate from what the dam was designed to handle. For example, more extreme precipitation events could increase the frequency of intentional discharges. Many other climate impacts—including shifts in seasonal and geographic rainfall patterns—could also cause the flow behavior of rivers to deviate from previous hydrographs. When flows are greater than expected, spillway overflow events (often referred to as “design failures”) can occur. These overflows result in increased discharges downstream and increased flooding potential. Therefore, although climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failures (MEMA & EOEEA, 2018).

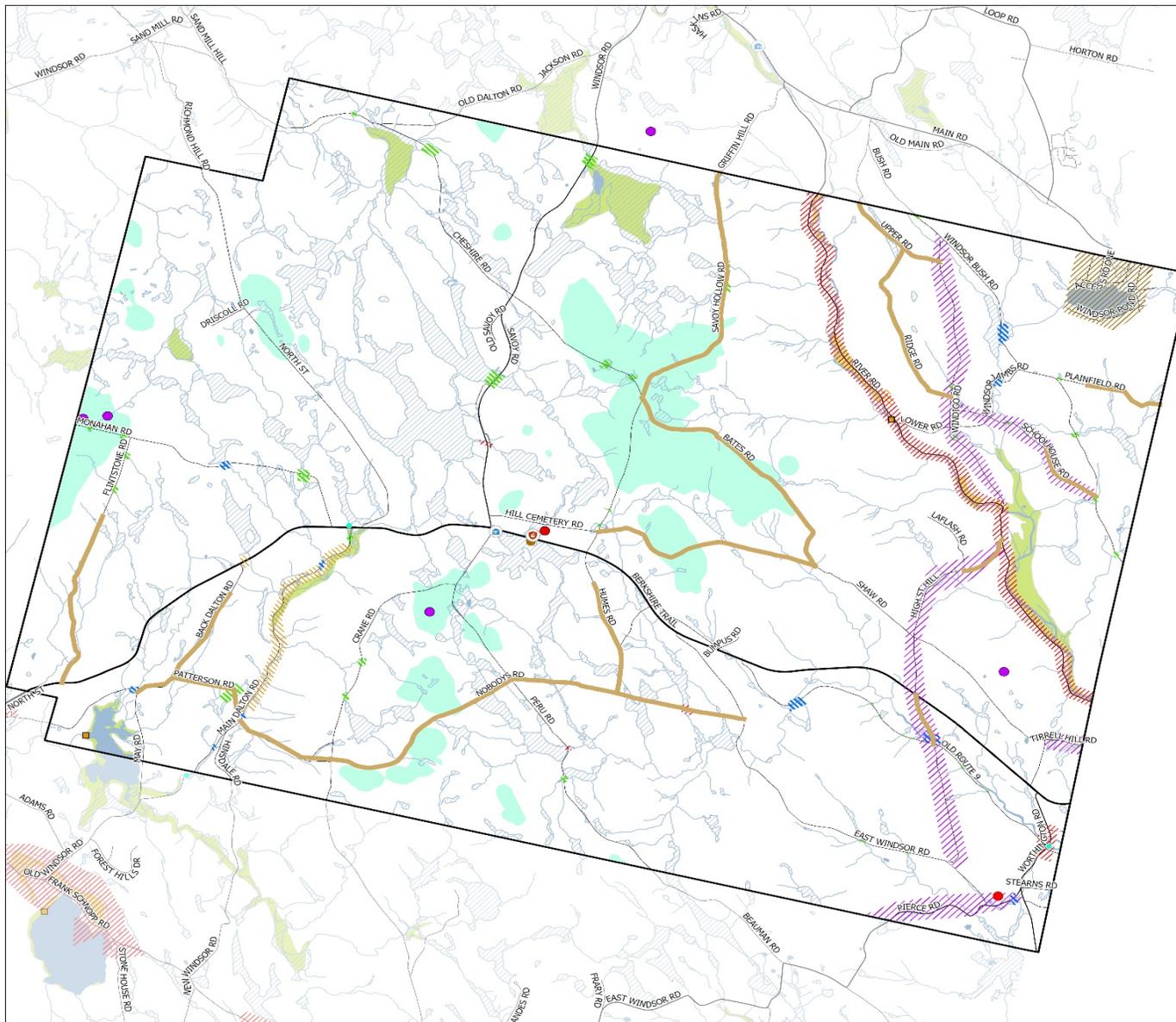
Geographic Areas Likely Impacted

Table 3.16 provides a summary of severity, probability and location for dams located in the Town of Windsor. Figure 3.22 shows a map of Windsor’s Critical Facilities & Areas of Concern with dams highlighted. The DCR Office of Dam Safety lists 2 dams in the Town of Windsor, as shown in Table 3.16. The information in this table was updated from the Office of Dam Safety 2014 data with the information available through the 2018 National Inventory of Dams maintained by the U.S. Army Corps of Engineers (USACE) and confirmed with the Town of Dalton Fire District

Table 3.16: Dam Hazard Status for Windsor

Name	Hazard Code	Size Class	Inspection Condition	Owner	Water Source
Windsor Reservoir Dam	High	Large	Good	Dalton Fire District	Waconah Falls Brook
Windsor State Park Dam	Low	Small	Good	DEM Region V Director	Westfield River

Figure 3.22: Town of Windsor Critical Facilities and Areas of Concern with Dam locations



Town of Windsor Critical Facilities and Areas of Concern

- Problem Areas**
 - Flooding/Beavers
 - Landslide
 - Culvert
 - Bridge
 - Road Maintenance
 - Trees
- FEMA 100yr Floodplain
- Dam
- Town Hall
- Fire Station
- DPW
- Stream Gauges
- Fire Pond
- Communication Towers
- Seasonal Roads
- Interstate
- Major Road
- Minor Road
- Local Road
- Railroad
- Stream
- Wetland
- Open Water
- 2100 feet and above

0 0.5 1 Miles



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

Historic Data

Historically, dam failure has had a low occurrence in Berkshire County. However, many of the dams within the region are more than 100 years old. The oldest dam in Windsor, at Windsor Reservoir, is owned by the Town of Dalton Water District, as it serves a part of that Town's water supply system. It was completely rebuilt within the last ten years. If Windsor Dam failed, the inundation area would affect downstream residents of Dalton and Pittsfield, MA most severely, with little or no impact in Windsor itself.

Vulnerability Assessment

People

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

Built Environment

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

Natural environment

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

Economy

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

Future Conditions

According to MEMA, dams are designed partly based on assumptions about a river's flow behavior, expressed in 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. (Massachusetts Emergency Management Agency, 2013)

If climate change results in a greater number of severe precipitation events and shortens recurrence intervals between 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.

Vector-borne Diseases

Hazard Profile

Likely Severity

The Town of Windsor chose to include the hazard of vector-borne diseases in their hazard profile for the community, because of a noticeable increase in tick populations and reports of Lyme and other illnesses reported by health officials in town. Vector-borne diseases are defined by the CDC as illnesses in humans derived from a “vector,” or an organism, typically a biting insect or tick, that transmits a disease or parasite from one animal or plant to another. Examples of tick-borne diseases include Lyme Disease, Anaplasmosis/Ehrlichiosis, Babesiosis, and Powassan. Examples of mosquito-borne diseases include Chikungunya, Eastern Equine Encephalitis (EEE), Zika, and the West Nile Virus. The damage rendered by vector-borne diseases can be significant in a community, and can significantly affect quality of life, ability to work, loss of specific bodily functions, and increase life-long morbidity and mortality.

Probability

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

Windsor and the rest of The Berkshires has significant year-round outdoor recreation opportunities for both residents and visitors, including snowmobiling, hunting, 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. As mentioned above, Windsor residents and visitors have reported an increase in the presence of ticks in the community. Lyme disease is the most reported disease in Berkshire County, with the highest rates among children aged 5-9 years and adults aged 65-69 years. Additionally, Massachusetts has seen cases of once non-existent or very rare tick-borne illnesses rise, including the sometimes-fatal Anaplasmosis/Ehrlichiosis, (848 cases in 2016), Babesiosis (518 cases in 2016, significantly higher than any other state), Lyme (198 cases in 2016),

Powassan (5 cases in 2016, fatality rate is 10%), Spotted fever rickettsiosis (8 cases in 2016, 20% untreated cases are fatal), and Tularemia (5 cases in 2016).

Geographic Areas Likely Impacted

The Town of Windsor in its entirety, is already impacted by vector-borne disease especially from ticks, which are a growing concern among residents. Exposure to any outdoor area with tall grasses, standing water, and trees increases risk. Residents and visitors in Windsor can be exposed at home, or in most areas of the community.

Historic Data

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

Vulnerability Assessment

People

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

Built Environment

Vector-borne illnesses pose little threat to the built environment in a community.

Natural Environment

Increases in vector-borne illnesses can increase the likelihood that a community needs to use chemical pesticides and herbicides to control vector populations. The increased use of these products and chemicals can significantly affect the natural environment, including vegetation and other animal populations. Reducing populations of ticks and mosquitos can reduce the food source for other dependent animal populations.

Economy

The economy is somewhat susceptible to vector-borne illnesses. First, 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. Second, the more individuals in a population affected by vector-borne disease that can cause life-long morbidity or mortality will reduce the overall economic participation and output of the population in a municipality.

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 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.

Cyber Security Hazards

Hazard Profile

Likely Severity

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

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

Probability

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

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

Geographic Areas Likely Impacted

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

Historic Data

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

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

Vulnerability Assessment

People

Cyberattacks rarely have direct impacts on humans, however the disruption they cause will impact people. Personal identifying information that may be stolen can cause disruption to peoples lives, impacting their finances, security, and future. Cyber attacks that impact the utilities may cause potential harm to those who rely on electricity for life support, heat, and water.

Built Environment

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

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

Natural Environment

There is little threat to the natural environment from cyber-attacks in Windsor, due to the absence of major manufacturing, power plant, water supply, railroad, sewage treatment or other commercial or industrial installations utilizing electronic controls.

Economy

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

Future Conditions

Continued expansion and connectivity of cyber assets will lead to a continued and growing threat to businesses, governments and individuals. Local governments will need to invest in 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.

CHAPTER 4: MITIGATION STRATEGY

44 CFR § 201.6(c)(3)

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

The Town of Windsor is fortunate in having natural mitigative infrastructure in their preserved and retained forests and wetlands. Windsor's undeveloped land serves as important green infrastructure performing ecosystem services including stormwater management, flood control and reduction, soil stabilization, wind mitigation, water filtration, and drought prevention amongst other benefits not easily quantified. There are many tools available for calculating ecosystem services such as FEMA's Ecosystem Service Benefits Calculator⁷. 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 services⁸. In the Town of Windsor, the natural features and facilities are managed and maintained for their services to the community by Windsor and regional partners.

The Town of Windsor has several initiatives ongoing to mitigate hazards. Windsor is in the process of joining the National Flood Insurance Program to make insurance available to residents whose historic properties were built in or near the rivers or streams. Windsor will also enforce a floodplain zoning bylaw, a requirement for joining the NFIP participation. The Town of Windsor was never surveyed, nor mapped for the Flood Insurance Rate Maps in the past. The NFIP floodplain ordinance requires that all development, including structural and nonstructural activities, be compliant with state building code requirements for construction in the floodplain. To build upon the floodplain zoning enhancement, it is recommended that the Town of Windsor seek Certified Floodplain Management (CFM) training and credentialing for the most appropriate town employee(s).

Windsor enforces the Massachusetts State building code and has adopted the Stretch Energy Code. The Town is interested in building codes that will increase resilience to extreme winter events, such as designing roofs to withstand heavy loads of snow.

If there is an emergency, the Town of Windsor utilizes the Code Red Reverse 911 system to alert residents of hazardous conditions. Additional outreach and a concerted effort to make sure all residents are enrolled in this critical communication system is identified as a mitigation priority. In addition, Windsor's Emergency Management Director is the Chief of the Volunteer Fire Dept. The EMD is currently updating the Town of

⁷ <https://www.fema.gov/media-library/assets/documents/110202>

⁸ <http://cloud.tpl.org/pubs/benefits-LWCF-ROI%20Report-11-2010.pdf>

Windsor Emergency Operations Plan. This EOP has a Fire and Rescue and Wildfire Protection component. Target date for completion of the update to the Emergency Operations Plan is June, 2020.

By December, 2020, Windsor’s new high speed, Town-financed fiber optic Broadband network will go live, enabling fast access to the internet – that was until now, only available with outdated dial-up modems. This new service will greatly enhance communications within the community and make regional communications easier, as well.

Windsor’s stormwater system also includes a drainage system along each side of the road bed. The drainage system is pervious and vegetated, allowing for filtration of water into the ground, slowing the velocity of flow, and reducing turbidity that could ultimately damage surface water quality. The Town’s drainage ditches and culverts are regularly maintained by the town’s Highway Department.



A table of Windsor’s planned mitigation actions is included in Table 3.17 below.

Large beaver dams pose a hazard if they fail unexpectedly during a precipitation event. The Town of Windsor actively manages beaver populations by installing Beaver Deceivers and occasionally trapping and removing beavers that build dams and flood out roads.

Windsor prioritized hazard mitigation projects are based on the most pressing issues identified, or those deemed to have the greatest immediate benefit. Cost was also a factor, though subordinate to protection of life and property. Since actual project costs were unknown for the majority of Windsor’s proposed mitigation actions, the costs are estimated and categorized as follows:

High: Over \$100,00

Medium: Between \$50,000 - \$100,000

Low: Less than \$50,000

For some projects, cost is not applicable (N/A).

Through the prioritization process conducted during the Community Resilience Building Workshop, Windsor identified Actions to address severe winter storms. In addition, one-on-one interviews with key town officials as well as through discussions during MVP Committee meetings, pointed out the need to address utility vulnerabilities and protect natural systems of flood management. Additionally, the Town identified the need to address vector-borne diseases and cyber security as posing additional threats to life, property and the environment in Windsor.

The mitigation actions listed in table 3.17 include the primary mitigation action categories suggested by MEMA and FEMA:

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

Table 3.17 shows **Windsor’s Hazard Mitigation Action Plan**, that provides a roadmap for increasing resiliency. This Mitigation Action Plan will be updated annually, for internal purposes, by relevant Town departments and every five years, as required by MEMA.

Table 3.17: Hazard Mitigation Action Plan - Town of Windsor

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Education Programs – Severe winter storms	Public ed on hazardous routes (GPS directions) and winter driving conditions; signage and warning lights especially on Rte. 9	Reduce traffic hazards due to speeding, trucks using wrong roads and severe weather accidents	Low	Town of Windsor, MA DOT, Google	4-6 years/ Medium	DOT, MEMA/FEMA, Town
Education Programs - Severe Winter Storms	Shelter-in-place education/preparation; evacuation routes; local and regional short-term and long-term shelter locations	Reduce risk to human life from extreme cold/ice or prolonged power outage	Low	Town of Windsor	4-6 years/ Medium	Town
Education Programs - Severe Winter Storms	Educational programs for homeowners on flood management, ice dam prevention	Reduce risk of residential interior water damage from extreme cold temps.	Low	Town of Windsor	4-6 years/ Medium	Town
Education Program - Invasive Species, Vector borne disease	Mount public education campaign with Health Dept., at fairs/public events, newsletter, workshops w/ Notchview/other enviro groups, on vector-borne illness and invasive species identification, self-protection, signage at trails and public spaces; ash tree culling	Reduce presence of invasives; protect population from disease	Low	Town of Windsor Health Dept.; NGO and state partners	1-2 years/high	Town, DPH, MA DCR, MVP and HM
Local Plans and Regulations	Inspect & enforced Title V septic regulations	Protect water quality and public health	High	Health Dept., Town of Windsor/Homeowners	Ongoing	Loans/Grant program; CDBG

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Local Plans and Regulations	Develop plan for uncapped landfill	Protect Windsor residents from environmental hazard	High	Town of Windsor	1-3 years/Medium	Town, EPA, DEP, loans
Local Plans and Regulations - multiple hazards	Develop economic development plan to attract businesses, new residents, promote eco-tourism	Strengthen tax base, promote Windsor; enable more robust mitigation and response to hazards	Low	Town of Windsor	3-5 years/medium	Town, State
Local Plans and Regulations - multiple hazards	Work with adjacent communities on publicly available transportation options for elders/disabled/non-drivers	Enable residents to reach medical and other necessary appointments; reduce isolation	Medium	Town of Windsor, BRTA, other providers	Ongoing	Town, state
Local Plans and Regulations & Structural project - multiple hazards	Develop a backup evacuation route for Route 9, in event that it is impassable; MA DOT needs to repave rte.9	Increase resiliency and safety for Windsor residents	Medium	Town of Windsor	4-6 years/low	Town, MA DOT
Local Plans and Regulations - Flooding	Adopt Floodplain Bylaw per MA DCR Flood Hazard Mgmt, Office of Water Resources; Enact flood hazard mitigation strategies	Prevent further development in flood hazard areas; protect water quality in rivers, streams and ponds	Low	Town of Windsor	1-3 years/Medium	Town funding
Natural Systems Protection - Drought	Encourage private well testing by offering free kits to residents	Increase safety of water supply and public health	Low	Town of Windsor Health Dept.	1-2 years/medium	DEP, DPH, others
Natural Systems Protection - Invasive species; severe weather	Investigate solutions/hold workshops on natural fences, slope stabilization, native plantings, invasives control and flood/ wind mitigation	Multiple Hazard reduction including landslide, invasive species, wind and storm damage	Low	Town of Windsor	Ongoing	Town, Notchview and other Enviro. NGO's, MA Riverways

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Natural Systems Protection - multiple hazards	Engage with state, nonprofits and other owners of forest lands on trail maintenance, signage needs, habitat protection, forestry mgmt. practices; invasive control, etc.	Enhance natural environmental assets	Low	Town of Windsor, MA DCR, Notchview, WRWA, etc.	Ongoing	Town, State, Notchview, public
Natural Systems Protection- Drought	Continue using Town-developed beaver control tools and methods to keep beaver populations stable	To reduce or eliminate risk of flooding of roads, yards and houses	Low	Town of Windsor	Ongoing	Town funding, MSPCA
Preparedness and Response Actions - Multiple hazards	Support creation of Town-owned backup water supply at springhouse, in case residential wells dry up	Improve ability to withstand extended drought	Medium	Town of Windsor	4-6 yrs. Medium	Town, DEP
Preparedness and Response Actions - All Hazards	Recruit and train additional first responders	Improve resilience to multiple hazards	Medium	EMD/Fire, Police, Regional EM	1-2 years/high	Town, State, Foundation
Preparedness and Response Actions - All Hazards	Identify historic structures, businesses and critical facilities located in hazard-prone areas, including floodplains and dam failure inundation areas. Develop plan for protecting historic assets	Protect property	Low	Town of Windsor, MEMA, Massachusetts Historical Commission	4-6 years/ Medium	Town

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Preparedness and Response Actions - All Hazards	Survey residents on backup power availability; Establish group buying program among municipality/residents/2 stores in Town for back up generators	Increase resilience to power outage due to multiple hazards; Continuity of operations for critical facilities and businesses	Medium	Town of Windsor; residents	1-2 years/low	Town/residents
Preparedness and Response Actions - All Hazards; cyber security	Conduct regular wellness checks with isolated residents including off-grid, families with young children, frail elder residents	Increase safety among Windsor residents	Low	Windsor PD	Ongoing	Town
Preparedness and response actions - Severe weather, hurricanes, etc.	Formalize emergency preparedness and homeowner education relative to severe storm and other potential hazards	Improve hazard response capabilities.	Low	Town of Windsor	4-6 years/ Medium	Town
Preparedness and Response Actions - Flooding	Develop Town Hall as full Shelter with accessible entrance/routes, shower, backup generator; Consider Notchview as backup shelter site	Improve emergency preparedness and hazard response capabilities.	High	Town of Windsor	5-15 years/ Medium	Town, USDA, loans
Preparedness and Response Actions - Wildfire	Enroll in National Flood Insurance Program	Enable homeowners and renters to protect property and recoup losses from floods both in and out of floodplain areas	High	Town of Windsor	1-2 years/ High	Town funding,

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Preparedness and Response Actions - Winter Storms, Severe Storms, Hurricane	Conduct Emergency Drills/ Table Top exercises with Police, Volunteer Fire dept and regional first responder	Increase preparedness and safety procedures	Low	EMD	1-2 years/High	Homeland Security/FEMA
Structural Project - All Hazards	Work with utility companies to ensure power lines are clear of branches in wind and snow prone areas	Ensuring the power lines are clear will enable electricity to continue to flow to houses during a disaster.	High	Town of Windsor, Utilities	Ongoing	Town, Utilities
Structural Project - All Hazards	Investigate wind turbines to capitalize on high elevation winds	Improve resilience in face of hazards for consistent power supply	High	Town of Windsor	4-6 years/Medium	Town/utility
Structural Project - Flooding	Replace first culvert under the bridge on Flintstone Road	Eliminate road flooding and increase safety for residents	High	Town of Windsor	Immediate/ High	Town funding, FEMA, DER, MA DOT
Structural Project - Flooding, landslide	Install enlarged culvert at 2nd stream crossing bridge on Flintstone Road and regrade road surface	Eliminate road flooding and ease road maintenance costs	High	Town of Windsor	1-2 years/ Medium	Town funding, MassDOT
Structural Project - Severe Storms	Replace culvert on Cheshire Road with larger unit	Improving drainage to reduce the risk of flooding and reduce the cost of road maintenance	High	Town of Windsor	1-3 years/ Medium	Town funding, FEMA

Category of Action	Description of Action	Benefit	Cost	Implementation Responsibility	Timeframe / Priority	Resources / Funding
Structural project - Preparedness & Response	Develop list and map locations of bridges, culverts and other critical infrastructure to address issues systematically	Increase ability to manage and maintain critical infrastructure	Medium	Town of Windsor; BRPC	1-2 years/high	Town, MVP or HM funds
Structural projects - Drought & Fire	Develop additional fire ponds in event of forest fire	Increase resiliency and safety for Windsor residents	Medium	Town of Windsor	4-6 years/low	Town
Structural projects - All Hazards	Lobby for full complement of cell towers to gain town-wide coverage; enhance Town connection to state Radio tower;	Increase communications capability and safety of residents	High	Town of Windsor, cell providers	4-6 years/medium	Town, Cell providers
Structural projects - All Hazards	Work with utilities on tree trimming, negotiate allowing fiber optic on poles; ID areas for power line burial as feasible.	Increase resilience to power outage due to multiple hazards; Continuity of operations for critical facilities and businesses	High	Town of Windsor, utilities	Ongoing	Town, FEMA

CHAPTER 5: PLAN ADOPTION

44 CFR § 201.6(c)(5)

This plan has been formally adopted by the Select Board of the Town of Windsor.

Insert copy of official document

DRAFT

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, by which Windsor 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 Windsor will officially review needed updates for the Windsor HMCAP on _____ basis. The Municipal Vulnerability Preparedness Committee members, acting in their official Town capacities, will maintain and update the mitigation action tables, complete site visits, produce reports of completed or initiated mitigation actions, research and document new disaster information and participate in resiliency- and mitigation-related initiatives available to the region, to incorporate into the next plan revision.

Annual review is scheduled to occur _____. Under the leadership of the Co-Chairs, the Windsor Hazard Mitigation Planning Committee will track updates based on completed mitigation actions, new development, changing problem areas, with input from residents and others.

Any updates to the Windsor HMCAP will be shared with Berkshire Regional Planning Commission, to maintain county-wide GIS and other data.

In reaching out to the residents and neighbors of Windsor, the Windsor Municipal Vulnerability Preparedness Committee began building a network of interested residents that can participate in the next required update. While the Hazard Mitigation Plan must be updated every five years, Windsor will begin the process of organizing and identifying funding for the plan update, every 3.5 years?

Integration in Future Planning

§201.6(c)(4)(ii)

This HMCAP will be used in all future planning efforts in the Town of Windsor. While the Town of Windsor has developed no recent Town-wide plans, they are in the process of developing a Capital Asset Management plan during 2020. The Town of Windsor has committed to integrating this Hazard Mitigation and Climate Adaptation Plan into any new plans developed going forward. The final Windsor HMCAP will be made publicly -available on the Town of Windsor and BRPC websites for reference and comment. Any regional plans developed by BRPC or the Commonwealth should refer to this Windsor Hazard Mitigation and Climate Adaptation Plan to ensure consistency with the vision for community resilience to hazards.

APPENDICES

APPENDIX A: MEETING DOCUMENTATION - Meeting Notes, Attendance Sheets, Meeting Notices

APPENDIX B: COMMUNITY RESILIENCE BUILDING MATRICES

APPENDIX C: WINDSOR CAPABILITY ASSESSMENT WORKSHEET

APPENDIX D: REQUEST FOR COMMENT FROM REGIONAL PARTNERS AND JURISDICTIONS

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APPENDIX A: MEETING DOCUMENTATION

Meeting Notes:

Windsor HAZARD MITIGATION/MVP KICK OFF MEETING
September 17, 2019
5:30PM Windsor Town Offices
MEETING NOTES

In Attendance: M.Tirrell, D.McNally, G.Roy, J.Denno, S.Eastwood, M.Scully, M.Volk, J.Caffrey
A.Egan & C.Massa for BRPC

BRPC reviewed the requirements of the Hazard Mitigation and MVP Programs, including:

Funding MVP planning grant to create a combined Hazard Mitigation & Climate Adaptation Plan

Benefits of having two plans – grants you can apply to

Mentioned Pittsfield action grant

Question from Committee: when can we apply for the grants? – discussion on completing the plans, and timeline to apply/when the next round opens

Handouts:

Went over the Few Key Words sheet

Overview of MVP planning process sheet

Went over proposed timeline - Complete the draft plan by March, including Committee review

Overview of the MVP workshop and options for the workshop (1 or 2 days), total of 6-8 hrs depending

Worksheet: Hazards with greatest impact/prioritization exercise

Workshop planning discussion:

Looking at calendar – discussion of timing -- a weekend or evening ?

Clarified that the workshop is typically by invite-only, but citizens are welcome to walk in too

Workshop location: Town Hall (across the street from Town offices) – larger room with stage

Committee selected the 3rd and 10th of December for workshop dates and 5th and the 12th as snow dates, to run from 5:30 to 8:30 p.m. on both nights.

Miscellaneous notes:

The planning committee would like tasks as “homework” – given FEMA worksheets
Jim (TTOR) and Doug (Select Board Chair) voted co-chairs of the HMCAP Committee
Over a 1000 culverts in Windsor, per John Denno, Highway Supt.

No railroad tracks

Everyone shops for groceries in Pittsfield

Magnitude of winter events high because of car accidents on icy roads mostly

Irene was a rain event and Sandy was a wind event for Windsor

Did not have ticks until recently

Standing question: is it an online application for action grants? (Answer: yes)

Regional Plans (copies) given to BRPC to Review for inclusion in Windsor HMCAP

Westfield River Wild Scenic Committee did a regionwide plan, and several Trustees of Reservation Notchview Plans, a Wildlife Corridor Study
and other plans exist, all related to natural resources

No Town Master Plan

Town is in the process of creating a Capital Asset plan – received a community compact grant – the select board will be looking at tool for long
term capital planning – fiscal and budget planning

Zoning, Land Use, Economy

Will be going to a special town meeting for zoning change for large scale industrial development, other than that it is a one zone town

Have a lot of people who work from home

They have proposal for large scale marijuana cultivation

Have small scale agriculture – landscape plants, bees, maple syrup, eggs

Invasive Species

Significant and urgent emerald ash borer problem – Significant loss of trees all over forested areas; actively cutting down ash trees already
damaged

Japanese knotweed – gets into the banks of the river and doesn’t have roots to provide support if on riverbanks causing streambank instability –
knotweed is in the rivers upstream from Windsor so there is concern that it will come downstream

They have a phragmites issue along the road, have bamboo everywhere as well

Emergency Response and Sheltering

They have an evacuation plan that needs to be updated

They expect that people would be evacuated to Windsor from lower-lying regions

They have a major trucking route through town that is also main evacuation route

The **fire station** is the Town Emergency Ops Center, is listed as shelter on the CEMP – there is a kitchen and shower facility, backup power generator too

Windsor would like to turn the town hall to a “full” shelter and add a generator and shower - there is already a kitchen.

There’s a generator in the hut for the new fiber network being installed; Windsor will be having a broadband sign up session – informational Communication will be continued in the 4 main municipal buildings

Windsor uses Code Red with Dalton and Hinsdale

Cyber Security

Windsor has updated and backed up files to minimize vulnerabilities

Windsor is building their own fiber network – will be done in early 2020

Committee started making map revisions, using the Critical Facilities and Areas of Concerns map marking spots recently affected by storm events/hazards:

Blue for flooding

Brown for beavers

Purple – wind and ice

Ice and wind on North St to Richmond hill road

It would be a major issue if Rte 9 was shut down - Shaw road needs to be an alternative route

Elevation increases at back Dalton road and ice is a major issue above that elevation

Flooding on river road – no armoring currently

Landslide is black on river road

Pink high hazard dam

Bridge culvert crossing at Worthington Rd and Stearns road is at risk

Pink highlighter – bridge on old route 9 high risk

Culvert on Cheshire Road at risk

Section of Highstreet Road is not plowed between Berkshire trail and old route 9 – there are houses in this area

Bates Road – not passable in winter (circled)

Nobody’s Road (circled) not passable in winter

Patterson road around the corner to back Dalton road is not passable

Culvert on Manahan road (highlighter) floods during regular rains – beaver dams above that area – working on getting a grant for the beaver deceiver where the pond is higher than the deck of the new bridge on Monahan

Savoy Hollow road is not passable in winter – also has several culverts that are under-capacity

Tirrell road closed beyond the town line

Small culverts up near Windsor Pond (private roads not under control of the town) – would be an issue to evacuate people from this area

Rtes 9 and 8A are the major evacuation routes – everything else has limited speed limits or dirt roads

Dam on lower road was taken out

Flooding was a 3 in frequency because of the beavers

Windsor frequently loses power, but Eversource has done some maintenance – there are ash trees along where there are powerlines (many ash trees in town) 2000 ash trees within 75 feet of trail system in Notchview

Rte 9 was flooded during Irene, even winds from Sandy were an issue – many trees down

Windsor was not shut down more than a week after Rte 9 flooding after Irene

Drought and Fire

Everyone in town is on their own well, no public water supply, a lot of people had to drill new wells because they dried up, no particular part of town

There was an unofficial drought before 2000 where wells were drying up – we could get information on how many wells dried up from the well driller, contact Henshaw (get contact information)

Generally this forest type is not prone to fires, however much of the town is forest and it could be significant

They have had very small fires – burn season permits

They had more calls for fire during the 2016-2017 drought

Landslides

Main Dalton Road is prone to landslides

Last landslide was 2011 during Irene – does not impact households

Extreme temperature/change in temperature

Temperatures can get to 27 below at this elevation

More 90 degree days

Next meeting scheduled October 8th 2019

Windsor HAZARD MITIGATION/MVP MEETING

October 8, 2019

5:30PM Windsor Town Offices

MEETING NOTES

In Attendance: Mark Volk - Resident, Past ConComm. & Civil Engr., Jim Caffrey-TTOR, Douglas McNally - Select Board, Glenn Roy - Con Comm, Michael Tirrell -(Ret'd) Fire Chief, David Zink - Planning Board, John Denno - Highway Supt., Kip Buoymaster - Police Dept., Scott Eastwood - Fire Chief & EMD and A.Egan and P.McDonough for BRPC

1. Discussion: Municipal Vulnerability Preparedness & Hazard Mitigation Planning proposed Mission Statement:

a. Windsor Mission Statement and Goals Development: (suggested language to be reviewed by Committee)

“To identify risks and sustainable cost-effective actions to mitigate the impact of natural hazards (and climate change (?)) in order to protect the life, property and the environment of Windsor. “ The following goals are set forth to achieve this mission: (list 1-6)

Discussion: Process is not just planning for big weather event impact on critical facilities, but gradual process of climate change impacts to residents and Windsor micro-climate - mountain environment, native species preservation from severe weather, invasive species, vector borne illness (e.g. ticks, mosquitos) pollinator gardens, etc. Recommend use of “climate change” or “adaptation” language in the Mission statement, including changing the title of Report to **“Windsor Hazard Mitigation & Climate Adaptation Plan.”**

b. MVP Workshop Planning (December 3rd and 10th, 5:30-9pm, Snow dates 5th and 13th registration 5-5:30pm) in Town Hall (not Town Offices)

- Identify Stakeholders/Invitees (See spreadsheet)
- Logistics:
 1. Roles and Responsibilities (Assign attendees to tables, color-coding to ensure good mix)
 2. Reserve Space for 20-40 people, chairs and tables in Town Hall (not Town Offices) Food: Sangars & Friendly Fred's to cater
 3. Send Invitations (Template handout, Committee to finish as homework)

4. Assign note takers – high school students? Others? (Doug)
- c. Reviewed and Updated Critical Infrastructure & Hazard Map – BRPC to send all maps in .pdf format to Committee members for additional marking up.

Reviewed culverts and bridges - Nobody's Road (Potash), a lot of beaver activity and b-dams., Icing on fieldstone near narrow bridge, 2100' elevation is constant icing, anything over 1600 is regular icing. Dalton Hardwoods site, microclimate (map extent) see Spruce fir trees - indicator species – stop where old rt9 meets new rte.9 on east side and on 8a (nr Moran property); North St and Main Dalton Rd. (Cold spot); During 1958 Hurricane – all bridges on tributaries were taken out, from Windsor to Westfield!

2. Other business
 - a. Capability Assessment Sheet 4.1, Homework (Handout to committee)
 - b. Request for Repetitive Loss Structure Data from FEMA, attn. Joy Duperault. (McNally to print out on town letterhead and send) Copy BRPC when response received.
3. Schedule next meeting – **Oct 29; 5:30-7 p.m. at Town Offices**
4. Adjourn

Windsor HAZARD MITIGATION/MVP MEETING

October 29, 2019

5:30PM Windsor Town Offices

MEETING NOTES

1. In Attendance: Doug McNally, Kip Buoymaster, John Denno, Scott Eastwood, Glenn Roy

2. Discussion: Municipal Vulnerability Preparedness and Hazard Mitigation Planning

- a. Windsor Mission Statement and Goals Development: Tentatively ok, will be discussed further as we go along
- b. MVP Workshop Planning (December 3rd and 10th, 5:30-9pm,

- Review Stakeholders/Invitees (See spreadsheet) Who is missing?! Who will be offended if not invited?

Added: Gola (ConsComm) DCR Camp; Paul Hoag former Fire Chief; Dalton Fire District (add) and Pete Menard – send via mail; Charlie Sturtevant Tree Farmer, Asst Fire Chief and lifelong resident; Mike Tirrell too, Steve & Val Bird (see Pittsfield Communications); Tim Crane (Finance Committee and Zoning); Steve Lord – ret'd State Police (look up); Berkshire Sno Seekers - Don Allard (Capt on FD) and Lila Howard is an EMD

- c. Review invite flyer – McNally to send BRPC Town letterhead to scan and put invite on; MVP committee members to make personal follow up calls for rsvps; Snow dates 5th and 13th registration 5-5:30pm) in Town Hall (not Town Offices!) PUT SNOW DATES ON FLYER!! Send Invitations by email and u.s. mail on Tuesday, 11/12 (3 weeks prior)

c. Logistics/Responsibilities for the Workshop:

1. Committee (McNally) will order food (sandwiches/samosas) from Friendly Freds and Sangar's and team/BRCP will set up Town Hall space for 20-40 people, at 4-5 tables, 5+ chairs per table. BRPC facilitators at each table, with maps, markers, sticky notes supplies provided
2. Assign or invite note takers – Margaret or Joe Birchfield, Sue Jacobs(?) or Janet Sadlo perhaps?
3. Discussed the required Public review session to present Workshop Results, including completed Hazard Matrices and Priority Actions:

Possibly in conjunction with highly anticipated Broadband Meeting on Saturday 9-11a.m. on Jan 11th?? Should draw large crowd (150 people). MVP Committee to consult with Broadband Committee and

Whip City (vendor) to see if MVP can use first part of the meeting to explain MVP process and review findings.

3. Other business
 - a. Request for Repetitive Loss Structure Data to FEMA sent ? McNally confirmed letter was sent. BRPC requested notification when reply received.
4. Schedule next meeting – November 19; 5:30-7:00 p.m.
5. Adjourn 6:15

**Windsor HAZARD MITIGATION/MVP MEETING
November 19, 2019
5:30PM Windsor Town Offices**

Meeting Notes

In attendance: Sgt Buoymaster, Doug McNally, Marc Volk, Michael Tirrell, Glenn Roy, John Denno, P McDonough for BRPC

1. Discussion: Municipal Vulnerability Preparedness Workshop
 - a. MVP Workshop Planning (December 3rd and 10th, 5-8:30pm, registration 5-5:30pm) Change letter time slot. Send flyer in mail to those with no email addresses. (Call Doug for consult on who those folks are)
 - Confirm invite list and sender for Wednesday 11/20 – Reviewed letter, handed out flyer for posting;
 - Q from BRPC: *How do we get notice out in case snow cancels? Who makes the call?* Consult with Committee by email; send weather watch email prior, if necessary.
 - Review Community Resilience Building process and materials (matrices) Asking Mrs Roy and Mrs. Denno, Holly and Margaret (Librarian) as note takers
 - Pictures of problem areas?? Requested photos of storm events and bridges/culverts etc.

- Criteria for assigned MVP workshop tables = Based on rsvp lists, send to Committee for assigning to up to 4 tables. Selectboard approved funds for purchasing food at Sangars and Friendly Freds
- Review/decide on maps for walls and MVP workshop tables –
 - Critical facilities lrg and small
 - NLCD Land cover on table and wall (NOT up to date, use LAND USE instead),
 - Topo on wall - add property lines and buildings (mark),
 - Slope stability (on wall),
 - Enviro concerns on table and wall size, beef up the key on all maps! Question: Interim well head protection area why is it *interim*?! (will research)

2. Public Session at Select Board meeting to review Workshop results **Tuesday, January 7, 2020** at 5:30 at Town Hall
3. Adjourned at 6:30

Attendance Sheets:

Sign In

Windsor Kick-Off Meeting		17-Sep-19		
#	Name	Affiliation/Title	Email	Phone
1	Michael W. Tinnell	Fire Chief/Ret. Police Chief/Ret.	MTinnell401@ verizon.net	413-441- 3696
2	Doug McNally	Select Board	D.Mcnally@windsor.mass.gov	413-522-4337
3	GLENN ROY	Conservation Com	roy51495@verizon.net	413 329 6254
4	John Dennis	Highway Superintendent	highway@windsor.mass.gov	413-344-7609 413-684-3780
5	Scott Eastwood	Fire Chief / EMD	Firechief@windsor.mass.gov	cell 413 441 5091 off. 413 684-3736
6	Mabeline Scully	Town Clerk	windsortownclerk@gmail.com	910-620-062
7	MARE VOK	RESIDENT	mvok@foresightland.com	413-899-1560
8	Jim Caffrey	Trustees of Res	jcaffrey@thetrustees.org	413 684-2182
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Sign In

Windsor 10/8/19 Meeting -- Sign In Sheet

Name	Agency or Town Affiliation
MARC VOLK	RES. ASST CON GRM, CIVIL ENGR
Jim Caffrey	Trustees of Reservations
Douglas McNamee	Select Board
Glen H Roy	Conservation Commission
Michael Tierney	Fire Chief Retired
DAVID ZINK	PLANNING BOARD
John Denno	Highway Superintendent
Kip Boatmaster	Police Department
Scott Eastwood	Fire Chief - Emergency Manager

Sign In

Windsor 10/29/19 Meeting -- Sign In Sheet				
#	Name	Affiliation/Title	Email	Phone
1	David McNALLY	Select Board		
2	W. Pagano	Police Dept		
3	John Deniro	Superintendent		
4	Scott Eastwood	Fire Chief / EMD		
5	Glenn Roy	Conservation Com		
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Sign In

Windsor 11/19/19 Meeting -- Sign In Sheet				
#	Name	Affiliation/Title	Email	Phone
1	Kip Buoymaster	Police Dept	Buoymaster, kip@gmail	413-344-6871
2	Doug/As M (VA11)	Select Board	dmenally@windsorvt.com	413-822-9337
3	Michael Tamm	Katonia Fire Dept	mtamm40@vernet.net	413-441-3696
4	Gleam Roy	Conservation Comm	royg1495@verizon.net	413-654-4887
5	John Devino	Superintendent	highway@windsorvt.com	413-684-0780
6	MARC VOLK	RESIDENT / ENGINEER	MVOLK@Foresightland.com	689-3355
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Windsor Community Resilience Building Workshop, Part I
Windsor Town Hall -- December 3, 2019 -- 5:00-8:30 p.m.

#	Name	Affiliation(s)
1	Doug McINTYRE	SELECT BOARD
2	Mike TINNELL	Fire Chief / RETIRED Police Chief / RETIRED
3	DAVID J Melle	Town Windsor
4	GLENN ROY	CONSERVATION COMMISSION
5	Leslie Reed	Resident
6	PETER M. REED	RESIDENT
7	Jim Caffrey	The Trustees
8	Kim Tobin	Select board
9	Don Allard	Fire Dept / Snowmobile Club
10	Val Kohn	Resident / Friends of Windsor
11	John Denno	Resident / Highway
12	Colleen Denno	Resident

#	Name	Affiliation(s)
26	Janet SADLO	Select Board
27	Kip Buoymaster	St. Police
28	Jessica Buoymaster	OUTReach C.O.A
29	Stu Beshoff	Green Committee
30	STEVE THILBRICK	MINISTRY, WEST CH CHURCH
31	Sue Jacobs	WINDSOR COA
32	Deb Balmuth	Friends of Windsor
33	May Raj	WINDSOR RES.
34	Joe Birchfield	Concerned Citizen
35	Margaret Birchfield	Library -
36	MARC VAUC	RESIDENT
37	Scott Eastwood	Fire Chief / END
38	Scott Gen	Fm Com

Windsor Community Resilience Building Workshop, Part II
Windsor Town Hall -- December 10, 2019 -- 5:00-8:30 p.m.

Name	Affiliation(s)
Doug/McMurry	Select Board
Din/Melle	Windsor Mg.
Jim Caffrey	Trustees
Stu Besnoff	Green Committee
Leslie Reed	Friends of Windsor
Michael Turrell	Police Chief Retired
Glenn Roy	Conservation Comm
Mary Roy	Scribe
Colleen Dennis	Scribe
John Dennis	Highway Super
Kip Bugmaster	Police
Jessica Bugmaster	COA

Windsor Community Resilience Building Workshop, Part II
Windsor Town Hall -- December 10, 2019 -- 5:00-8:30 p.m.

Name	Affiliation(s)
MARC Vork	MVP Committee
Janet Sadelo	SB
Don Allard	Fire Dept. / Snowmobile Club
- Scott Rogas	Finance Committee
Margaret Bird & Feb	Library
Scott Eastwood	Fire Chief / EMD
Jim Clewano	Farmer

Meeting Notices:

Town of Windsor Municipal Vulnerability Preparedness Committee Meeting, September 17, 2019, 5:30 p.m. Windsor Town Offices

Town of Windsor Municipal Vulnerability Preparedness Committee Meeting, October 8, 2019, 5:30 p.m. Windsor Town Offices

Town of Windsor Municipal Vulnerability Preparedness Committee Meeting, October 29, 2019, 5:30 p.m. Windsor Town Offices

Town of Windsor Municipal Vulnerability Preparedness Committee Meeting, November 19, 2019, 5:30 p.m. Windsor Town Offices

Town of Windsor Municipal Vulnerability Preparedness COMMUNITY RESILIENCE BUILDING WORKSHOP, December 3, 5:00-8:30 p.m., Windsor Town Hall

Town of Windsor Municipal Vulnerability Preparedness COMMUNITY RESILIENCE BUILDING WORKSHOP, December 10, 5:00-8:30 p.m., Windsor Town Hall

Town of Windsor Select Board Meeting – Public Review Session, Municipal Vulnerability Preparedness Community Resilience Building Workshop Results, 7:00 p.m. Windsor Town Hall

APPENDIX B: WINDSOR COMMUNITY RESILIENCE BUILDING RISK MATRICES

Community Resilience Building Risk Matrix				www.CommunityResilienceBuilding.org		
H-M-L Priority for action over the Short or Long term (and Ongoing)				Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)		
V = Vulnerability S = Strength				Ice, Wind, Severe Storms and Drought		
Features	Location	Ownership	V or S	Priority	Time	
				H - M - L	Short Ongoing	Long Ongoing
Infrastructural						
Route 9	Rte. 9 in Windsor	State	V & S	1) Coordinate with the State to address monitoring and speed in which roads are plowed and salted; 2) Repave Route 9. Route 9 has been repaved in surrounding towns, but not in Windsor. The deteriorated road will capture more moisture causing hazardous damage over the winter months.	II	O
Radio Tower - services county and has a generator that the town can also utilize	Refer to Map	State	V & S	The Commonwealth's radio is maintained and is a strength, the town could build upon this strength by improving its own equipment at this site.	M	O
Fire Ponds	Refer to Map	Firefighters Association	S	1) Maintenance 2) Windsor can benefit from the construction of additional fire ponds in areas of town that are not currently serviced by one.	M	O
Municipal Buildings	Refer to Map	Town	S	1) Establish the Town Hall as a shelter with shower, improved foundation and septic system, and generator. 2) Evaluate establishing a microgrid for critical facilities.	H	O
Windsor State Forest Dam	Refer to Map	State	V & S	The recreational area at Windsor State Forest Dam has been closed since 2008 due to financial constraints, the Town supports the plan to reopen the area to the public in the Spring of 2021 and continued maintenance.	L	O
Bridges and Culverts	Throughout Town, i.e., Old Rte. 9 Bridge	Town, State, Private	V	1) Complete an assessment, mapping and prioritization of culverts in town. 2) Maintain culverts. 3) Upsize culverts to meet stream crossing standards. 4) Assess and maintain private driveway culverts in the right of way.	II	O
Transfer Station	Route 9	Town	S	Maintain the transfer station and support the "item swap" that takes place there.	L	O
Broadband Network	Town wide	Town + hired management company	V + S	Continue the implementation and support the network maintenance.	H	O
"Discontinued for maintenance" Roads	i.e., Bates Rd, throughout town	Various	V + S	1) Encourage private landowners to maintain the roads. 2) Address the erosion from roads that can damage waterways 3) Maintain culverts.	M	L
Societal						
Senior Population	Throughout Town	N/A	V & S	1) Build affordable, safe, and centrally located senior housing possibly designed through a community-based competition. 2) Provide transportation alternatives.	H	L
Communication (communication networks)	Throughout Town	Various	S	Improve communication and ensure there are designated people and/or entities contacting residents at risk in hazardous conditions.	II	O
Windsor Now & then Newsletter	Throughout Town	Friends of Windsor	S	Continue the newsletter.	L	O
Historical Commission & Museum	Next to Town Hall & Church	Town	S	1) Maintain the museum. 2) Install climate control in the museum and take other necessary actions to protect papers and artifacts. 3) Maintain historical sites. 4) Build upon existing guides and signage.	II	S
Community Luncheon	Town Hall	N/A	S	1) Continue the community luncheon at the Town Hall for all age groups. 2) Take the opportunity while residents are gathered socially to provide speakers and education on emergency preparedness.	M	O
The Two Stores in Town	Route 9	Private	S	1) Identify disaster planning needs to ensure continuity of operations 2) Get generators, particularly for the sole source of fuel. 3) Identify needed support to keep them open.	H	O
Notchview	Route 9	Trustees	S	Establish a secondary shelter with generator at Notchview.	M	S
Mohawk Trail Woodlands Partnership	Region	N/A	S	Support, publicity, messaging	M	O
Massachusetts Forest Stewardship Program	State	State	S	Support, publicity, messaging	M	O
Home Heating	Town wide	Homeowners	S & V	Assess the number of people and which households could heat their homes without grid power.	H	S
Library	Town Offices	Town	S	Maintain the library.	L	O
Environmental						
Spruce, Fir, & Northern Hardwood Forests	Throughout Town	Various	S	1) Forest maintenance 2) Encourage and support Forest Stewardship Plans and their implementation.	M	S
Invasive Species	Throughout Town	N/A	V	1) Undergo an Ash tree culling on town property before the Emerald Ash Borer renders the wood useless and to protect power lines and people. 2) Apply for funding to mitigate invasive species and use MYP as match funds. 3) Address the spread of Japanese knotweed along waterways by ensuring that fill used for stream erosion and bridge work does not have knotted fragments or seeds.	II	S
Pests	Throughout Town	N/A	V	1) Install bait boxes 2) Seek assistance in forested land aggregation for smaller landowners to take advantage of carbon markets with forest carbon sequestration services to "keep it cold."	M	L
Beaver Dams	Throughout Town	N/A	V	Control beavers using beaver deceivers when they pose a hazard to homes or infrastructure.	H	O
Stormwater	Throughout Town	N/A	V	1) Evaluate and adopt zoning or bylaws that regulate water coming from private property and driveways when they are a certain slope and size.	H	O
State Forest	Mapped	State	S	1) Coordinate with the State, possibly through a meeting, to understand how the properties integrate with the town, what the state is doing there, and how to have a sustainable relationship. 2) Address invasive species.	M	O
Dalton Watershed Property	Refer to Map	Dalton Fire District	V	1) Ensure the area is not contaminated for Dalton residents 2) Address invasive species.	M	O
Notchview	Route 9	Trustees	S & V	1) Address invasive species.	M	O
Eugene Moran Wildlife WMA Property	Windsor	MassWildlife	S	1) Coordinate with the State, possibly through a meeting, to understand how the properties integrate with the town, what the state is doing there, and how to have a sustainable relationship. 2) Address invasive species.	M	O
MassWildlife Properties	Windsor	MassWildlife	S	1) Coordinate with the State, possibly through a meeting, to understand how the properties integrate with the town, what the state is doing there, and how to have a sustainable relationship. 2) Address invasive species.	M	O
Westfield River Watershed	Westfield Watershed	Various	S	1) Coordinate with the State, possibly through a meeting, to understand how the properties integrate with the town, what the state is doing there, and how to have a sustainable relationship. 2) Address invasive species.	M	O

Community Resilience Building Risk Matrix 				www.CommunityResilienceBuilding.org						
				Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)						
H-M-L priority for action over the Short or Long term (and Ongoing) V = Vulnerability S = Strength				ICE STORMS	POWER OUTAGE	FLOODING/HEAVY RAINS	EXTREME TEMPERATURE FLUCTUATION	DROUGHT	Priority H - M - L	Time Short Long Ongoing
Features	Location	Ownership	V or S							
Infrastructural										
Power Poles & Lines Down	Var	Eversource, Verizon	V	Report to Utility Co's; Discuss burying power lines whenever possible; Conduct Wellness Checks					M	O
Prolonged Power Outages	Var		V/S	Neighbors open homes to Neighbors; In-town Warming Spot at Town Hall; No "Full" Shelter					H	S
Well Pumps & Sump Pumps out of commission	Var		V	Consider group buying of backup Generators; Establish monitored public water source for emergency supply					M	S
Road Washouts -- Paved/Unpaved - Budget hits	Var		V	Pave select Vulnerable Roads (see below); Monitor Beaver Activity;					II	O
Roads, Culverts, Bridges damaged	Var		V	Create prioritized List of Upgrades for Roads, Culverts, Bridges					II	O
Homes flooding (basements)	Var		V	H.O. Education program on downspout diversion, rain gardens, french drains, other flood prevention/mitigation measures					I.	O
Town Owned Historic buildings	Town Ctr.	Town	V	Need Capital Improvement Plan and robust Reserve Fund					H	O
Broadband	Var	Town	S	Encourage residents to sign up for new system					H	S
Cell Tower Coverage - Spotty	Var	Town	V	Work with providers to provide additional towers; consider Plan B (town-owned tower)					L	O
Town springhouse	Town Ctr.	Town	S	Test water quality; consider/protect as a backup water source for emergencies					I.	O
Societal										
Residents Shelter in Place	Var	Town	V/S	Establish more "formal" procedures for Emergency Preparedness for homeowners, vulnerables and etc.						O
Isolated populations in parts of town	Var	Town	V	Use town website, facebook, newsletter, Community Directory, Annual Rpt. to share important info.						O
Emergency Communications -- Use Code Red		Town	V/S	Expand access to Code Red to make sure everyone is receiving notifications					M	S
Sheltering		Town	V	Conduct Feasibility Study looking at Town Hall or other as full Community Center & Overnight Shelter					H	
Vulnerable populations			V	Continue outreach to elders, veterans, disabled, etc that respects people's privacy but insures all are appropriately monitored						
Budget/Tax Base limited by low population and state law	all	Town	V	Work to attract younger homeowners; create Economic Development plan					H	L
Transportation	all	Town	V	Work with providers and neighboring communities on transportation; use VFD 4-wheel vehicle for wider purposes(?)					M	L
Aging Emergency Response Crew	all	Town	V	Recruit younger residents/neighbors to become EMT or VFD members					M	O
Economic Impacts of hazards on town budgets			V	Work thru Parks & Rec Committee and Library for outreach to young families w/Children					H	
Environmental										
Trees damaged; a lot of timber down	all	various	V/S	Proactive Tree Warden; Education on invasive insect affecting trees						I.
Local Economy	all	Town	S	Write Economic Development Plan to boost Eco-tourism, attract young Homebuyers, enhance outdoor recreation						L
Invasive Insects, Plants	all	various	V	Mount public ed campaign on protection, including signage at trails, etc., via Public Health Dept. Expos/other townwide events						L
Water Quality impacts at ponds (swimmers itch), aquife	all	Town & Owners	V	Education on well testing, make kits available (group rates), public edu on what to look for					L.	O
Impacts to wildlife, bees, farm products (maple produce)	all	Town	V	Funding to combat invasives; protect bees, mitigate loss of production; ID state resources						L
Water Quality preservation	all	various	V	Encourage regular well water testing w/Homeowners; enforce and find help with Title V septic upgrades						S
Uncapped landfill		Town	V	Seek brownfields/other funding; increase size of Town budget reserves; get estimates						S

Capability Assessment Worksheet

Jurisdiction: Windsor, Massachusetts

Local mitigation capabilities are existing authorities, policies, programs, and resources that reduce hazard impacts or that could be used to implement hazard mitigation activities. Please complete the tables and questions in the worksheet as completely as possible. Complete one worksheet for each jurisdiction.

Planning and Regulatory

Planning and regulatory capabilities are the plans, policies, codes, and ordinances that prevent and reduce the impacts of hazards. Please indicate which of the following your jurisdiction has in place.

Plans	Yes/No Year	Does the plan address hazards? Does the plan identify projects to include in the mitigation strategy? Can the plan be used to implement mitigation actions?
Comprehensive/Master Plan	No	
Capital Improvements Plan	Yes 2020	Signed Community Compact; Developing 5 Yr CIP
Economic Development Plan	No	
Local Emergency Operations Plan	Yes 2020	Being Revised by EMD
Continuity of Operations Plan	No	
Transportation Plan	No	
Stormwater Management Plan	No	
Community Wildfire Protection Plan	Yes 2020	Part of Local Emergency Ops Plan
Other special plans (e.g., brownfields redevelopment, disaster recovery, coastal zone management, climate change adaptation)	No	

Worksheet 4.1

Capability Assessment Worksheet

Building Code, Permitting, and Inspections	Yes/No	Are codes adequately enforced?
Building Code	Yes	Version/Year: Stretch Code/2018
Building Code Effectiveness Grading Schedule (BCEGS) Score		Score:
Fire department ISO rating		Rating:
Site plan review requirements	Yes	Zoning Bylaws
Land Use Planning and Ordinances	Yes/No	Is the ordinance an effective measure for reducing hazard impacts? Is the ordinance adequately administered and enforced?
Zoning ordinance	Yes	
Subdivision ordinance	No	
Floodplain ordinance	No	Joining NFIP 2020; draft bylaws to be developed
Natural hazard specific ordinance (stormwater, steep slope, wildfire)	No	
Flood insurance rate maps	No	
Acquisition of land for open space and public recreation uses	No	Have Town Park, Notchview, Windsor State Park, Windsor Jams, Chapter and other State Lands
Other		
How can these capabilities be expanded and improved to reduce risk?		

Worksheet 4.1
Capability Assessment Worksheet

Administrative and Technical

Identify whether your community has the following administrative and technical capabilities. These include staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions. For smaller jurisdictions without local staff resources, if there are public resources at the next higher level government that can provide technical assistance, indicate so in your comments.

Administration	Yes/No	Describe capability Is coordination effective?
Planning Commission	Yes	Regularly reviews and updates codes
Mitigation Planning Committee	Yes	Newly formed for MVP process
Maintenance programs to reduce risk (e.g., tree trimming, clearing drainage systems)	Yes	Highway Dept./Culvert cleaning & mowing
Mutual aid agreements	Yes	Dalton and Hilltowns
Staff	Yes/No FT/PT-	Is staffing adequate to enforce regulations? Is staff trained on hazards and mitigation? Is coordination between agencies and staff effective?
Chief Building Official	Yes	Part-time
Floodplain Administrator	No	
Emergency Manager	Yes	
Community Planner	No	
Civil Engineer	No	Contract with Hill Engineering as needed
GIS Coordinator	No	
Other		

1 Full-time (FT) or part-time (PT) position

Worksheet 4.1

Capability Assessment Worksheet

Technical	Yes/No	Describe capability Has capability been used to assess/mitigate risk in the past?
Warning systems/services (Reverse 911, outdoor warning signals)	Yes/No	Reverse 911 is ltd to voluntary enrollment
Hazard data and Information	Yes	MVP & Hazard Mitigation report in process
Grant writing	Yes	Select Board
Hazus analysis	Yes	In process
Other		
How can these capabilities be expanded and improved to reduce risk?		

Worksheet 4.1
 Capability Assessment Worksheet

Education and Outreach

Identify education and outreach programs and methods already in place that could be used to implement mitigation activities and communicate hazard-related information.

Program/Organization	Yes/No	Describe program/organization and how relates to disaster resilience and mitigation. Could the program/organization help implement future mitigation activities?
Local citizen groups or non-profit organizations focused on environmental protection, emergency preparedness, access and functional needs populations, etc.	Yes	Friends of Windsor, Green Communities, COA, Age Friendly Berkshires
Ongoing public education or information program (e.g., responsible water use, fire safety, household preparedness, environmental education)	Yes	Town website and newsletter, new educational programs recommended in Haz Mit Climate Adaptation Plan
Natural disaster or safety related school programs	Yes	Central Berkshire Reg'l School District
StormReady certification	No	
Firewise Communities certification	No	
Public-private partnership initiatives addressing disaster-related issues	No	
Other		
How can these capabilities be expanded and improved to reduce risk?		

Financial

Identify whether your jurisdiction has access to or is eligible to use the following funding resources for hazard mitigation.

Funding Resource	Access/ Eligibility (Yes/No)	Has the funding resource been used in past and for what type of activities? Could the resource be used to fund future mitigation actions?
Capital Improvements project funding	Yes	Robust Stabilization Fund
Authority to levy taxes for specific purposes	Yes	Yes with voter approval
Fees for water, sewer, gas, or electric services	n/a	
Impact fees for new development		
Storm water utility fee	n/a	
Incur debt through general obligation bonds and/or special tax bonds	Yes	Annual Audit
Incur debt through private activities	No	
Community Development Block Grant	No	
Other federal funding programs	No	
State funding programs	Yes	Broadband, small bridge, STRAP, MVP, Hazard Mitig.
Other		
How can these capabilities be expanded and improved to reduce risk?		

APPENDIX D: REQUEST FOR COMMENT FROM REGIONAL PARTNERS AND JURISDICTIONS

Correspondence Draft:

To (Town Manager/Select Boards of Dalton, Cummington, Savoy, Peru)

The Town of Windsor has drafted a Hazard Mitigation and Climate Adaptation Plan which is attached for your review and comment. The Town of Windsor will incorporate your comments when the Plan is reviewed and revised during the Spring, 2020. Please endeavor to return comments by (date).

Thank you,

Town of Windsor Select Board

Town of Windsor Municipal Vulnerability Preparedness Committee

[Attachment: Windsor Hazard Mitigation and Climate Adaptation Plan]

Correspondence Received: