

Town of Orange Hazard Mitigation Plan



Photo credit: Greenfield Recorder

Adopted by the Orange Select Board on January 27, 2021
Approved by FEMA on February 4, 2021

Prepared by

Orange Hazard Mitigation Committee

and

Franklin Regional Council of Governments

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Greenfield, MA 01301

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This project was funded by grants received from the Massachusetts Emergency Management Agency (MEMA) and the Federal Emergency Management Agency (FEMA).



U.S. Department of Homeland Security
FEMA Region I
99 High Street, Sixth Floor
Boston, MA 02110-2132

FEMA

February 5, 2021

Samantha C. Phillips, Director
Massachusetts Emergency Management Agency
400 Worcester Road
Framingham, Massachusetts 01702-5399

Dear Director Phillips:

The U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA) Region I Mitigation Division has approved the Town of Orange Hazard Mitigation Plan effective **February 4, 2021** through **February 3, 2026** in accordance with the planning requirements of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), as amended, the National Flood Insurance Act of 1968, as amended, and Title 44 Code of Federal Regulations (CFR) Part 201.

With this plan approval, the jurisdiction is eligible to apply to the Massachusetts Emergency Management Agency for mitigation grants administered by FEMA. Requests for funding will be evaluated according to the eligibility requirements identified for each of these programs. A specific mitigation activity or project identified in this community's plan may not meet the eligibility requirements for FEMA funding; even eligible mitigation activities or projects are not automatically approved.

The plan must be updated and resubmitted to the FEMA Region I Mitigation Division for approval every five years to remain eligible for FEMA mitigation grant funding.

Thank you for your continued commitment and dedication to risk reduction demonstrated by preparing and adopting a strategy for reducing future disaster losses. Should you have any questions, please contact Melissa Surette at (617) 956-7559 or Melissa.Surette@fema.dhs.gov.

Sincerely,

Paul F. Ford
Acting Regional Administrator
DHS, FEMA Region I

PFF:ms

cc: Sarah White, State Hazard Mitigation Officer, MEMA
Jeffrey Zukowski, Hazard Mitigation Planner, MEMA
Beth Dubrawski, Hazard Mitigation Contract Specialist, MEMA



Town of Orange
Office of the Board of Selectmen
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CERTIFICATE OF ADOPTION

Town of Orange, MASSACHUSETTS

BOARD OF SELECTMEN

**A RESOLUTION ADOPTING THE Town of Orange
HAZARD MITIGATION PLAN**

WHEREAS, the Town of Orange established a Committee to prepare the 2020 Hazard Mitigation plan; and

WHEREAS, the Town of Orange Hazard Mitigation Plan contains several potential future projects to mitigate potential impacts from natural hazards in the Town of Orange, and

WHEREAS, a duly-noticed public meeting was held by the BOARD OF SELECTMEN on Date 11/17/2021, and

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

NOW, THEREFORE BE IT RESOLVED that the Town of Orange BOARD OF SELECTMEN adopts the 2020 Hazard Mitigation Plan, in accordance with M.G.L. Ch. 40.

ADOPTED AND SIGNED this Date 11-18-2021.

Name(s) Jane Peirce

Title(s) Board of Selectmen, Chair

Signature(s) [Signature]

ATTEST

[Type here]

Acknowledgements

The Orange Select Board extends special thanks to the Orange Hazard Mitigation Planning Committee as follows:

James Young, Orange Fire Chief & Emergency Management Director

Jane Pierce, Board of Selectmen

Mercedes Clingerman, Planning Board

Colin Killay, Highway Superintendent

Ken Wysk, Water Department Superintendent

Phil Harris, Building Inspector

Brenda Anderson, Representative for local businesses

Glen Ohlund, Franklin County Housing & Redevelopment Authority

Gabe Voelker, Town of Orange Administrator

Leanna Dennis, Town of Orange Administrative Assistant

Alec Wade, Director of Community Development

The Orange Select Board offers thanks to the Massachusetts Emergency Management Agency (MEMA) for developing the 2018 Massachusetts Hazard Mitigation and Climate Adaptation Plan which served as a resource for this plan and to staff for reviewing and commenting on the draft plan and to the Federal Emergency Management Agency (FEMA) for making the funds available and for the development of the Local Mitigation Planning Handbook, which provides a thorough overview of the Mitigation Planning process.

Franklin Regional Council of Governments

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1 PLANNING PROCESS

1.1 INTRODUCTION

The Federal Emergency Management Agency (FEMA) and the Massachusetts Emergency Management Agency (MEMA) define Hazard Mitigation as any sustained action taken to reduce or eliminate long-term risk to people and property from natural hazards such as flooding, storms, high winds, hurricanes, wildfires, earthquakes, etc. Mitigation efforts undertaken by communities will help to minimize damages to buildings and infrastructure, such as water supplies, sewers, and utility transmission lines, as well as natural, cultural and historic resources.

Planning efforts, like the one undertaken by the Town of Orange, make mitigation a proactive process. Pre-disaster planning emphasizes actions that can be taken before a natural disaster occurs. Future property damage and loss of life can be reduced or prevented by a mitigation program that addresses the unique geography, demography, economy, and land use of a community within the context of each of the specific potential natural hazards that may threaten a community.

Preparing, and updating a hazard mitigation plan every five years, can save the community money and facilitate post-disaster funding. Costly repairs or replacement of buildings and infrastructure, as well as the high cost of providing emergency services and rescue/recovery operations, can be avoided or significantly lessened if a community implements the mitigation measures detailed in the plan.

FEMA requires that a community adopt a pre-disaster mitigation plan as a condition for mitigation funding. For example, the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance Program (FMA), and the Pre-Disaster Mitigation Program are programs with this requirement.

1.2 HAZARD MITIGATION COMMITTEE

Updating the Town of Orange's Hazard Mitigation plan involved a committee comprised of the following members:

James Young, Orange Fire Chief & Emergency Management Director
Jane Pierce, Board of Selectmen

Mercedes Clingerman, Planning Board
Colin Killay, Highway Superintendent
Ken Wysk, Water Department Superintendent
Phil Harris, Building Inspector
Brenda Anderson, Representative for local businesses
Glen Ohlund, Franklin County Housing & Redevelopment Authority
Gabe Voelker, Town of Orange Administrator
Leanna Dennis, Town of Orange Administrative Assistant
Alec Wade, Director of Community Development

The Hazard Mitigation Planning process update for the Town included the following tasks:

- Hosting a Community Resilience Building workshop with local and regional stakeholders who identified Orange's key natural and man-made hazard vulnerabilities and strengths and proposed actions to build infrastructural, social, and environmental resilience to climate change
- Reviewing and incorporating existing plans and other information including changes in development in the years since the Town's previous Hazard Mitigation planning process
- Updating the natural hazards that may impact the community from the previous plan
- Conducting a Vulnerability/Risk Assessment to identify the infrastructure and populations at the highest risk for being damaged by the identified natural hazards, particularly flooding
- Identifying and assessing the policies, programs, and regulations the community is currently implementing to protect against future disaster damages
- Identifying deficiencies in the current Hazard Mitigation strategies and establishing goals for updating, revising or adopting new strategies
- Adopting and implementing the final updated Hazard Mitigation Plan

The key product of this Hazard Mitigation Plan Update process is the development of an Action Plan with a Prioritized Implementation Schedule.

Meetings

Meetings of the Hazard Mitigation Committee were held on the dates listed below. Agendas for these meetings are included in Appendix B. All meetings followed Massachusetts Open Meeting Law and were open to the public.

July 25, 2019

Work group meeting included hazard mitigation planning overview, updating the hazard

profiles and past events, and initial discussion of hazard identification and risk assessment.

September 26, 2019

Work group continued a discussion of hazard identification and risk, and completed the vulnerability assessment. Work group identified critical facilities in town, made edits to their critical facilities and past hazard map, and reviewed existing hazard mitigation strategies.

October 22, 2019

Held a Community Resilience Building workshop as part of Orange's Municipal Vulnerability Preparedness (MVP) designation process. The objectives of the workshop were to:

- Define the top natural and climate-related hazards of local concern
- Identify existing and future strengths and vulnerabilities
- Develop prioritized actions for the community
- Identify immediate opportunities to collaboratively advance actions to increase resilience.

This workshop served as the first community meeting for the Hazard Mitigation Plan update process.

August 25, 2020

Work group reviewed the draft 2020 Orange Hazard Mitigation Prioritized Action Plan and updated all action items.

Agendas and sign-in sheets for each meeting can be found in Appendix A. While not all members of the Hazard Mitigation Committee were able to attend each meeting, all members collaborated on the plan and were updated on progress by fellow Committee members after meetings occurred.

1.3 PARTICIPATION BY STAKEHOLDERS

A variety of stakeholders were provided with an opportunity to be involved in the update of the Orange Hazard Mitigation Plan. The different categories of stakeholders that were involved, and the engagement activities that occurred, are described below.

Local and Regional Agencies Involved in Hazard Mitigation Activities

In the Fall of 2019, Orange held a Community Resiliency Building workshop as part of the Massachusetts's Municipal Vulnerability Preparedness (MVP) designation program. The workshop was critical to enabling participants to think about and engage across different

sectors. The Fire Chief, Police Chief, Highway Superintendent, Town Administrator, a Planning Board member, local farmers and business owners, and representatives from other Town Departments all came together to determine the most threatening hazards to the Town of Orange and to agree upon high priorities and actions to address them. The results of the workshop are documented in the Town of Orange's *MVP Resiliency Plan*, and were integrated into this Hazard Mitigation Plan update process. The Franklin Regional Council of Governments (FRCOG), the regional planning agency for Orange and all 26 towns in Franklin County, facilitated the workshop.

In addition to the MVP process, FRCOG regularly engages with the Town of Orange as part of its regional planning efforts, which include the following:

- Developing the Sustainable Franklin County Plan, which advocates for sustainable land use throughout the region and consideration of the impact of flooding and other natural hazards on development.
- Developing and implementing the Franklin County Comprehensive Economic Development Strategy, which includes goals and strategies to build the region's economic resilience.
- Developing the Franklin County Regional Transportation Plan, which includes a focus on sustainability and climate resilience, and implementing the Franklin County Transportation Improvement Program to complete transportation improvements in our region.
- FRCOG Emergency Preparedness Program staff work with four regional committees: the Mohawk Area Public Health Coalition, the Franklin County Regional Emergency Planning Committee, the Franklin County Emergency Communications System Oversight Committee, and the Western Mass. Health and Medical Coordinating Coalition. Working with these committees and with local governments, the FRCOG works to provide integrated planning and technical assistance to improve and enhance our communities' ability to prepare for, respond to, and recover from natural and man-made disasters.

All of these FRCOG initiatives consider the impact of natural hazards on the region and strategies for reducing their impact to people and property through hazard mitigation activities. The facilitation of the Orange Hazard Mitigation Plan by FRCOG ensured that information from these plans and initiatives were incorporated into the Hazard Mitigation Planning process.

Agencies that Have the Authority to Regulate Development

The Orange Planning Board is the primary Town agency responsible for regulating development in town. Feedback to the Planning Board was ensured through the participation of a planning board member on the Hazard Mitigation Committee. In addition, the Franklin Regional Council of Governments, as a regional planning authority, works with all agencies that regulate development in Orange, including the municipal entities listed above and state agencies, such as the Department of Conservation and Recreation and MassDOT. This regular involvement ensured that during the development of the Orange Hazard Mitigation Plan, the operational policies and any mitigation strategies or identified hazards from these entities were incorporated into the Hazard Mitigation Plan.

Participation by the Public, Businesses, and Neighboring Communities

The plan update and public meetings were advertised on the Town website, and were posted at the Town Hall and at other designated public notice buildings. A copy of the draft plan was available to the public at the Town Hall, and on the Town website at www.townoforange.gov. A public forum was held on September 30th, 2020 and provided an opportunity for the public and other stakeholders to provide input on the mitigation strategies and to prioritize action items. Stakeholder letters were sent to Town boards, committees, and departments, and to all neighboring communities, inviting them to the public forum and to review the plan and provide comments. The public forum and subsequent comment period was advertised via a press release in the Greenfield Recorder and on the Town website. The final public Comment Period was held from September 23rd, 2020 through October 7th, 2020. (See Appendix A, Public Participation Process, for copies of all press releases and stakeholder letters mailed to solicit comments on the draft Plan). Comments were reviewed by the Committee and incorporated into the final plan as appropriate.

The Committee and FRCOG staff reviewed and incorporated the following existing plans, studies, reports and technical information, which are cited in footnotes throughout this plan:

- Orange Electronic Comprehensive Emergency Management Plan (eCEMP)
- 2016 Orange Open Space and Recreation Plan
- 2020 Town of Orange MVP Resiliency Plan
- 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan
- Resilient MA Climate Change Clearinghouse for the Commonwealth
- Additional data sources cited in footnotes throughout this Plan

2 LOCAL PROFILE AND PLANNING CONTEXT

2.1 COMMUNITY SETTING

The Town of Orange is located in the north central portion of Massachusetts, in eastern Franklin County. The town contains both rural and urban landscapes, and has the third highest population in the county, with an estimated 7,664 residents in 2018.¹ Orange is a regional employment center for surrounding communities.

European settlement of the town began in the mid 1700s. Farming dominated the town's economy until the early 1800s, although the power of the Millers River was used for mill operations after its damming in 1790. By early 1800s, a shift from agriculture to manufacturing had begun, which would transform the town socially, economically and physically. Orange saw many new industries spring up along the Millers River, including the manufacturing of furniture, sewing machines, palm-leaf hats and shoes.

During the last half of the 19th century, Orange's population grew significantly, primarily due to the expansion of local industries. Orange Center became the hub of economic and civic activity with a primary industrial corridor along the Millers River Railroad line. Throughout the 20th century and into this century, the Town of Orange has been known for its various manufacturing businesses, contributing to its reputation as a regional employment center in the greater Franklin County area.

Orange has six employers with at least fifty employees each. In 2018, according to Massachusetts Labor and Workforce data², there were on average 1,743 people employed in Orange by 277 employers. Roughly fifty percent of the total employment in Orange is currently provided by the six major employers. Two of the six employers are manufacturing firms, which are more likely to provide full-time jobs. In addition, this group represents a large share of the industrial property that provides tax revenues. By the same token, over 200 small businesses provide about 50 percent of the employment in town. These businesses provide basic services and commerce for the community and visitors to the area.³

In May 2019, MassGIS released a new land cover/land use dataset. This statewide dataset contains a combination of land cover mapping from 2016 aerial and satellite imagery, LiDAR

¹ <https://www.census.gov/quickfacts/orangetownfranklincountymassachusetts>

² Employment and Wages (ES-202), MA Department of Workforce Development.

³ Orange Open Space and Recreation Plan, 2016.

and other data sources. Land use mapping is derived from standardized assessor parcel information for Massachusetts. This land cover/land use dataset does not conform to the classification schemes or polygon delineation of previous land use data from MassGIS (1951-1999; 2005) so comparisons of land use change over time can't be made using this current data.^[1]

However, the 2016 land cover/land use dataset does reveal interesting information about Conway that most residents probably already know. For example, most of the *land cover* is forests but the *land use* is primarily residential.

Table 2-1: Orange 2016 MassGIS Land Cover and Land Use Data				
Total Acres = 23,270.68				
Land Cover	Acres		Land Use	Acres
Bare Land	191.41		Agriculture	546.76
Cultivated	137.79		Commercial	846.07
Deciduous Forest	5610.52		Forest	2407.49
Developed Open Space	1316.24		Industrial	267.51
Evergreen Forest	11453.06		Mixed use, other	1118.88
Grassland	589.16		Mixed use, primarily commercial	120.23
Impervious	1126.80		Mixed use, primarily residential	3232.62
Palustrine Aquatic Bed	191.10		Open land	2952.58
Palustrine Emergent Wetland	428.75		Recreation	181.64
Palustrine Forested Wetland	784.56		Residential - multi-family	923.71
Palustrine Scrub/Shrub Wetland	152.95		Residential - single family	4230.01
Pasture/Hay	678.49		Right-of-way	865.54
Scrub/Shrub	138.66		Tax exempt	4335.56
Water	471.19		Unknown	735.30
			Water	506.78

According to the 2016 MassGIS data in Table 2-1, approximately 77 percent of Orange's land cover is forest. Approximately 2 percent of the town is classified as agricultural land use, and 36 percent of the town is classified as residential land use. About 5 percent of the total area in town is comprised of commercial or industrial land uses.

Population Characteristics

According to the 2010 U.S. Census, there are 7,839 residents. As of 2018, Orange's total

^[1] <https://docs.digital.mass.gov/dataset/massgis-data-2016-land-coverland-use>

population is estimated to be 7,664 (a 2.2% decrease since 2010).⁴

Environmental Justice Populations

The State of Massachusetts defines an environmental justice community if any of the following conditions are met:

- Block group whose annual median household income is equal to or less than 65 percent of the statewide median (\$62,072 in 2010); or
- 25% or more of the residents identifying as minority; or
- 25% or more of households having no one over the age of 14 who speaks English only or very well - Limited English Proficiency (LEP)

Based upon these criteria, the Franklin County towns with Environmental Justice populations are Greenfield, Montague and Orange. Sections of all three towns were categorized as such based on the low income criteria. In Orange, the EJ area is roughly bounded by the Red Brook and South Main Street to the west, Route 2A to the north, the town border with Athol to the east and the town border with New Salem to the south. Route 2 and the railroad pass through the EJ area. Additionally, some of the EJ area also overlaps with areas in the floodplain, or are adjacent to areas zoned industrial which may also contain hazardous materials. In 2010, roughly 2,311 people, 30% of Orange's population, lived within the Environmental Justice areas.⁵

Current Development Trends

Waterpower, manufacturing, the railroad, and Route 2 all have influenced the development and growth of the Town of Orange. The Town developed from a sparsely populated agricultural community with its civic center in the northern highlands to a red brick downtown based on manufacturing powered by the river with transportation access provided by the railroad. This resulted in small lot housing to the north of the Main Streets, suburban neighborhoods to the south, and large lot single-family residential uses along all the main roads. Like many communities across New England, Orange's pattern of development over the past one hundred and fifty-years has been one of attraction to and exodus from the Town Center. People were attracted away from farming in the highlands to manufacturing in the village center. Much later this was followed by an exodus of residents from the failing manufacturing centers to the ample open spaces of rural residential districts by way of suburban subdivisions and large lot

⁴ <https://www.census.gov/quickfacts/orangetownfranklincountymassachusetts>

⁵ 2010 Environmental Justice Populations. MA Executive Office of Energy and Environmental Affairs. <https://www.mass.gov/doc/ej2010communitystatisticspdf/download>. This is the most up to date information available from the State.

single family development along the Town's scenic roadways.⁶

Infrastructure plays a vital role in current and future development patterns. Drinking water supplies can be a constraint to future growth in Orange. According to the 2016 Orange Open Space and Recreation Plan, a lack in pipe size (and thus fire protection) had limited commercial development along the eastern portion of Route 2A in Orange. However, a replacement of the pipe in this area has removed that constraint. The wastewater treatment plant and sewer collection system also play an important role in determining the location of dense residential development and future industrial and commercial development. Extending sewer lines without careful planning can increase residential development, reduce farming and forest acreage, and increase hydraulic flows to the wastewater treatment facility due to both.

Orange is located along highways that connect different portions of the north central Massachusetts to other regions. Route 2 is the major east/west highway in Northern Massachusetts. The nearest passenger rail service is located in Fitchburg. If commuter service is extended westward, Orange could see an increase in residential and commercial development as people take advantage of an additional link to metropolitan Boston.

The airport provides the local community with access to the national air transportation system, and likewise, provides communities and businesses throughout the United States with access to Orange. Although the airport is still utilized largely for recreational purposes, recent trends have changed the airport's role much more toward corporate use. The airport currently has about 38,000 aircraft operations annually and about 60 percent of those operations are non-recreational in nature.⁷

Orange has six zoning districts, all of which contain portions of the 100-year floodplain. The districts have different minimum lot size requirements in areas with and without public sewer service (see Table 3-55). In parts of downtown, the minimum lot size is 10,000 square feet, less than one-quarter acre, per unit for homes served by water and sewer. In the downtown area, there are a number of former multi-storied mill buildings that are currently vacant or underutilized and could potentially be redeveloped. In the center of downtown, the Commercial Area Redevelopment District (CARD district) is approximately 10 blocks in size, spanning the Millers River, and was created to encourage high-density development and redevelopment in downtown. Within the CARD district, there are no onsite parking requirements, buildings can occupy 100% of a lot area and can be up to five stories in height, and multi-family homes over two units are allowed by right.

⁶ Orange Open Space and Recreation Plan, 2016.

⁷ Orange Open Space and Recreation Plan, 2016.

The largest zoning district in Orange is the rural residential district, which covers an estimated 75% of the town, and has a minimum lot size of 2 acres. In recent years, new single-family homes have been increasingly built outside of the village centers. Table 2-2 provides a summary of new residential and commercial building permits issued over the last 5 and a half years.

Table 2-2: New residential and commercial permits issued in Orange 2015-2020			
	# of building permits		
Year	Residential	Commercial	Total
2015	4	3	7
2016	4	0	4
2017	7	0	7
2018	6	1	7
2019	4	1	5
2020	1	0	1
Total	26	5	31

According to information provided by Orange’s Building Inspector, between January 2015 and August 2020, the Town issued thirty-one (31) building permits for new construction. FRCOG staff reviewed the addresses of the building permits and determined the majority of them were located outside of known hazard areas.

According to 2005 MassGIS Land Use/Land Cover data, 1,132 acres lie within the 100-year floodplain in Orange and thirty-three (33) dwelling units located in the floodplain. Newer Mass GIS land use/land cover data from 2016 indicates a slight increase in floodplain acres in Orange (to 1,138 acres) but the number of dwelling units located within the floodplain has stayed the same. However, the two land use data sets – 2005 and 2016 – utilize different methodologies and cannot be directly compared. Franklin County does not have digital floodplain maps. FRCOG’s analysis is limited by the lack of digital floodplain maps. As noted below, FEMA is currently updating the floodplain maps for Orange. Once the update is complete, a more accurate understanding of any recent development within the floodplain will be possible.

The review of the building permit data and land use data sets as described above indicate that new development that may have been built adjacent to or within hazard prone areas in Orange since the previously approved plan is not expected to increase the Town’s overall vulnerability to flooding or other hazards. To assess and update the community’s vulnerability to hazard events, the Committee completed an exercise to discuss the results of the Risk Assessment (see

Section 3) and used the results to update the Overall Hazard Vulnerability Rating for each hazard. The ranking is qualitative and is based, in part, on local knowledge of past experiences with each type of hazard, the anticipated probability of occurrence, severity of impacts, and area of occurrence for each hazard given historical and climate change data, and a discussion of the type and location of current development trends and new development in Town, and other local knowledge.

The Town of Orange Planning Board is currently working to revise the Town's zoning bylaws to further limit development in the 100-year flood plain and other hazardous areas. This project is further detailed in Table 4-3.

National Flood Insurance Program Status

Orange is a participating member of the National Flood Insurance Program. Currently there are six flood insurance policies in effect in Orange, for a total insurance value of \$798,100. One loss has been paid in Orange, for a total of \$8,300. The town does not have any repetitive loss properties. Orange's floodplain map is from 1982. In 2018, the Federal Emergency Management Agency (FEMA) initiated a 5-10 year process to update the floodplain maps for Franklin County towns, which will primarily involve using recent LiDAR topographic mapping and limited field surveys to create digital floodplain maps and correcting some anomalies in the 1980 maps (floodplains on the tops of hills) that may be revealed by the LiDAR mapping.

Roads and Highways

The major artery running through Orange is Route 2, which traverses the width of the town. Route 2 connects Orange to nearby towns and urban centers, and offers three exits to enter the town, from Routes 2A, 122 and 202. Route 2A connects the center of Orange with that of Athol. Route 122 is a north/south route, which links to Route 202. Route 202 travels south and then west, and is a link to urban centers such as Holyoke. The closest access to I-91, Franklin County's major north/south route, is in Greenfield via Route 2. Route 2 is the major east/west highway in Northern Massachusetts and is currently going through a significant upgrade to improve safety and access for commercial and industrial users. When this project is completed, it could have major implications for land use in Orange. Orange has a total of 102 miles of roads, of which slightly more than 15% or 15.2 miles are gravel.⁸

Orange's reliance on Route 2 as an emergency evacuation route, and the susceptibility of Route 2 to closures due to traffic accidents or natural hazards, and its proximity to a freight railroad line, was highlighted by participants at the 2018 MVP Community Resilience Building workshop

⁸ Franklin Regional Council of Governments Road Mileage 2017

as a primary vulnerability for the Town.

Rail

The main rail line of Pan Am Systems connects New England to the Midwest, serving Orange-based companies like Rodney Hunt and the Leavitt Machine Company. Passenger rail service can be accessed in Fitchburg in Worcester County.

Aviation

The Orange Regional Airport covers four hundred and eighty (480) acres in the southern portion of town in between the town's two industrial parks. The airport, originally named Orange-Athol Airport, was created in 1929 on the site of an existing private landing site. During World War II the U.S. Civil Aeronautics Administration expanded the airport from what was originally only the front field to its current 480 acres and constructed three 5,000 foot runways to upgrade the airport for military use as an alternate landing site to Westover Air Force Base.

The airport offers several transportation benefits to the local community. The airport provides access to the national air transportation system, and likewise, the airport provides communities and businesses throughout the United States with access to Orange. In fact, the location of an airport is one of the most important considerations in locating a major business. A recent survey conducted by the Dow Jones Company found that local air transportation access is the single most important attribute in selecting a location for corporate headquarters, and research and development facilities.

The airport enhances the well-being of the community, maintains environmental resources, supports law enforcement, transports goods and supplies, provides emergency medical transportation, and is used extensively by area businesses. The airport is a valuable economic development resource for the area and is self-sufficient.

The airport also provides many recreational opportunities to the community. The front field area is available to the public and is frequently used by local residents for various activities including youth sports, dog walking, kite flying, and picnic lunches. The Jumptown skydiving facility provides thrill seekers with state of the art parachute instruction for the novice as well as the advanced jump enthusiast. Jumptown and the airport both sponsor several events throughout the year which are enjoyed by spectators from near and far.

Public Transportation

The Franklin Regional Transit Authority (FRTA) operates fixed route service between Greenfield and Athol with stops in Orange. In Athol, the service connects to the Montachusett Regional

Transit Authority with routes to Gardner and an intermodal transportation station in Fitchburg offering commuter rail service to the Boston area. Demand response door-to-door transit service for seniors and the disabled is also provided by the FRTA.

The Community Transit Service (CTS), which operates out of Athol, is a dial-a-ride transit service available for workers to commute between home and work. It also provides residents with rides around town and from their homes to connection points with the FRTA route.

Public Drinking Water Supply

The Orange Water Department is a community water supply system with 1,837 service connections serving approximately 1,634 residences plus businesses and industries from three groundwater sources (Wells #1, #2, and #3). Private wells serve the remainder of Orange. Well #1 is located on North Pond Brook, Well #2 is located west of Holtshire Road and Well #3 is east of Route 202 in the southeastern portion of town. These ground sources are supported by two, one million gallon storage tanks. The wells had their Zone II and Zone III recharge areas delineated and mapped in 1994. That same year the safe yields were calculated for each well and the entire system's permitted withdrawal volume was established. The permit is for twenty years with reviews of the water withdrawal data occurring every five years by the Department of Environmental Protection. It is expected that the permitted withdrawal volume will increase over time as the community's population and demand for water increases.

As of 2017, Orange's average daily use is approximately 330,735 gallons per day (GPD), and the maximum daily use is 619,954 GPD. The current registered/permitted daily average withdrawal volume is 960,000 GPD. The safe yield of the three wells combined is estimated at 1,717,000 GPD, which exceeds current demand under normal operating conditions. The safe yield is the amount of water that can be withdrawn on a continuous basis during an extended dry period without adverse hydrological or ecological impacts. Despite current safe yield estimates, Wells #1 and #2 are aging and inefficient. In addition, Well #1 has poor water quality and neither well is capable of fully backing up Well #3 in the event that Well #3 is unavailable. The Orange Water Department is currently working on developing a satellite source for Well #1, which should be complete in the next 5 years.

Orange Town Officials are considering the long-term protection of both the quantity and quality of the public drinking water supplies. The public water supply wells' Zone II recharge areas are a part of the Town's zoning bylaws and are considered as Water Resource Districts. Within these districts land uses that are commonly associated with the use, production and storage of materials that could contaminate the water within the aquifers are prohibited.

There are also three surface water supplies that are reserved for use as emergency drinking water sources by the Orange Water Department. These include Lake Mattawa, Coolage Brook Reservoir, and Crystal Springs. None of these emergency sources are connected to the current distribution system; however, they are all close to one another and would connect to the main distribution system at the same point. All would require an on-site package treatment plant for the treatment of water. There are four transient non-community water supply systems in Orange serving three commercial establishments and the Farm School. A non-transient non-community water supply system serves the Gale Brook School.

Water supplies and the reach of their delivery systems could limit growth in the future. A watershed can only supply a certain volume of water before its plants and animals suffer. This is theoretically the basis for having registered withdrawal volumes and for the calculation of safe yield figures. Because drinking water is a finite natural resource that is heavily regulated in Massachusetts, Town Officials should consider use of the water mains as a boundary to new growth in the future. At some point in the future, demand for water could exceed both drinking water and fire protection supplies.

The Quabbin Reservoir, Boston's water supply, is a unique resource which is located southeast of Orange and which could have a significant impact on the availability of water. The Quabbin is part of the Chicopee River watershed, some of which is located in Orange, and is a major tributary to the larger Connecticut River. The Millers River is also a major tributary of the Connecticut. As the number of cities and towns with access to the Quabbin Reservoir increase, so does the risk of shortages in supply when periodic droughts occur. The same is true of cities to the south in the Connecticut River watershed – Springfield, Massachusetts and Hartford, Connecticut – which would want to protect flows upstream from rivers like the Millers and Chicopee Rivers. This is an issue that communities such as Orange need to consider and to present to the Commonwealth and the Massachusetts Water Resources Authority as they consider growth and change in the eastern portion of the State.

Sewer Service

The Town's sewer system includes one wastewater treatment plant located off Route 2A along the Millers River and a collection system that dates back to the 1890's. The facility serves a population of approximately 3,500 residents in the area of Orange Center. The remaining parts of Town are served by private septic systems. Orange upgraded the treatment facility in the late 1990's. These improvements included increasing the capacity of the pumps, a new fine bubble aeration system, and upgrades to the return activated sludge controls. The current design capacity of the plant for handling hydraulic flow, which is the water entering the plant, is 1.1 MGD.

The Town of Orange is in the process of updating the Comprehensive Wastewater Treatment Master Plan, completed in 2000. The updated plan will evaluate the existing conditions of the wastewater treatment facility (WWTF) and wastewater collection system, make recommendations for cost-effective improvements for increasing the system's efficiency over the next twenty years, and look at the potential of expanding the sewer system. Ongoing improvements for the WWTF will include a number of collection system improvements and construction projects, including flow equalization, grit removal, an additional clarifier, and a new aeration and disinfection system.

The public sewer system can impact development in a number of ways. First, where new sewer lines go, development will follow. Sewer infrastructure should be expanded to ensure that new industrial development occurs away from sensitive natural resources and that new dense residential development is built ideally within existing areas of service. Second, due to Title 5 regulations, Towns may be inclined to rescue residents with problem sewer systems. Expanding sewer to areas with physical and hydrogeologic constraints may open up other areas to future development. Third, expanding sewer lines increases the cost of upkeep and repair to the Town of Orange, particularly with respect to infiltration and inflow problems. In addition, new demand for public sewer service may require further expansion of the wastewater treatment capacity, which can be very expensive.⁹

Emergency Shelters/Community Emergency Response

Orange's designated shelters are the Ralph C. Mahar Regional School, the Fisher Hill Elementary School, and the Armory. The Fisher Hill School is equipped with a backup generator, but using the school as a shelter during the academic year poses logistical issues. The Armory was recently used as a temporary shelter when a bomb cyclone hit Orange in October 2019.

Residents in the North Orange and Tully neighborhoods are working to develop a community emergency response network called the Neighbors Meeting Working Group. The neighborhoods were divided among volunteers to serve as individual cluster leaders, with the leaders being responsible for checking in on residents in their designated areas during emergencies. The network will serve as an information resource during emergencies; leaders will help residents in need of assistance evacuate their homes, organize temporary cooling or warming shelters in homes with power or woodstoves, and direct residents to official shelters made available by the Town of Orange. The group began its work in March 2020 at the beginning of the COVID-19 pandemic.

⁹ Orange Open Space and Recreation Plan, 2016.

Natural Resources

Orange's most noteworthy natural features are its forested uplands, farmlands and water resources. The Town of Orange is almost entirely within the Millers River Watershed. The Millers River itself, which flows through Orange Center, generally flows east to west, through the central portion of the town on its way to the Connecticut River. The southwestern portion of town lies within the Swift River Watershed. Large contiguous forested areas in the town can be found in North Orange, West Orange and the Chestnut Hill area. Tully Mountain, in northeastern Orange, is the town's highest point at 1,163 feet.

The Town of Orange has approximately 1,366 acres covered by wetlands, which are fed by nearby brooks and rivers.¹⁰ Wetlands are essential for promoting water quality and biodiversity of both plant and animal species. The town also has a fairly substantial amount of open water within its borders (approximately 586 acres). The rivers and wetlands in Orange are buffered in accordance with the Massachusetts Wetlands Protection Act. The Millers River is supportive of recreational use.

There are a number of other surface water resources in Orange, including Lake Mattawa, Lake Rohunta/Eagleville Pond, and Tully and Packard Ponds, as well a number of rivers and brooks.

The topography of Orange offers unusual hill formations and magnificent local views, as well as low-lying farmland and wetlands. The areas with the least change in elevation occur in the area of the Municipal Airport and in a valley just northeast of Orange Center. The steeper slopes occur along the upland ridges in the west, northwest, and northern portions of Town.

The Town of Orange as viewed from above is situated in an area of lush forested uplands and rolling hills, all interlaced with diverse water bodies. The terrain is that of the western slope of a basin. The hills to the northwest have a predominantly southeastern aspect, those in the southwest face northeast. And in the middle of this basin the Millers River cuts through the landscape over the more level plains in the east and then dividing the steeper banks of the river in West Orange.

The outstanding and distinctive scenic characteristics of this landscape are best observed by traveling through the different parts of Town. Downtown in Orange Center, on the floodplain of the Millers River, is the heart of the Town's cultural activities as well as the center for most of the community's institutional and economic activities. Today, the Millers River still links Orange

¹⁰ 2016 MassGIS Land Use Data.

Center to its industrial beginnings. The river, waterfall, and red brick mill buildings create a sense of place in Orange Center.

Traveling north on North Main Street one can view the upland ridges of Far Hill and Beech Hill that demarcate the Town's western boundary. The road takes you over gentle rises towards the wetlands referred to as "The Rookery" which is one of several areas known for bird sightings. Beyond "The Rookery" lies scenic North Orange, the original 18th century settlement, which is home to the few remaining active farms that were first settled in the 1700's. These farms, for the most part, provide only supplementary income to their owners, today, largely from haymaking operations. North Orange also offers views of Tully Mountain, the most pronounced topographical feature in the North Quabbin Region. Views to and from Tully are among the most significant in the area. Nearby, Tully and Packard Ponds (both man-made) are surrounded by a mix of vacation homes and full time residences.

Traveling south from North Orange down Wheeler Avenue one finds an area of gentle hills and streams that are part of the drainage of West Brook. This area has been called "wild" by area residents but parts are also blanketed with crop and pasture land.

A drive south of Orange Center takes one through the glacial outwash plain, known locally as "The Plains," where the Municipal Airport takes advantage of broad, flat terrain. The nearby lakes, Mattawa and Rohunta/Eagleville are both popular fishing and recreation spots. Continuing south, Orange State Forest and Chestnut Hill provide wildlife habitat and hunting grounds.

Cultural and Historic Resources

The importance of integrating cultural resource and historic property considerations into hazard mitigation planning is demonstrated by disasters that have occurred in recent years, such as the Northridge earthquake in California, Hurricane Katrina in New Orleans, or floods in the Midwest. The effects of a disaster can be extensive—from human casualty to property and crop damage to the disruption of governmental, social, and economic activity. Often not measured, however, are the possibly devastating impacts of disasters on historic properties and cultural resources. Historic structures, artwork, monuments, family heirlooms, and historic documents are often irreplaceable, and may be lost forever in a disaster if not considered in the mitigation planning process. The loss of these resources is all the more painful and ironic considering how often residents rely on their presence after a disaster, to reinforce connections with neighbors and the larger community, and to seek comfort in the aftermath of a disaster.¹¹

¹¹ Integrating Historic Property and Cultural Resource Considerations Into Hazard Mitigation Planning, State and Local Mitigation Planning How-To Guide, FEMA 386-6 / May 2005.

Historic properties and cultural resources can be important economic assets, often increasing property values and attracting businesses and tourists to a community. While preservation of historic and cultural assets can require funding, it can also stimulate economic development and revitalization. Hazard mitigation planning can help forecast and plan for the protection of historic properties and cultural resources.

Cultural and historic resources help define the character of a community and reflect its past. These resources may be vulnerable to natural hazards due to their location in a potential hazard area, such as a river corridor, or because of old or unstable structures. The 2010 Orange Comprehensive Emergency Management Plan (CEMP) identifies cultural resources in Orange, some of which contain historic documents and cultural artifacts (Table 2-3).

Table 2-3: Orange Cultural Resources			
Resource Name	Resource Location	Resource Type	Materials Contained
Moore-Leland Library	Athol Road	Library	
Orange Historical Society	41 North Main Street	Historical Building; Historical Landscape; Library; Museum	Archives; Art; Artifacts
Peace Statue – Orange Memorial	South Main Street	Outdoor Sculpture	
Town Hall	6 Prospect Street	Historical Building	Archives
Moore-Leland Library	Athol Road	Library	

Source: 2010 Orange CEMP

The Massachusetts Cultural Resource Information System (MACRIS)¹² lists a total of 447 areas, buildings, burial grounds, objects, and structures of cultural and/or historic significance in Orange. Some of these include the Orange Baptist Church, The Commons, Orange Center, and the Lake Mattawa Camps. Designation on this list does not provide any protective measures for the historic resources but designated sites may qualify for federal and state funding if damaged during a natural or manmade hazard.

¹² <http://mhc-macris.net/Results.aspx>

2.2 IMPACTS OF CLIMATE CHANGE

Greater variation and extremes in temperature and weather due to climate change has already begun to impact Orange, and must be accounted for in planning for the mitigation of future hazard events. In 2017, the Commonwealth launched the Massachusetts Climate Change Clearinghouse (Resilient MA), an online gateway for policymakers, planners, and the public to identify and access climate data, maps, websites, tools, and documents on climate change adaptation and mitigation. The goal of Resilient MA is to support scientifically sound and cost-effective decision-making, and to enable users to plan and prepare for climate change impacts. Climate projections for Franklin County available through Resilient MA are summarized in this section. Additional information about the data and climate models is available on the resilient MA website: <http://resilientma.org>





Figure 2-1 identifies primary climate change impacts and how they interact with natural hazards assessed in the State Hazard Mitigation and Climate Adaptation Plan. Following is a summary of the three primary impacts of climate change on Franklin County and Orange: rising temperatures, changes in precipitation, and extreme weather. How these impacts affect individual hazards is discussed in more detail within Section 3: Hazard Identification and Risk Assessment.

Rising Temperatures

Average global temperatures have risen steadily in the last 50 years, and scientists warn that the trend will continue unless greenhouse gas emissions are significantly reduced. The nine warmest years on record all occurred in the last 20 years (2017, 2016, 2015, 2014, 2013, 2010, 2009, 2005, and 1998), according to the U.S. National Oceanographic and Atmospheric Administration (NOAA).

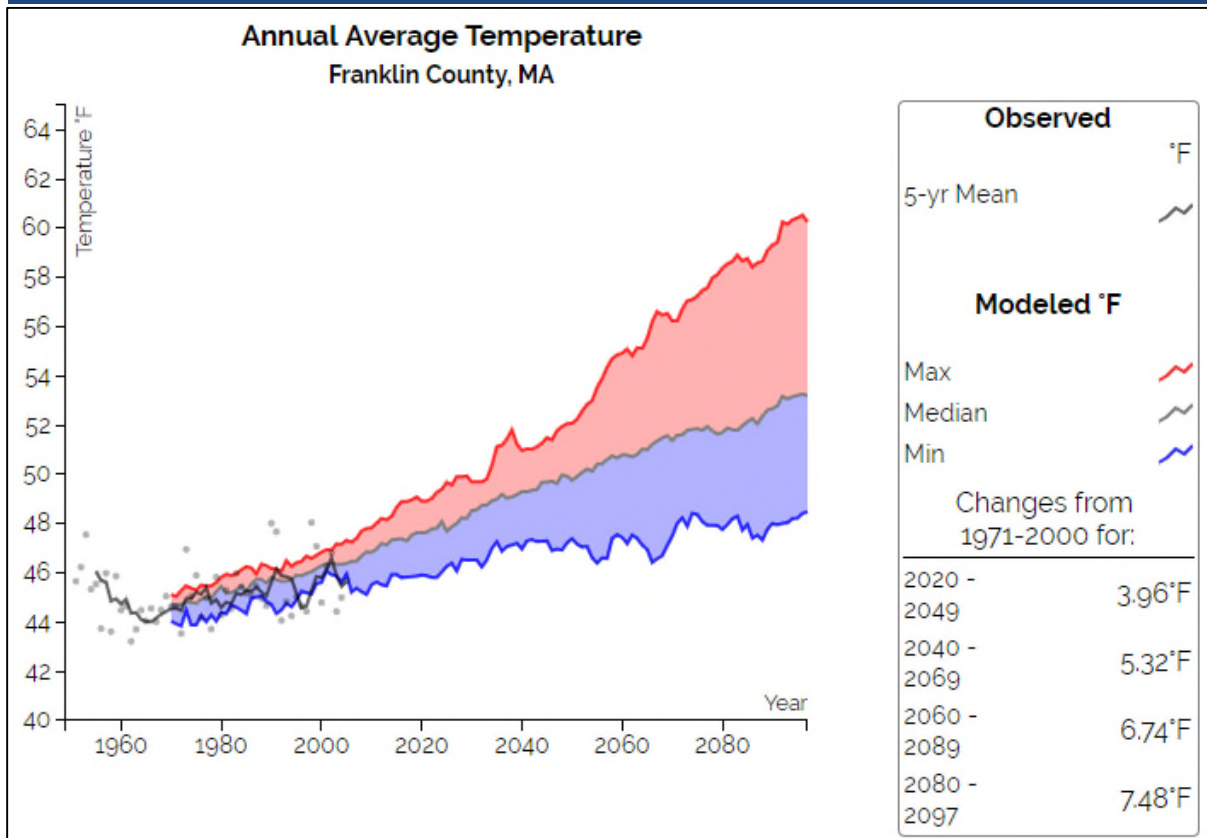
The average, maximum, and minimum temperatures in Franklin County are likely to increase significantly over the next century (resilient MA, 2018). Figure 2-2 displays the projected increase in annual temperature by mid-century and the end of this century, compared to the observed annual average temperature from 1971-2000. The average annual temperature is projected to increase from 45.3 degrees Fahrenheit (°F) to 50.6°F (5.32°F change) by mid-century, and to 52.8°F (7.48°F change) by the end of this century. The variation in the amount of change in temperature shown in Figure 2-2 is due to projections that assume different amounts of future GHG emissions, with greater change occurring under a higher emissions scenario, and less change occurring under a lower emissions scenario. For example, under a high emission scenario, the annual average temperature by the end of the century could be as high as 60°F.

Figure 2-1: Climate Change and Natural Hazard Interactions from the Massachusetts State Hazard Mitigation and Climate Adaptation Plan

Primary Climate Change Interaction	Natural Hazard	Other Climate Change Interactions	Representative Climate Change Impacts
 Changes in Precipitation	Inland Flooding	Extreme Weather	Flash flooding, urban flooding, drainage system impacts (natural and human-made), lack of groundwater recharge, impacts to drinking water supply, public health impacts from mold and worsened indoor air quality, vector-borne diseases from stagnant water, episodic drought, changes in snow-rain ratios, changes in extent and duration of snow cover, degradation of stream channels and wetland
	Drought	Rising Temperatures, Extreme Weather	
	Landslide	Rising Temperatures, Extreme Weather	
 Sea Level Rise	Coastal Flooding	Extreme Weather	Increase in tidal and coastal floods, storm surge, coastal erosion, marsh migration, inundation of coastal and marine ecosystems, loss and subsidence of wetlands
	Coastal Erosion	Changes in Precipitation, Extreme Precipitation	
	Tsunami	Rising Temperatures	
 Rising Temperatures	Average/Extreme Temperatures	N/A	Shifting in seasons (longer summer, early spring, including earlier timing of spring peak flow), increase in length of growing season, increase of invasive species, ecosystem stress, energy brownouts from higher energy demands, more intense heat waves, public health impacts from high heat exposure and poor outdoor air quality, drying of streams and wetlands, eutrophication of lakes and ponds
	Wildfires	Changes in Precipitation	
	Invasive Species	Changes in Precipitation, Extreme Weather	
 Extreme Weather	Hurricanes/Tropical Storms	Rising Temperatures, Changes in Precipitation	Increase in frequency and intensity of extreme weather events, resulting in greater damage to natural resources, property, and infrastructure, as well as increased potential for loss of life
	Severe Winter Storm / Nor'easter	Rising Temperatures, Changes in Precipitation	
	Tornadoes	Rising Temperatures, Changes in Precipitation	
	Other Severe Weather (Including Strong Wind and Extreme Precipitation)	Rising Temperatures, Changes in Precipitation	
Non-Climate-Influenced Hazards	Earthquake	Not Applicable	There is no established correlation between climate change and this hazard

Source: Massachusetts State Hazard Mitigation and Climate Adaptation Plan. September 2018

Figure 2-2: Projected Annual Average Temperature

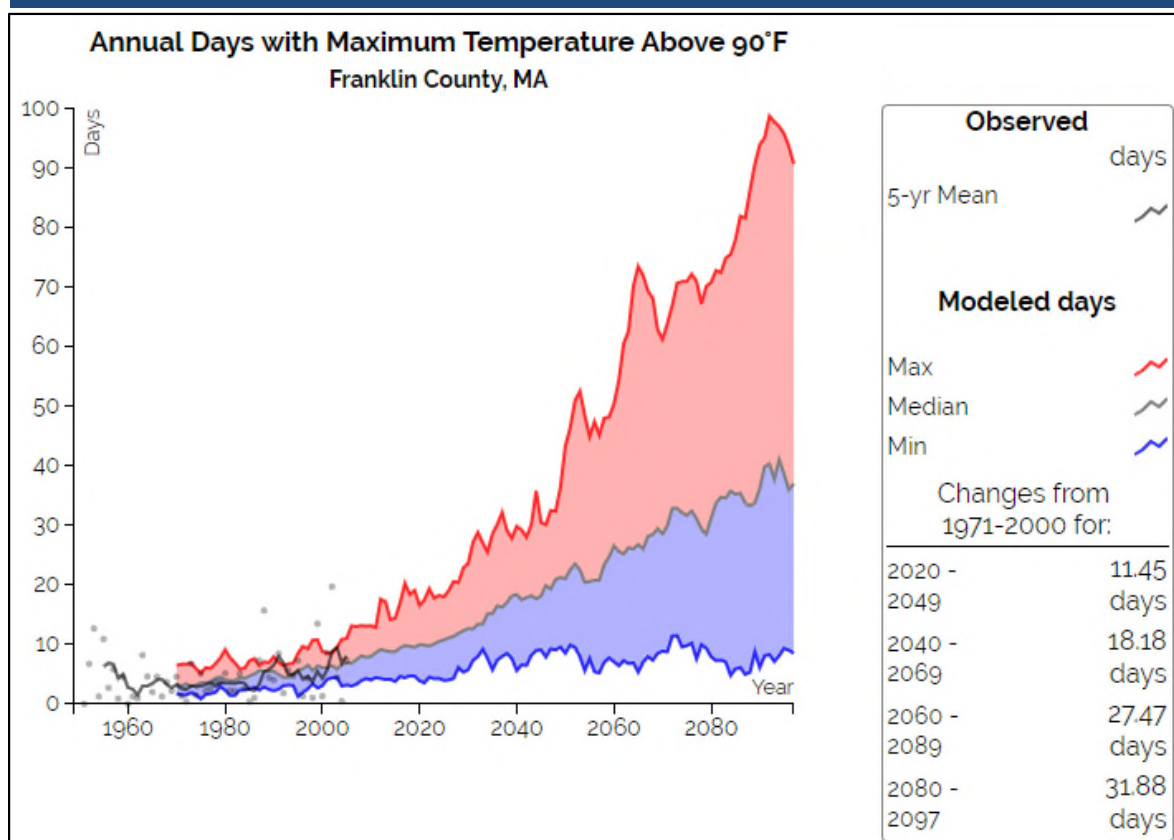


Source: Resilient MA, 2018

Winter temperatures are projected to increase at a greater rate than spring, summer, or fall. Currently Franklin County experiences an average of 169 days per year with a minimum temperature below freezing (32°F). The number of days per year with daily minimum temperatures below freezing is projected to decrease anywhere from 13 to 40 days by the 2050s, and by 15 to as many as 82 days (down to 87 days total) by the 2090s.

Although minimum temperatures are projected to increase at a greater rate than maximum temperatures in all seasons, significant increases in maximum temperatures are anticipated, particularly under a higher GHG emissions scenario. Figure 2-3 displays the projected increase in the number of days per year over 90°F. The number of days per year with daily maximum temperatures over 90°F is projected to increase by 18 days by the 2050s, and by 32 days by the end of the century (for a total of 36 days over 90°F), compared to the average observed range from 1971 to 2000 of 4 days per year. Under a high emissions scenario, however, there could be as many as 100 days with a maximum temperature above 90°F by the end of the century.

Figure 2-3: Projected Annual Days with a Maximum Temperature Above 90°F



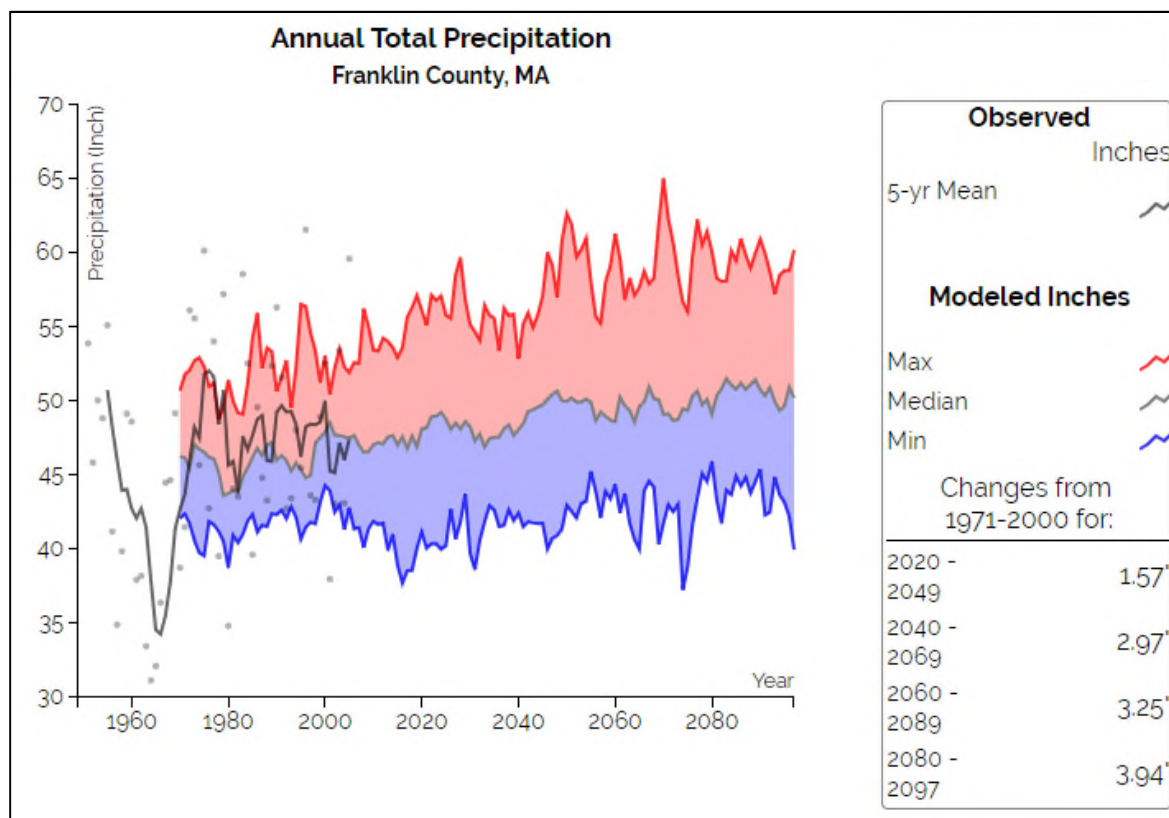
Source: Resilient MA, 2018

Changes in Precipitation

Changes in the amount, frequency, and timing of precipitation—including both rainfall and snowfall—are occurring across the globe as temperatures rise and other climate patterns shift in response. Precipitation is expected to increase over this century in Franklin County. Total annual precipitation is projected to increase by 3 inches by mid-century, and by 4 inches by the end of this century (see Figure 2-4). This will result in up to 52 inches of rain per year, compared to the 1971-2001 average annual precipitation rate of 48 inches per year in Franklin County. Precipitation during winter and spring is expected to increase, while precipitation during summer and fall is expected to decrease over this century. In general precipitation projections are more uncertain than temperature projections.¹³

¹³ <http://resilientma.org/datagrapher/?c=Temp/county/pcpn/ANN/25011/>

Figure 2-4: Projected Annual Total Precipitation (Inches)



Source: Resilient MA, 2018

Extreme Weather

Climate change is expected to increase extreme weather events across the globe, as well as right here in Massachusetts. There is strong evidence that storms—from heavy downpours and blizzards to tropical cyclones and hurricanes—are becoming more intense and damaging, and can lead to devastating impacts for residents across the state. Climate change leads to extreme weather because of warmer air and ocean temperatures and changing air currents. Warmer air leads to more evaporation from large water bodies and holds more moisture, so when clouds release their precipitation, there is more of it. In addition, changes in atmospheric air currents like jet streams and ocean currents can cause changes in the intensity and duration of stormy weather.

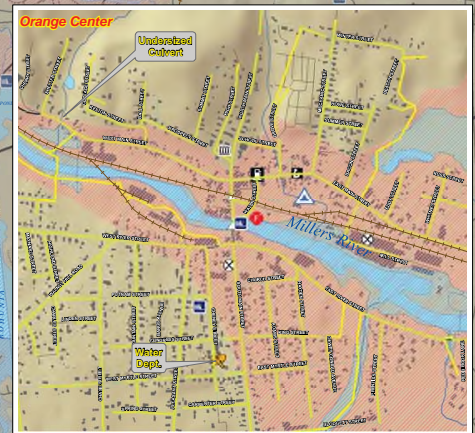
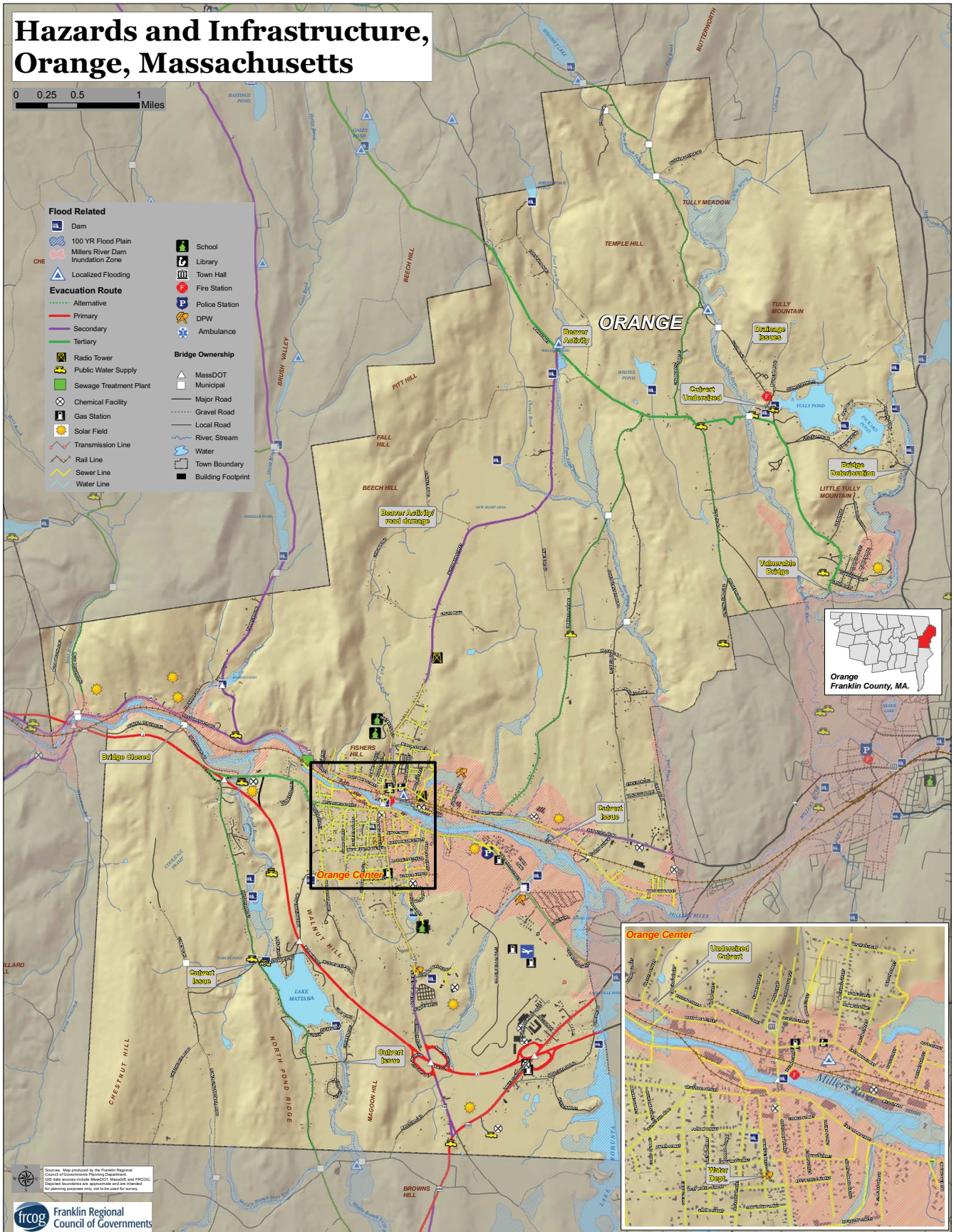
In Franklin County, recent events such as Tropical Storm Irene in 2011, and the February tornado in Conway in 2018, are examples of extreme weather events that are projected to become more frequent occurrences due to climate change. While it is difficult to connect one storm to a changing climate, scientists point to the northeastern United States as one of the

regions that is most vulnerable to an increase in extreme weather driven by climate change.

Hazards and Infrastructure, Orange, Massachusetts

0 0.25 0.5 1 Miles

- | | |
|-------------------------|-----------------------------------|
| Flood Related | |
| | Dam |
| | 100 YR Flood Plain |
| | Millers River Dam Inundation Zone |
| | Localized Flooding |
| Evacuation Route | |
| | Alternative |
| | Primary |
| | Secondary |
| | Tertiary |
| | Radio Tower |
| | Public Water Supply |
| | Sewage Treatment Plant |
| | Chemical Facility |
| | Gas Station |
| | Solar Field |
| | Transmission Line |
| | Rail Line |
| | Sewer Line |
| | Water Line |
| Bridge Ownership | |
| | MassDOT |
| | Municipal |
| | Major Road |
| | Gravel Road |
| | Local Road |
| | River, Stream |
| | Water |
| | Town Boundary |
| | Building Footprint |
| | School |
| | Library |
| | Town Hall |
| | Fire Station |
| | DPW |
| | Ambulance |



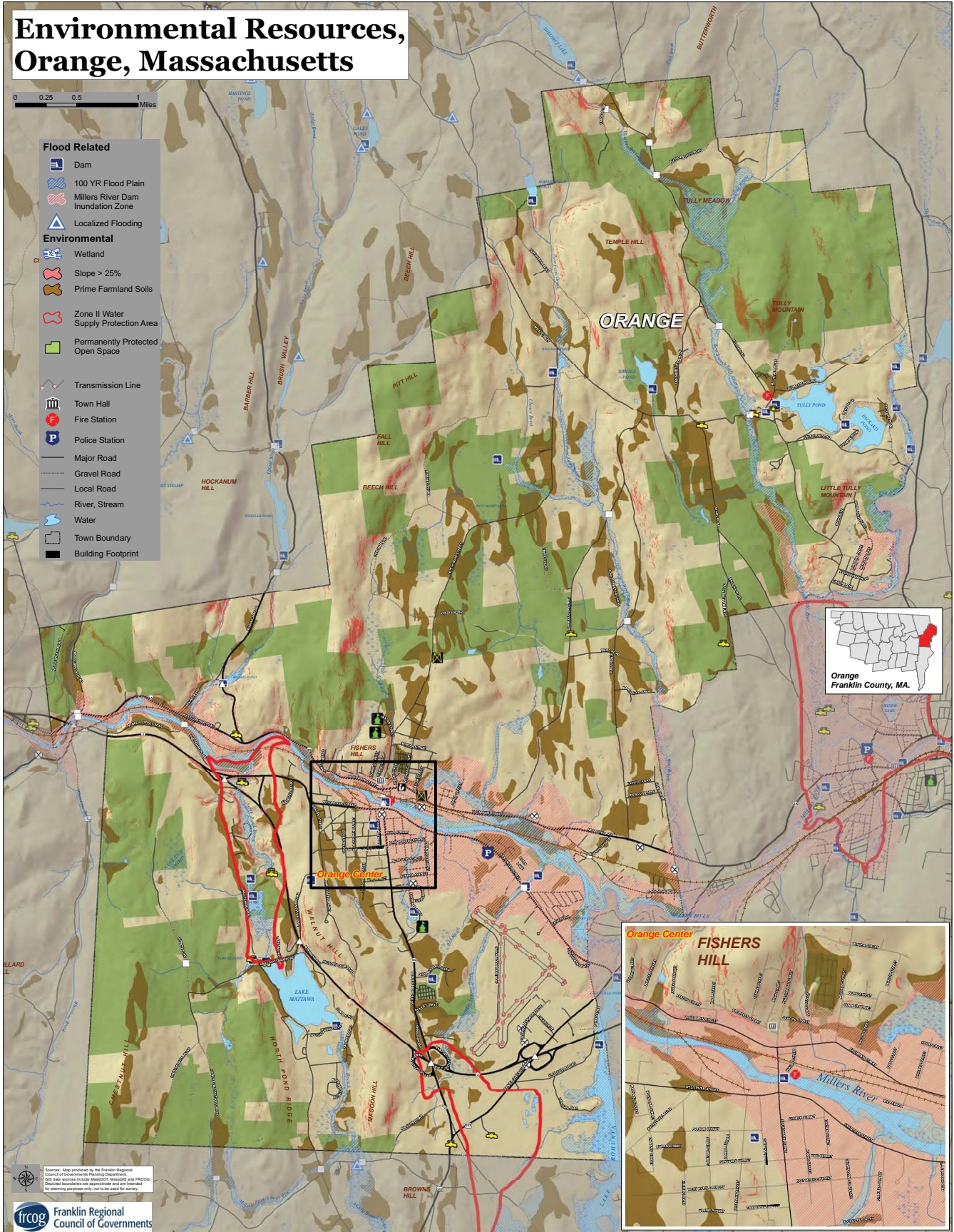
Environmental Resources, Orange, Massachusetts

0 0.25 0.5 1 Miles

Flood Related

-  Dam
 -  100 YR Flood Plain
 -  Millers River Dam Inundation Zone
 -  Localized Flooding
- ## Environmental
-  Wetland
 -  Slope > 25%
 -  Prime Farmland Soils
 -  Zone II Water Supply Protection Area
 -  Permanently Protected Open Space

-  Transmission Line
-  Town Hall
-  Fire Station
-  Police Station
-  Major Road
-  Gravel Road
-  Local Road
-  River, Stream
-  Water
-  Town Boundary
-  Building Footprint



3 HAZARD IDENTIFICATION AND RISK ASSESSMENT

The following section includes a summary of disasters that have affected or could affect Orange. Historical research, conversations with local officials and emergency management personnel, available hazard mapping and other weather-related databases were used to develop this list.

The Hazard Mitigation Committee referred to the *Massachusetts State Hazard Mitigation and Climate Adaptation Plan* (September 2018) as a starting point for determining the relevant hazards in Orange. The table below illustrates a comparison between the relevant hazards in the State plan and in Orange's plan.















Table 3-1: Comparison of Hazards in the Massachusetts State Hazard Mitigation and Climate Adaptation Plan, Orange Hazard Mitigation Plan, and Orange MVP Resiliency Plan		
Massachusetts State Hazard Mitigation and Climate Adaptation Plan (2018)	Town of Orange Relevance	MVP Resiliency Plan Top Priority Hazard
 Inland Flooding	YES	YES
 Drought	YES	NO
 Landslide	YES	NO
 Coastal Flooding	NO	NO
 Coastal Erosion	NO	NO

Table 3-1: Comparison of Hazards in the Massachusetts State Hazard Mitigation and Climate Adaptation Plan, Orange Hazard Mitigation Plan, and Orange MVP Resiliency Plan

Massachusetts State Hazard Mitigation and Climate Adaptation Plan (2018)	Town of Orange Relevance	MVP Resiliency Plan Top Priority Hazard
 <p>Tsunami</p>	NO	NO
 <p>Average/Extreme Temperatures</p>	YES	NO
 <p>Wildfires</p>	YES	NO
 <p>Invasive Species</p>	YES	YES
 <p>Hurricanes/Tropical Storms</p>	YES	NO
 <p>Severe Winter Storm</p>	YES	NO
 <p>Tornadoes</p>	YES	NO
 <p>Other Severe Weather</p>	YES	YES – Severe thunderstorms, wind, and microbursts
 <p>Earthquake</p>	YES	NO

3.1 NATURAL HAZARD RISK ASSESSMENT METHODOLOGY

This chapter examines the hazards in the *Massachusetts State Hazard Mitigation and Climate Adaptation Plan* which are identified as likely to affect Orange. The analysis is organized into the following sections: Hazard Description, Location, Extent, Previous Occurrences, Probability of Future Events, Impact, and Vulnerability. A description of each of these analysis categories is provided below.

Hazard Description

The natural hazards identified for Orange are: severe winter storms, flooding (including dam failure), hurricanes/tropical storms, severe thunderstorms/tornados/microbursts, earthquakes, landslides, average/extreme temperatures, drought, and wildfire. Many of these hazards result in similar impacts to a community. For example, hurricanes, tornados and severe snowstorms may cause wind-related damage.

Location

Location refers to the geographic areas within the planning area that are affected by the hazard. Some hazards affect the entire planning area universally, while others apply to a specific portion, such as a floodplain or area that is susceptible to wild fires. Classifications are based on the area that would potentially be affected by the hazard, on the following scale:

Table 3-2: Location of Occurrence Rating Scale	
Classification	Percentage of Town Impacted
Large	More than 50% of the town affected
Medium	10 to 50% of the town affected
Isolated	Less than 10% of the town affected

Extent

Extent describes the strength or magnitude of a hazard. Where appropriate, extent is described using an established scientific scale or measurement system. Other descriptions of extent include water depth, wind speed, and duration.

Previous Occurrences

Previous hazard events that have occurred are described. Depending on the nature of the hazard, events listed may have occurred on a local, state-wide, or regional level.

Probability of Future Events

The likelihood of a future event for each natural hazard was classified according to the following scale:

Table 3-3: Probability of Occurrence Rating Scale	
Classification	Probability of Future Events
Very High	Events that occur at least once each 1-2 years (50%-100% probability in the next year)
High	Events that occur from once in 2 years to once in 4 years (25%-50% probability in the next year)
Moderate	Events that occur from once in 5 years to once in 50 years (2%-25% probability in the next year)
Low	Events that occur from once in 50 years to once in 100 years (1-2% probability in the next year)
Very Low	Events that occur less frequently than once in 100 years (less than 1% probability in the next year)

Impact

Impact refers to the effect that a hazard may have on the people and property in the community, based on the assessment of extent described previously. Impacts are classified according to the following scale:

Table 3-4: Impacts Rating Scale	
Classification	Magnitude of Multiple Impacts
Catastrophic	Multiple deaths and injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of facilities for 30 days or more.
Critical	Multiple injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of facilities for more than 1 week.
Limited	Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of facilities for more than 1 day.
Minor	Very few injuries, if any. Only minor property damage and minimal disruption of quality of life. Temporary shutdown of facilities.

Vulnerability

Based on the above metrics, a hazard vulnerability rating was determined for each hazard. The hazard vulnerability ratings are based on a scale of 1 through 3 as follows:

- 1 – High risk
- 2 – Medium risk
- 3 – Low risk

The ranking is qualitative and is based, in part, on local knowledge of past experiences with each type of hazard, review of available data, and the work of the Committee. The size and impacts of a natural hazard can be unpredictable. However, many of the mitigation strategies currently in place and many of those proposed for implementation can be applied to the expected natural hazards, regardless of their unpredictability.

Table 3-5: Orange Hazard Identification and Risk Analysis				
Type of Hazard	Location of Occurrence	Probability of Future Events	Impact	Overall Hazard Vulnerability Rating
Severe Winter Storms	Large	Very High	Limited	High
Flooding	Medium	Moderate	Limited	Medium
Tornadoes	Isolated	Moderate	Catastrophic	Low
Dam Failure	Isolated	Moderate	Critical	Medium
Hurricanes / Tropical Storms	Large	Moderate	Limited	Medium
Severe Thunderstorms / Wind / Microbursts	Large	Very High	Limited	High
Extreme Temperatures	Large	High	Critical	Medium
Earthquakes	Large	Very Low	Catastrophic	Low
Landslides	Isolated	Low	Limited	Low
Drought	Large	Moderate	Limited – Might be critical for Agriculture	Low/Medium for Agriculture
Wildfires	Isolated	Very High	Minor	Low

Invasive Species	Large	Very High	Critical	High
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The Committee developed problem statements and/or a list of key issues for each hazard to summarize the vulnerability of Orange’s structures, systems, populations and other community assets identified as vulnerable to damage and loss from a hazard event. These problem statements were used to identify the Town’s greatest vulnerabilities that will be addressed in the mitigation strategy (Section 4).

3.2 FLOODING

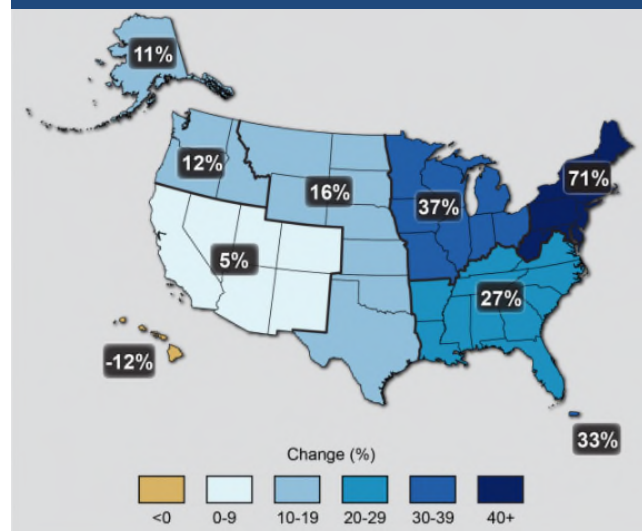
Potential Effects of Climate Change

In Massachusetts, annual precipitation amounts have increased at a rate of over 1 inch per decade since the late 1800s, and are projected to continue to increase largely due to more intense precipitation events. The Northeast has experienced a greater increase in extreme precipitation events than the rest of the U.S. in the past several decades (Figure 3-1). Although overall precipitation is expected to increase as the climate warms, it will occur more in heavy, short intervals, with a greater potential for dry, drought conditions in between.

Observed average annual precipitation in Massachusetts between 1971-2000 was 47 inches. Total annual precipitation in Massachusetts is expected to increase between 2% to 13% by 2050, or by roughly 1 to 6 inches.

The Climate Data Grapher tool on the resilientMA website contains down-scaled climate data for Franklin County (discussed in Section 2) and for the Millers River Watershed, which includes the Town of Orange. Observed annual precipitation over the last several decades (1970-2005) is approximately 43 inches. By 2050, the model predicts that 40 inches per year would be the minimum annual precipitation; the median (middle value of the model predictions) could be 46 inches/year with a maximum of 58 inches per year. In general, precipitation projections are more uncertain than temperature projections.¹⁴

Figure 3-1: Observed Change in Very Heavy Precipitation






The northeast has seen a greater increase in heavy precipitation events than the rest of the country.
Source: updated from Karl et al. 2009, Global Climate Change Impacts in the United States.

An increase in stronger storms leads to more flooding and erosion. A shift to winter rains instead of snow will lead to more runoff, flooding, and greater storm damage along with less spring groundwater recharge. More frequent heavy precipitation events also lead to an increased risk for people who live along rivers or in their floodplains. Furthermore, residents who live outside the current flood zone could find themselves within it as the century

¹⁴ <http://resilientma.org/datagrapher/?c=Temp/basin/pcpn/ANN/Deerfield/>

progresses. Figure 3-2 shows potential effects of climate change on flooding from the Massachusetts State Hazard Mitigation and Climate Adaptation Plan.

Figure 3-2: Effects of Climate Change on Flooding		
Potential Effects of Climate Change		
	CHANGES IN PRECIPITATION → MORE INTENSE AND FREQUENT DOWNPOURS	More intense downpours often lead to inland flooding as soils become saturated and stop absorbing more water, river flows rise, and urban stormwater systems become overwhelmed. Flooding may occur as a result of heavy rainfall, snowmelt or coastal flooding associated with high wind and storm surge.
	EXTREME WEATHER → MORE FREQUENT SEVERE STORMS	Climate change is expected to result in an increased frequency of severe storm events. This would directly increase the frequency of flooding events, and could increase the chance that subsequent precipitation will cause flooding if water stages are still elevated.
	CHANGES IN PRECIPITATION → EPISODIC DROUGHTS	Vegetated ground cover has been shown to significantly reduce runoff. If drought causes vegetation to die off, this flood-mitigating capacity is diminished.

Source: Massachusetts State Hazard Mitigation and Climate Adaptation Plan. September 2018

Hazard Description

Nationally, inland flooding causes more damage annually than any other severe weather event (U.S. Climate Resilience Toolkit, 2017). Between 2007 and 2014, the average annual cost of flood damages in Massachusetts was more than \$9.1 million (NOAA, 2014). 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 and exacerbate flooding by concentrating and channeling stormwater runoff into nearby waterbodies. Increases in precipitation and extreme storm events from climate change are already resulting in increased flooding. Common types of flooding are described in the following subsections.

Riverine Flooding

Riverine flooding often occurs after heavy rain. Areas with high slopes and minimal soil cover (such as found in many areas of Orange and Franklin County) are particularly susceptible to flash flooding caused by rapid runoff that occurs in heavy precipitation events and in combination with spring snowmelt, which can contribute to riverine flooding. Frozen ground conditions can also contribute to low rainfall infiltration and high runoff events that may result in riverine flooding. Some of the worst riverine flooding in Massachusetts' history occurred as a result of strong nor'easters and tropical storms in which snowmelt was not a factor. Tropical storms can produce very high rainfall rates and volumes of rain that can generate high runoff when soil infiltration rates are exceeded. Inland flooding in Massachusetts is forecast and classified by the National Weather Service's (NWS) Northeast River Forecast Center as minor, moderate, or severe based upon the types of impacts that occur. Minor flooding is considered a

“nuisance only” degree of flooding that causes impacts such as road closures and flooding of recreational areas and farmland. Moderate flooding can involve land with structures becoming inundated. Major flooding is a widespread, life-threatening event. River forecasts are made at many locations in the state where there are United States Geological Survey (USGS) river gauges that have established flood elevations and levels corresponding to each of the degrees of flooding.

- 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,” according to FEMA.
- 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,” according to FEMA.

Fluvial Erosion

Fluvial erosion is the process in which the river undercuts a bank, usually on the outside bend of a meander, causing sloughing and collapse of the riverbank. Fluvial erosion can also include scouring and down-cutting of the stream bottom, which can be a problem around bridge piers and abutments. In hillier terrain where streams may lack a floodplain, such as in many areas of Orange, fluvial erosion may cause more property damage than inundation. Furthermore, fluvial erosion can often occur in areas that are not part of the 100- or 500-year floodplain.

Fluvial erosion hazard (FEH) zones are mapped areas along rivers and streams that are susceptible to bank erosion caused by flash flooding. Any area within a mapped FEH zone is considered susceptible to bank erosion during a single severe flood or after many years of slow channel migration. As noted above, while the areas of the FEH zones often overlap with areas mapped within the 100-year floodplain on Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) or Flood Hazard Boundary Maps (FHBMs), the FIRMs or FHBMs only show areas that are likely to be inundated by floodwaters that overtop the riverbanks during a severe flood. However, much flood-related property damage and injuries is the result of bank erosion that can undermine roads, bridges, building foundations and other infrastructure. Consequently, FEH zones are sometimes outside of the 100-year floodplain shown on FIRMs or FHBMs. FEH zones can be mapped using fluvial geomorphic assessment data as well as historic data on past flood events. Both the FIRMs and FEH maps should be used in concert to understand and avoid both inundation and erosion hazards, respectively.¹⁵

¹⁵ *Ammonoosuc River Fluvial Erosion Hazard Map for Littleton, NH*. Field Geology Services, 2010.

Urban Drainage Flooding

Urban drainage flooding entails floods caused by increased water runoff due to urban development and drainage systems that are not capable of conveying high flows. Drainage systems are designed to remove surface water from developed areas as quickly as possible to prevent localized flooding on streets and other urban areas. They make use of a closed conveyance system that channels water away from an urban area to surrounding streams, bypassing natural processes of water infiltration into the ground, groundwater storage, and evapotranspiration (plant water uptake and respiration). Since drainage systems reduce the amount of time the surface water takes to reach surrounding streams, flooding can occur more quickly and reach greater depths than if there were no urban development at all. In urban areas, basement, roadway, and infrastructure flooding can result in significant damage due to poor or insufficient stormwater drainage.

Ground Failures

Flooding and flood-related erosion can result from various types of ground failures, which include mud floods and mudflows, and to a much lesser degree, subsidence, liquefaction, and fluvial erosion (discussed above).

Mud floods are floods that carry large amounts of sediment, which can at times exceed 50 percent of the mass of the flood, and often occur in drainage channels and adjacent to mountainous areas. Mudflows are a specific type of landslide that contains large amounts of water and can carry debris as large as boulders. Both mudflows and mud floods result from rain falling on exposed terrain, such as terrain impacted by wildfires or logging. Mud floods and mudflows can lead to large sediment deposits in drainage channels. In addition to causing damage, these events can exacerbate subsequent flooding by filling in rivers and streams.

Subsidence is the process where the ground surface is lowered from natural processes, such as consolidation of subsurface materials and movements in the Earth's crust, or from manmade activities, such as mining, inadequate fill after construction activity, and oil or water extraction. When ground subsides, it can lead to flooding by exposing low-lying areas to groundwater, tides, storm surges, and areas with a high likelihood of overbank flooding.

Liquefaction, or when water-laden sediment behaves like a liquid during an earthquake, can result in floods of saturated soil, debris, and water if it occurs on slopes. Floods from liquefaction are especially common near very steep slopes.

Ice Jam

An ice jam is an accumulation of ice that acts as a natural dam and restricts the flow of a body

of water. There are two types of ice jams: a freeze-up jam and a breakup jam. A freeze-up jam usually occurs in early winter to midwinter during extremely cold weather when super-cooled water and ice formations extend to nearly the entire depth of the river channel. This type of jam can act as a dam and begin to back up the flowing water behind it. The second type, a breakup jam, forms as a result of the breakup of the ice cover at ice-out, causing large pieces of ice to move downstream, potentially piling up at culverts, around bridge abutments, and at curves in river channels. Breakup ice jams occur when warm temperatures and heavy rains cause rapid snowmelt. The melting snow, combined with the heavy rain, causes frozen rivers to swell. The rising water breaks the ice layers into large chunks, which float downstream and often pile up near narrow passages and obstructions (bridges and dams). Ice jams may build up to a thickness great enough to raise the water level and cause flooding upstream of the obstruction. The Ice Jam Database, maintained by the Ice Engineering Group at the U.S. Army Corps of Engineers (USACE) Cold Regions Research and Engineering Laboratory currently consists of more than 18,000 records from across the U.S.



Ice forms on the Millers River in January 2018. Photo courtesy of the Greenfield Recorder/Andy Castillo.

Ice jams have occurred in recent years on the Millers River. The Town of Athol is more often affected by these ice jams, but Orange has still experienced some minor flooding issues. The Committee reported that if flooding occurs in Orange it is due to the shallow riverbed. The river is supposed to be dredged regularly to mitigate the effects of ice jams, but hasn't been.

Dam Failure

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. 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. Impacts and Orange’s vulnerability to dam failure is discussed in more detail in the Dam Failure section of this plan.

Additional Causes of Flooding

Additional causes of flooding include beaver dams or levee failure. Beaver dams obstruct the flow of water and cause water levels to rise. Significant downstream flooding can occur if beaver dams break.

Floodplains

Floodplains by nature are vulnerable to inland flooding. Floodplains are the low, flat, and periodically flooded lands adjacent to rivers, lakes, and oceans. These areas are subject to geomorphic (land-shaping) and hydrologic (water flow) processes. Floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon. These areas form a complex physical and biological system that not only supports a variety of natural resources, but also provides natural flood storage and erosion control. When a river is separated from its floodplain by levees and other flood control facilities, these natural benefits are lost, altered, or significantly reduced. When floodwaters recede after a flood event, they leave behind layers of rock and mud. These gradually build up to create a new floor of the floodplain. Floodplains generally contain unconsolidated sediments known as alluvium (accumulations of sand, gravel, loam, silt, and/or clay), often extending below the bed of the stream. These sediments provide a natural filtering system, with water percolating back into

the ground and replenishing groundwater supplies.

Flooding is a natural and important part of wetland ecosystems that form along rivers and streams. Floodplains can support ecosystems that are rich in plant and animal species. Wetting the floodplain soil releases an immediate surge of nutrients from the rapid decomposition of organic matter that has accumulated over time. When this occurs, microscopic organisms thrive and larger species enter a rapid breeding cycle. Opportunistic feeders (particularly fish or birds) often utilize the increased food supply. The production of nutrients peaks and falls away quickly, but the surge of new growth that results endures for some time. Species growing in floodplains are markedly different from those that grow outside floodplains. For instance, riparian trees (trees that grow in floodplains) tend to be very tolerant of root disturbance and grow quickly in comparison to non-riparian trees.

Location

A floodplain is the relatively flat, lowland area adjacent to a river, lake or stream. Floodplains serve an important function, acting like large “sponges” to absorb and slowly release floodwaters back to surface waters and groundwater. Over time, sediments that are deposited in floodplains develop into fertile, productive farmland like that found in the Connecticut River valley. In the past, floodplain areas were also often seen as prime locations for development. Industries were located on the banks of rivers for access to hydropower. Residential and commercial development occurred in floodplains because of their scenic qualities and proximity to the water, and because these areas were easier to develop than the hilly, rocky terrain characteristic of many towns in the county. Although periodic flooding of a floodplain area is a natural occurrence, past and current development and alteration of these areas can result in flooding that is a costly and frequent hazard.

In Orange, the 100-year floodplain covers about 1,131 acres, or approximately five percent of the town, including an estimated twenty-four acres of developed residential land. Additionally, the Town’s wastewater treatment plant is in the 100-year floodplain, as well as the primary Fire Station. Dams and flood control measures upstream on both the Millers and Connecticut Rivers, especially the Army Corps of Engineers’ flood control projects on the Millers River, provide some level of protection to the town during high flow events.

In addition to the 100-year floodplain, areas upstream from major rivers play an important role in flood mitigation. Upland areas and the small tributary streams that drain them are particularly vulnerable to impacts from development, which can increase the amount of flooding downstream. These areas are critical for absorbing, infiltrating, and slowing the flow of stormwater. When these areas are left in a natural vegetated state (forested or forested

floodplain), they act as “green infrastructure,” providing flood storage and mitigation through natural processes.

Fragmentation and development in upland areas, including roads, which commonly were built along stream and river corridors, can alter this natural process and result in increased amounts of stormwater runoff into streams. For example, the channels of many of these streams were altered centuries ago because of widespread deforestation for agriculture and lumber. The many small mills that used to dot the landscape built dams on the streams to generate power. Many of these streams are still unstable and flashy during storm events, generating high volumes of runoff and transporting sediment to the lower, flatter reaches of the watershed.

In addition, stressors to forests such as drought, extreme weather, and invasive species, can result in the loss of forest cover in upland areas. In particular, cold-water streams shaded by dense hemlock stands are particularly vulnerable due to the hemlock woolly adelgid that is causing widespread mortality of these trees in the region.

Areas of chronic flooding due to undersized culverts or culverts in poor condition include:

- Faraman Road
- Lake Mattawa Road
- Main Road and William Pond Road
- Oxbow road
- Fall Hill Brook
- Mountain Road
- West Branch of Tully on Creamery Hill Road and Tully Road
- Jones Street
- EZ Storage facility – there is a culvert in poor condition under the railroad tracks that causes EZ storage to flood. The railroad company will not respond to repair requests.
- East Main Street Culverts

The Committee also discussed areas in Town that are susceptible to flooding. These areas include:

- Businesses on North Main Street, due to drainage issues
- Large scale solar farms, due to construction and siting issues
- Fairman Road
- Chestnut Hill Road
- The Armory
- Town Hall

- The Town Hall often floods due to storm water runoff coming from the hill behind the building. The runoff has recently caused the building's basement to flood several feet. The Town is currently working to build a trench to mitigate some of the flooding.

Based on these locations, flooding has a "Medium" area of occurrence, with 10% to 50% percent of the town affected.

Extent

The principal factors affecting the strength and magnitude of flood damage are flood depth and velocity. The deeper and faster that flood flows become, 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.

The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge (discussed further in the following subsection) has a 1 percent chance of being equaled or exceeded in any given year. The "annual flood" is the greatest flood event expected to occur in a typical year. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher recurrence interval to occur in a short time period. The same flood can have different recurrence intervals at different points on a river.

Floods can be classified as one of two types: flash floods and general floods.

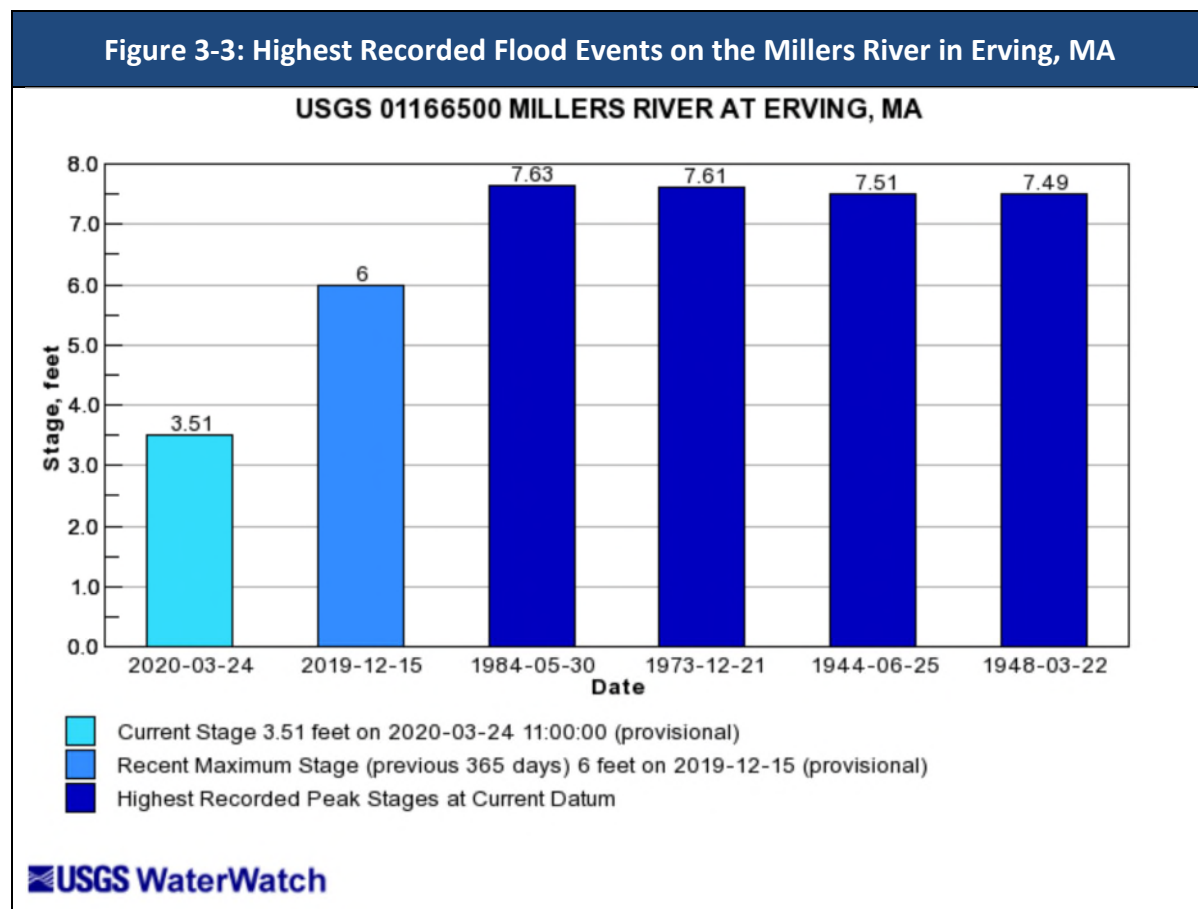
Flash Floods

Flash floods are the product of heavy, localized precipitation in a short time period over a given location. Flash flooding events typically occur within minutes or hours after a period of heavy precipitation, after a dam or levee failure, or from a sudden release of water from an ice jam. Most often, flash flooding is the result of a slow-moving thunderstorm or the heavy rains from a hurricane. In rural areas, flash flooding often occurs when small streams spill over their banks. However, in urbanized areas, flash flooding is often the result of clogged storm drains (leaves and other debris) and the higher amount of impervious surface area (roadways, parking lots, roof tops).

General Floods

General flooding may last for several days or weeks and are caused by precipitation over a longer time period in a particular river basin. Excessive precipitation within a watershed of a stream or river can result in flooding particularly when development in the floodplain has obstructed the natural flow of the water and/or decreased the natural ability of the groundcover to absorb and retain surface water runoff (e.g., the loss of wetlands and the higher amounts of impervious surface area in urban areas).

Flood flows in Massachusetts are measured at numerous USGS stream gauges. The gauges operate routinely, but particular care is taken to measure flows during flood events to calibrate the stage-discharge relationships at each location and to document actual flood conditions. In the aftermath of a flood event, the USGS will typically determine the recurrence interval of the event using data from a gauge's period of historical record. Figure 3-3 shows the four highest recorded peak flooding events on the Millers River in Erving, as well as the highest flow event in the last 365 days. This stream gage is located downstream of Orange.



Source: USGS WaterWatch https://waterwatch.usgs.gov/index.php?id=wwchart_ftc&site_no=01166500.

The 100-Year Flood

The 100-year flood is the flood that has a 1 percent chance of being equaled or exceeded each year. The 100-year flood is the standard used by most federal and state agencies. For example, it is used by the National Flood Insurance Program (NFIP) to guide floodplain management and determine the need for flood insurance.

The extent of flooding associated with a 1 percent annual probability of occurrence (the base flood or 100-year flood) is called the 100-year floodplain, which is used as the regulatory boundary by many agencies. Also referred to as the Special Flood Hazard Area (SFHA), this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. This extent generally includes both the stream channel and the flood fringe, which is the stream-adjacent area that will be inundated during a 100-year (or 1 percent annual chance) flood event but does not effectively convey floodwaters.

The 500-Year Flood

The term “500-year flood” is the flood that has a 0.2 percent chance of being equaled or exceeded each year. Flood insurance purchases are not required by the Federal Government in the 500-year floodplain, but could be required by individual lenders.

Secondary Hazards

The most problematic secondary hazards for flooding are fluvial erosion, river bank erosion, and landslides affecting infrastructure and other assets (e.g., agricultural fields) built within historic floodplains. Without the space required along river corridors for natural physical adjustment, such changes in rivers after flood events can be more harmful than the actual flooding. For instance, fluvial erosion attributed to Hurricane Irene caused an excess of \$23 million in damages along Route 2. The impacts from these secondary hazards are especially prevalent in the upper courses of rivers with steep gradients, where floodwaters may pass quickly and without much damage, but scour the banks, edging buildings, and structures closer to the river channel or cause them to fall in. Landslides can occur following flood events when high flows oversaturate soils on steep slopes, causing them to fail.

These secondary hazards also affect infrastructure. Roadways and bridges are impacted when floods undermine or wash out supporting structures. Railroad tracks may be impacted, potentially causing a train derailment, which could result in the release of hazardous materials into the environment and nearby waterways. Dams may fail or be damaged, compounding the

flood hazard for downstream communities. Failure of wastewater treatment plants from overflow or overtopping of hazardous material tanks and the dislodging of hazardous waste containers can occur during floods as well, releasing untreated wastewater or hazardous materials directly into storm sewers, rivers, or the ocean. Flooding can also impact public water supplies and the power grid.

Previous Occurrences

The average annual precipitation for Orange and surrounding areas in western Massachusetts is 48 inches. Between 1996 and 2017, 17 flash floods have been reported in Franklin County (Table 3-6), resulting in \$3,245,000 in property damages.

Table 3-6: Previous Occurrences of Flash Floods in Franklin County			
Year	# of Flash Flood Events	Annual Property Damage	Annual Crop Damage
1996	4	\$1,800,000	\$0
1998	1	\$75,000	\$0
2000	1	\$0	\$0
2003	1	\$10,000	\$0
2004	1	\$10,000	\$0
2005	3	\$1,235,000	\$0
2013	3	\$65,000	\$0
2014	2	\$50,000	\$0
2017	1	\$0	\$0
Total	17	\$3,245,000	\$0

Source: National Oceanic and Atmospheric Administration (NOAA) Storm Events Database:

<https://www.ncdc.noaa.gov/stormevents/>

From 1996 to 2018, 44 flood events were reported in Franklin County, resulting in total property damages worth \$25,582,000 (Table 3-7). The bulk of these damages (\$22,275,000) were from Tropical Storm Irene in August, 2011. Orange did not suffer major flooding from Tropical Storm Irene. The most severe impacts from Irene were experienced in the western portion of Franklin County.

Table 3-7: Previous Occurrences of Floods in Franklin County			
Year	# of Flood Events	Annual Property Damage	Annual Crop Damage
1996	7	\$0	\$0
1998	3	\$0	\$0

Table 3-7: Previous Occurrences of Floods in Franklin County			
Year	# of Flood Events	Annual Property Damage	Annual Crop Damage
2001	1	\$0	\$0
2004	1	\$0	\$0
2005	2	\$2,600,000	\$0
2007	1	\$250,000	\$0
2008	3	\$38,000	\$0
2010	1	\$150,000	\$0
2011	8	\$22,375,000	\$0
2012	2	\$0	\$0
2015	10	\$31,000	\$0
2017	1	\$1,000	\$0
2018	4	\$137,000	\$0
Total	44	\$25,582,000	\$0

Source: National Oceanic and Atmospheric Administration (NOAA) Storm Events Database:

<https://www.ncdc.noaa.gov/stormevents/>

Ice jams have caused damage to riverbanks, and between the Millers River and Route 2. Tree scarring is apparent in these areas, where blocks of ice have gouged and damaged riparian trees, which could have effects on riverbank stability and riparian habitat if ice jams become a more frequent occurrence. Ice Jams upstream in the Town of Athol in 2018 had a big impact on the town as well as downstream in Orange. Orange had to closely monitor the ice jams. Ice jams also threaten Orange's wastewater treatment plant. Table 3-8 further describes damage from the previously mentioned ice jam that occurred in January 2018.

Table 3-8: Flooding Events in Orange since 1993				
Date	Location	Type	Recorded Property Damages	Event Narrative
1/13/2018	Tully/North Orange	Ice Jam	\$100,000	As reported by the Greenfield Recorder: a mass of ice broke free on the Millers River in Athol early the morning of the 13th. Additional ice broke free on the river near L. S. Starrett Company at 7 AM EST. The ice first struck the Exchange Street bridge, where hangers that secure a 10-inch water main to the bridge were swept downstream. The ice jam then

Table 3-8: Flooding Events in Orange since 1993				
Date	Location	Type	Recorded Property Damages	Event Narrative
				migrated downstream to the South Main Street bridge, and finally downstream of this bridge to a sandbar one-half mile southwest. Flooding reached into the first floor level of homes on Canal Street. The Morton Meadows elderly housing complex was evacuated, as water came to within a few feet of the nearest building. By the end of January, this jam was flushed downstream to reform near the Orange-Athol town line, but the river was flowing through this new jam.

Source: National Oceanic and Atmospheric Administration (NOAA) Storm Events Database:

<https://www.ncdc.noaa.gov/stormevents/>

Probability of Future Events

Based on previous occurrences, the frequency of occurrence of flooding events in Orange is "Moderate" with a 2 to 25 percent probability in any given year. Flooding frequencies for the various floodplains in Orange are defined by FEMA as the following:

- 10-year floodplain – 10 percent chance of flooding in any given year
- 25-year floodplain – 2.5 percent chance of flooding in any given year
- 100-year floodplain – 1 percent chance of flooding in any given year
- 500-year floodplain – 0.2 percent chance of flooding in any given year

Of all the regions in the United States, the Northeast has seen the most dramatic increase in the intensity of rainfall events. The U.S. National Climate Assessment reports that between 1958 and 2010, the Northeast saw more than a 70% increase in the amount of precipitation falling in very heavy events (defined as the heaviest 1% of all daily events). Climate projections for Massachusetts, developed by the University of Massachusetts, suggest that the frequency of high-intensity rainfall events will continue to trend upward, and the result will be an increased risk of flooding. Specifically, the annual frequency of downpours releasing more than two inches of rain per day in Massachusetts may climb from less than 1 day per year to

approximately 0.9-1.5 days by 2100. Events which release over one inch during a day could climb to as high as 8-11 days per year by 2100. A single intense downpour can cause flooding and widespread damage to property and critical infrastructure. While the coastal areas in Massachusetts will experience the greatest increase in high-intensity rainfall days, some level of increase will occur in every area of Massachusetts, including Orange.¹⁶

Impact

Flooding can cause a wide range of issues, from minor nuisance roadway flooding and basement flooding to major impacts such as roadway closures. Specific damages associated with flooding events include the following primary concerns:

- Blockages of roadways or bridges vital to travel and emergency response
- Breaching of dams
- Damaged or destroyed buildings and vehicles
- Uprooted trees causing power and utility outages
- Drowning, especially people trapped in cars
- Contamination of drinking water
- Dispersion of hazardous materials
- Interruption of communications and/or transportation systems, including train derailments

The impact of a flood event would likely be Limited in Orange, with more than 10% of property in the affected area damaged or destroyed, and possible shutdown of facilities (roads, bridges, critical facilities) for more than one week.

Vulnerability

Society

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 traveling in flooded areas and those living in urban areas with poor stormwater drainage may be exposed to floodwater. People may also be impacted when transportation infrastructure is compromised from flooding.

Of Orange's total acreage, 1,131 acres lie within the 100-year floodplain. According to 2005

¹⁶ ResilientMA: Climate Change Clearing House for the Commonwealth: <http://resilientma.org/changes/changes-in-precipitation>. Accessed December 13, 2018.

MassGIS Land Use data there are 33 dwelling units located in the floodplain (Table 3-9). Using this number and Orange's estimated average household size, it is estimated that 81 people, or 1% of Orange's total population, reside in the floodplain.

Table 3-9: Estimated Orange Population Exposed to a 1 Percent Flood Event				
Total Population	# of Dwelling Units in Flood Hazard Area	Average # of People Per Household	Estimated Population in Flood Hazard Area	% of Total Population in Flood Hazard Area
7,703	33	2.44	81	1%

Source: 2013-2017 American Community Survey Five-Year Estimates; 2005 MassGIS Land Use data.

Vulnerable Populations

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

Table 3-10 estimates the number of vulnerable populations and households in Orange. Individuals and households may fall into multiple categories, so the numbers should not be added. Rather, the table provides Town officials and emergency response personnel with information to help plan for responding to the needs of Orange residents during a flood event.

Table 3-10: Estimated Vulnerable Populations in Orange		
Vulnerable Population Category	Number	Percent of Total Population*
Population Age 65 Years and Over	1,308	17%
Population with a Disability	1,437	19%
Population who Speak English Less than "Very Well"	75	1%
Vulnerable Household Category	Number	Percent of Total Households*

Low Income Households (annual income less than \$35,000)	1,242	40%
Householder Age 65 Years and Over Living Alone	426	14%
Households Without Access to a Vehicle	273	9%

*Total population = 7,682; Total households = 3,137

Note: Individuals and households may be counted under multiple categories.

Source: U.S. Census American Community Survey 2013-2017 Five-Year Estimates.

Health Impacts

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 1996 to 2018 indicates that there have been no fatalities or injuries associated with flooding or flash flooding events in Orange. 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, 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).

Economic Impacts

Economic losses due to a flood include, but are not limited to, damages to buildings (and their contents) and infrastructure, agricultural losses, business interruptions (including loss of wages), impacts on tourism, and impacts on the tax base. Flooding can also cause extensive damage to public utilities and disruptions to the delivery of services. Loss of power and communications may occur, and drinking water and wastewater treatment facilities may be temporarily out of operation. Flooding can shut down major roadways and disrupt public transit systems, making it difficult or impossible for people to get to work. Floodwaters can wash out sections of roadway and bridges, and the removal and disposal of debris can also be an enormous cost during the recovery phase of a flood event. Agricultural impacts range from crop and infrastructure damage to loss of livestock. Extreme precipitation events may result in crop failure, inability to harvest, rot, and increases in crop pests and disease. In addition to having a detrimental effect on water quality and soil health and stability, these impacts can result in increased reliance on crop insurance claims.

Damages to buildings can affect a community's economy and tax base; the following section includes an analysis of buildings in Orange that are vulnerable to flooding and their associated value.

Infrastructure

Buildings, infrastructure, and other elements of the built environment are vulnerable to inland flooding. At the site scale, buildings that are not elevated or flood-proofed and those located within the floodplain are highly vulnerable to inland flooding. These buildings are likely to become increasingly vulnerable as riverine flooding increases due to climate change (resilient MA, 2018). At a neighborhood to regional scale, highly developed areas and areas with high impervious surface coverage may be most vulnerable to flooding. Even moderate development that results in as little as 3 percent impervious cover can lead to flashier flows and river degradation, including channel deepening, widening, and instability (Vietz and Hawley,

2016).

Additionally, changes in precipitation will threaten key infrastructure assets with flood and water damage. Climate change has the potential to impact public and private services and business operations. Damage associated with flooding to business facilities, large manufacturing areas in river valleys, energy delivery and transmission, and transportation systems has economic implications for business owners as well as the state's economy in general (resilient MA, 2018). Flooding can cause direct damage to Town-owned facilities and result in roadblocks and inaccessible streets that impact the ability of public safety and emergency vehicles to respond to calls for service.

Table 3-11 shows the amount of commercial, industrial, and public/institutional land uses located in town and within the floodplain. Less than half an acre of commercial and public/institutional land uses lie within the floodplain, accounting for only 0.4 percent of commercial land uses in town and .02 percent of public/institutional uses in town. Roughly five and a half acres of industrial land use is located in the floodplain, accounting for 11 percent of the industrial land in town.

Table 3-11: Acres of Commercial, Industrial, and Public/Institutional Land Use Within the Flood Hazard Area in Orange			
Land Use	Total acres in Town	Acres in Flood Hazard Area	% of total acres in Flood Hazard Area
Commercial	165	6	4%
Industrial	133	13	10%
Public/Institutional	68	1.5	2%

Source: 2005 MassGIS Land Use data.

The Wastewater Treatment Plant is the only significant structure located within the floodplain in Orange. The 2011 assessed building value is presented in Table 3-12. In December 2019, the United States Department of Agriculture awarded Orange with a \$6.6 million grant to cover 40% of the cost of upgrading the plant, along with a \$10 million loan to cover the rest of the project costs.¹⁷ The construction on the facility is currently planned for late 2020; the improvements will increase the total building value within the floodplain.

Table 3-12: Total Building Value in Flood Hazard Area			
Structure	Building Structure Value	Building Contents Value	Total Building Value in Flood

¹⁷ [https://www.recorder.com/Orange-gets-\\$10-million-wastewater-grant-31090664](https://www.recorder.com/Orange-gets-$10-million-wastewater-grant-31090664)

	in Flood Hazard Area		Hazard Area
Orange Wastewater Treatment Plant	\$220,700	\$220,700	\$441,400

Source: 2011 Orange Assessors data.

NFIP data are useful for determining the location of areas vulnerable to flood and severe storm hazards. Table 3-13 summarizes the NFIP policies, claims, repetitive loss (RL) properties, and severe repetitive loss (SRL) properties in Orange associated with all flood events as of December 2018. A RL property is a property for which two or more flood insurance claims of more than \$1,000 have been paid by the NFIP within any 10-year period since 1978. A SRL property is defined as one that “has incurred flood-related damage for which 4 or more separate claims payments have been paid under flood insurance coverage, with the amount of each claim payment exceeding \$5,000 and with cumulative amount of such claims payments exceeding \$20,000; or for which at least 2 separate claims payments have been made with the cumulative amount of such claims exceeding the reported value of the property” (FEMA). Orange currently has six policies in force, one loss has been paid and there are no repetitive loss properties in town.

Table 3-13: NFIP Policies, Claims, and Repetitive Loss Statistics for Orange						
Number of Housing Units (2017 Estimates)	Number of Policies in Force	Percent of Housing Units	Total Insurance in Force	Number of Paid Losses	Total Losses Paid	Number of Repetitive Loss Properties
3,539	6	.2%	\$798,100	1	\$8,300	0

Source: National Flood Insurance Program (NFIP), FEMA Region I; U.S. Census Bureau 2013-2017 American Community Survey Five-Year Estimates.

Many dams within the Commonwealth have aged past their design life. As a result, they are less resilient to hazards such as inland flooding and extreme precipitation, and may not provide adequate safety following these disasters. These structures, if impacted by disasters, can affect human health, safety, and economic activity due to increased flooding and loss of infrastructure functions. These dams require termination or restoration to improve their infrastructure and better equip them to withstand the hazards that the Commonwealth will face due to climate change.

As already stated, climate change impacts, including increased frequency of extreme weather events, are expected to raise the risk of damage to transportation systems, energy-related facilities, communication systems, a wide range of structures and buildings, solid and hazardous waste facilities, and water supply and wastewater management systems. A majority of the

infrastructure in Massachusetts and throughout the country has been sited and designed based on historic weather and flooding patterns. As a result, infrastructure and facilities may lack the capacity to handle greater volumes of water or the required elevation to reduce vulnerability to flooding. Examples of climate change impacts to sectors of the built environment are summarized below.

Agriculture

Inland flooding is likely to impact the agricultural sector. Increased river flooding is likely to cause soil erosion, soil loss, and crop damage (resilient MA, 2018). In addition, wetter springs may delay planting of crops, resulting in reduced yields.

Energy

Flooding can increase bank erosion and also undermine buried energy infrastructure, such as underground power, gas, and cable infrastructure. Basement flooding can destroy electrical panels and furnaces. This can result in releases of oil and hazardous wastes to floodwaters. Inland flooding can also disrupt delivery of liquid fuels.

Public Health

The impacts to the built environment extend into other sectors. For example, flooding may increase the vulnerability of commercial and residential buildings to toxic mold buildup, leading to health risks, as described in the Populations section of the inland flooding hazard profile. Inland flooding may also lead to contamination of well water and contamination from septic systems (DPH, 2014).

Public Safety

Flash flooding can have a significant impact on public safety. Fast-moving water can sweep up debris, hazardous objects, and vehicles, and carry them toward people and property. Flooding can impact the ability of emergency response personnel to reach stranded or injured people. Drownings may also occur as people attempt to drive through flooded streets or escape to higher ground.

Transportation

Heavy precipitation events may damage roads, bridges, and energy facilities, leading to disruptions in transportation and utility services (resilient MA, 2018). Roads may experience greater ponding, which will further impact transportation. If alternative routes are not available, damage to roads and bridges may dramatically affect commerce and public health and safety.

Water Infrastructure

Stormwater drainage systems and culverts that are not sized to accommodate larger storms are likely to experience flood damage as extreme precipitation events increase (resilient MA, 2018). Both culverts that are currently undersized and culverts that are appropriately sized may be overwhelmed by larger storms. Gravity-fed water and wastewater infrastructure that is located in low lying areas near rivers and reservoirs may experience increased risks. Combined sewer overflows may increase with climate change, resulting in water quality degradation and public health risks (resilient MA, 2018).

Environment

Flooding is part of the natural cycle of a balanced environment. However, severe flood events can also result in substantial damage to the environment and natural resources, particularly in areas where human development has interfered with natural flood-related processes. As described earlier in this section, severe weather events are expected to become more frequent as a result of climate change; therefore, flooding that exceeds the adaptive capacity of natural systems may occur more often.

One common environmental effect of flooding is riverbank and soil erosion. Riverbank erosion occurs when high, fast water flows scour the edges of the river, transporting sediment downstream and reshaping the ecosystem. In addition to changing the habitat around the riverbank, this process also results in the deposition of sediment once water velocities slow. This deposition can clog riverbeds and streams, disrupting the water supply to downstream habitats. Soil erosion occurs whenever floodwaters loosen particles of topsoil and then transport them downstream, where they may be redeposited somewhere else or flushed into the ocean. Flooding can also influence soil conditions in areas where floodwaters pool for long periods of time, as continued soil submersion can cause oxygen depletion in the soil, reducing the soil quality and potentially limiting future crop production.

Flooding can also affect the health and well-being of wildlife. Animals can be directly swept away by flooding or lose their habitats to prolonged inundation. Floodwaters can also impact habitats nearby or downstream of agricultural operations by dispersing waste, pollutants, and nutrients from fertilizers. While some of these substances, particularly organic matter and nutrients, can actually increase the fertility of downstream soils, they can also result in severe impacts to aquatic habitats, such as eutrophication.

Vulnerability Summary

Based on the above analysis, Orange has a "Medium" vulnerability to flooding. The following problem statements summarize Orange's areas of greatest concern regarding the flood hazard.

Flood Hazard Problem Statements

- Orange does not yet have a comprehensive list of GIS mapping of culverts throughout Town.
- There is an issue with flooding at Orange’s Town hall due to storm water runoff coming from the hill behind it. The Town is currently working to build a trench in the back of the building to promote drainage. Other projects located upland of the Town Hall should be explored to mitigate storm water runoff.
- The bridge going over the East Branch of Tully River is noted to be of concern – emergency vehicles may not be able to cross the bridge during an emergency.
- Drainage infrastructure on North Main Street/in downtown Orange is not sufficient, and there are several businesses that experience flooding during heavy rain events.
- The Fire Station located on Tully Road can become isolated during hazard events, especially if key bridges go out. This station also does not have cell service, and power outages cause the station to lose internet access and cable, which further isolates emergency responders during severe weather.
- Many bridges in Orange have low weight limits, which complicates access routes for emergency vehicles.
- Town bylaws for residential and commercial development reflect the 100 year flood plain and previous norms in precipitation. The Committee has noted that these bylaws do not adequately reflect changes in annual precipitation, and they should be updated.
- Several solar fields throughout Orange are susceptible to flooding and landslides due to the way they were sited. A landslide from one of the fields recently resulted in a road closure.
- Ice jams on the Millers River in Athol are of concern, as they result in localized flood events in Orange. Regular dredging of the river is needed in order to prevent ice jams
- Private wells located close to floodways may be vulnerable to flooding and contamination.
- Many of the Town’s evacuation routes may be impacted by flooding. There are areas of Town where residents might become isolated if roads, bridges, or culverts were blocked or damaged during a flood.
- New initiatives are needed to improve household disaster preparedness Town-wide and to better reach vulnerable populations, including seniors and disabled residents with lessened mobility or medical needs, as well as homeless or transient people who may be difficult to reach in the event of an emergency. The Town may need to review and update evacuation planning for vulnerable populations in its CEMP, explore additional sheltering options, and pursue supportive partnerships for sheltering in the community.
- Emergency shelters may not be adequately staffed or supplied with water, food, and first aid supplies. There is a need to inventory the supplies currently available at Orange shelters.




Flood Hazard Problem Statements

- Although the Town has a Reverse 911 Warning System (CodeRED) with a large percentage of residents subscribing to the service, there is a need to continue to increase subscription among residents and businesses. Education and outreach are needed to ensure that all residents are aware of emergency situations and have access to evacuation and sheltering instructions, including options for residents with specialized medical needs, and pet sheltering options.
- Many residents live in isolated locations with unreliable cell service, which can decrease access to emergency services.

3.3 SEVERE SNOWSTORMS / ICE STORMS

Potential Effects of Climate Change

Climate projections for Massachusetts indicate that in future decades, winter precipitation could increase annually by as much as 0.4-3.9 inches (an increase of 4-35%), but by the end of the century most of this precipitation is likely to fall as rain instead of snow. There are many human and environmental impacts that could result from this change including reduced snow cover for winter recreation and tourism, less spring snow melt to replenish aquifers and lower spring river flows for aquatic ecosystems. Figure 3-4 show potential effects of climate change on severe winter storms from the Massachusetts State Hazard Mitigation and Climate Adaptation Plan.

Figure 3-4: Effects of Climate Change on Severe Winter Storms		
Potential Effects of Climate Change		
	EXTREME WEATHER AND RISING TEMPERATURES → INCREASED SNOWFALL	Increased sea surface temperature in the Atlantic Ocean will cause air moving north over the 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.
	RISING TEMPERATURES → CHANGING CIRCULATION PATTERNS AND WARMING OCEANS	Research has found that increasing water temperatures and reduced sea ice extent in the Arctic are producing atmospheric circulation patterns that favor the development of winter storms in the eastern U.S. Global warming is increasing the severity of winter storms because warming ocean water allows additional moisture to flow into the storm, which fuels the storm to greater intensity.
	EXTREME WEATHER → INCREASE IN FREQUENCY AND INTENSITY	There is evidence suggesting that nor'easters along the Atlantic coast are increasing in frequency and intensity. Future nor'easters may become more concentrated in the coldest winter months when atmospheric temperatures are still low enough to result in snowfall rather than rain.

Source: Massachusetts State Hazard Mitigation and Climate Adaptation Plan. September 2018

Hazard Description

Severe winter storms include ice storms, nor'easters, heavy snow, blowing snow, and other extreme forms of winter precipitation. A blizzard is a winter snowstorm with sustained or frequent wind gusts to 35 mph or more, accompanied by falling or blowing snow that reduces visibility to or below a quarter of a mile (NWS, 2018). These conditions must be the predominant condition over a 3-hour period. Extremely cold temperatures are often associated with blizzard conditions, but are not a formal part of the 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.

Storm systems powerful enough to cause blizzards usually form when the jet stream dips far to the south, allowing cold air from the north to clash with warm air from the south. Blizzard

conditions often develop on the northwest side of an intense storm system. The difference between the lower pressure in the storm and the higher pressure to the west creates a tight pressure gradient, resulting in strong winds and extreme conditions due to the blowing snow. Blowing snow is wind-driven snow that reduces visibility to 6 miles or less, causing significant drifting. Blowing snow may be snow that is falling and/or loose snow on the ground picked up by the wind.

Ice Storms

Ice storm conditions are defined by liquid rain falling and freezing on contact with cold objects, creating ice buildups of one-fourth of an inch or more. These can cause severe damage. An ice storm warning, which is now included in the criteria for a winter storm warning, is issued when a half 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.

Ice pellets are another form of freezing precipitation, formed when snowflakes melt into raindrops as they pass through a thin layer of warmer air. The raindrops then refreeze into particles of ice when they fall into a layer of subfreezing air near the surface of the earth. Finally, sleet occurs when raindrops fall into subfreezing air thick enough that the raindrops refreeze into ice before hitting the ground. The difference between sleet and hail is that sleet is a wintertime phenomenon whereas hail falls from convective clouds (usually thunderstorms), often during the warm spring and summer months.

Nor'easters

A nor'easter is a storm that occurs along the East Coast of North America with winds from the northeast (NWS, n.d.). A nor'easter is characterized by a large counter-clockwise wind circulation around a low-pressure center that often results in heavy snow, high winds, and rain. A nor'easter gets its name from its continuously strong northeasterly winds blowing in from the ocean ahead of the storm and over the coastal areas.

Nor'easters are among winter's most ferocious storms. These winter weather events are notorious for producing heavy snow, rain, and oversized waves that crash onto Atlantic beaches, often causing beach erosion and structural damage. These storms occur most often in late fall and early winter. The storm radius is often as much as 100 miles, and nor'easters often sit stationary for several days, affecting multiple tide cycles and causing extended heavy precipitation. Sustained wind speeds of 20 to 40 mph are common during a nor'easter, with short-term wind speeds gusting up to 50 to 60 mph. Nor'easters are commonly accompanied with a storm surge equal to or greater than 2.0 feet.

Nor'easters begin as strong areas of low pressure either in the Gulf of Mexico or off the East Coast in the Atlantic Ocean. The low will then either move up the East Coast into New England and the Atlantic provinces of Canada, or out to sea. The level of damage in a strong hurricane is often more severe than a nor'easter, but historically Massachusetts has suffered more damage from nor'easters because of the greater frequency of these coastal storms (one or two per year). The comparison of hurricanes to nor'easters reveals that the duration of high surge and winds in a hurricane is 6 to 12 hours, while a nor'easter's duration can be from 12 hours to 3 days.

Severe winter storms can pose a significant risk to property and human life. The rain, freezing rain, ice, snow, cold temperatures and wind associated with these storms can cause the following hazards:

- Disrupted power and phone service
- Unsafe roadways and increased traffic accidents
- Infrastructure and other property are also at risk from severe winter storms and the associated flooding that can occur following heavy snow melt
- Tree damage and fallen branches that cause utility line damage and roadway blockages
- Damage to telecommunications structures
- Reduced ability of emergency officials to respond promptly to medical emergencies or fires
- Elderly are affected by extreme weather

Location

Although the entire Commonwealth may be considered at risk to the hazard of severe winter storms, higher snow accumulations appear to be prevalent at higher elevations in Western and Central Massachusetts, and along the coast where snowfall can be enhanced by additional ocean moisture. Ice storms occur most frequently in the higher-elevation portions of Western and Central Massachusetts. Inland areas, especially those in floodplains, are also at risk for flooding and wind damage.

The entire town of Orange is susceptible to severe snowstorms and ice storms. Because these storms occur regionally, they impact the entire town. As a result, the location of occurrence is "Large," with over 50 percent of land area affected.

Extent

Since 2005, the Regional Snowfall Index (RSI) has become the descriptor of choice for

measuring winter events that impact the eastern two-thirds of the U.S. The RSI ranks snowstorm impacts on a scale system from 1 to 5 as depicted in Table 3-15. The RSI is similar to the Fujita scale for tornadoes or the Saffir-Simpson scale for hurricanes, except that it includes an additional variable: population. The RSI is based on the spatial extent of the storm, the amount of snowfall, and population.

The RSI is a regional index. Each of the six climate regions (identified by the NOAA National Centers for Environmental Information) in the eastern two-thirds of the nation has a separate index. The RSI incorporated region-specific parameters and thresholds for calculating the index. The RSI is important because, with it, a storm event and its societal impacts can be assessed within the context of a region's historical events. Snowfall thresholds in Massachusetts (in the Northeast region) are 4, 10, 20, and 30 inches of snowfall, while thresholds in the Southeast U.S. are 2, 5, 10, and 15 inches.

Table 3-14: Regional Snowfall Index Categories		
Category	RSI Value	Description
1	1—3	Notable
2	2.5—3.99	Significant
3	4—5.99	Major
4	6—9.99	Crippling
5	10.0+	Extreme

Source: NOAA National Climatic Data Center

Prior to the use of the RSI, the Northeast Snowfall Impact Scale (NESIS), developed by Paul Kocin of The Weather Channel and Louis Uccellini of the National Weather Service, was used to characterize and rank high-impact northeast snowstorms with large areas of 10-inch snowfall accumulations and greater. In contrast to the RSI, which is a regional index, NESIS is a quasi-national index that is calibrated to Northeast snowstorms. NESIS has five categories, as shown in Table 3-15.

Table 3-15: Northeast Snowfall Impact Scale Categories		
Category	NESIS Value	Description
1	1—2.499	Notable
2	2.5—3.99	Significant
3	4—5.99	Major

4	6—9.99	Crippling
5	10.0+	Extreme

Source: NOAA National Climatic Data Center

Previous Occurrences

New England generally experiences at least one or two severe winter storms each year with varying degrees of severity. Severe winter storms typically occur during January and February; however, they can occur from late September through late April. According to NOAA's National Climatic Data Center, there have been 80 heavy snow events in Franklin County since 1996, resulting in \$15,440,000 in damages; 29 winter storm events since 2002, resulting in \$1,170,000 in damages; and two ice storms have resulted in damages of \$3,150,000.

In 2018, New England was hit by three Nor'easters within the first two weeks of March. The first was Winter Storm Riley which brought damaging winds, heavy snow and coastal flooding. Then, Winter Storm Quinn dumped heavy snow, taking down more trees and causing additional power outages on top of those caused by Riley. The third Nor'easter, called Winter Storm Skylar, occurred on March 11-13 and brought over a foot of snow in Massachusetts. With severe winter storms occurring soon after each other, there is little time to recover from one storm before needing to brace for the next. Utilities companies may have to work for weeks or months to restore power after mounting failures, leaving some customers without power for extended time periods. Snow storage and disposal becomes more challenging and expensive when designated snow storage areas fill up, forcing municipalities to pay for snow removal and hauling. For example, after the second-highest snowfall record was set in Boston's recorded history in 2015, the City had to spend an estimated \$35 million - double the allotted budget - on snow and ice removal, setting another record for the most money ever spent on snow removal, according to local news reporting.¹⁸

In December 2008, a major ice storm impacted the northeast. The hardest hit areas in southern New England were the Monadnock region of southwest New Hampshire, the Worcester Hills in central Massachusetts, and the east slopes of the Berkshires in western Massachusetts. Anywhere from half an inch to an inch of ice built up on many exposed surfaces. Combined with breezy conditions, the ice downed numerous trees, branches, and power lines which resulted in widespread power outages. More than 300,000 customers were reportedly without power in Massachusetts and an additional 300,000 were without power in the state of New Hampshire.

Damage to the infrastructure in Massachusetts and New Hampshire amounted to roughly 80

¹⁸ <https://www.boston.com/news/local-news/2015/02/18/boston-to-set-record-for-most-dollars-spent-on-snow-removal>

million dollars. This amount does not include damage to private property. The extent of the damage and number of people affected prompted the governors of both Massachusetts and New Hampshire to request federal assistance. FEMA approved both requests. President Bush issued a Major Disaster Declaration for Public Assistance for seven Massachusetts counties and all of New Hampshire.

Based on data available from the National Oceanic and Atmospheric Administration, there are 210 winter storms since 1900 that have registered on the RSI scale. Of these, approximately 18 storms resulted in snow falls in all or parts of Franklin County of at least 10 inches. These storms are listed in Table 3-16, in order of their RSI severity.

Table 3-16: High-Impact Snowstorms in Franklin County, 1958 - 2018			
Date	RSI Value	RSI Category	RSI Classification
2/22/1969	34.0	5	Extreme
3/12/1993	22.1	5	Extreme
1/6/1996	21.7	5	Extreme
2/5/1978	18.4	5	Extreme
2/23/2010	17.8	4	Crippling
2/15/2003	14.7	4	Crippling
1/29/1966	12.3	4	Crippling
3/12/2017	10.7	4	Crippling
2/27/1947	10.6	4	Crippling
12/25/1969	10.1	4	Crippling
12/4/2003	9.4	3	Major
2/8/2013	9.2	3	Major
2/2/1961	8.3	3	Major
2/10/1983	7.9	3	Major
2/14/1958	7.9	3	Major
2/12/2007	6.9	3	Major
3/2/1960	6.9	3	Major
1/25/2015	6.2	3	Major

Source: <https://www.ncdc.noaa.gov/snow-and-ice/rsi/societal-impacts>

Probability of Future Events

Based upon the availability of records for Franklin County, the likelihood that a severe snow storm will hit Orange in any given year is "Very High," or a 70 to 100 percent probability in any given year.

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. Climate projections for Massachusetts indicate that in future decades, winter precipitation could increase annually by as much as 0.4-3.9 inches (an increase of 4-35%), but by the end of the century most of this precipitation is likely to fall as rain instead of snow. There are many human and environmental impacts that could result from this change including reduced snow cover for winter recreation and tourism, less spring snow melt to replenish aquifers and lower spring river flows for aquatic ecosystems.

Impact

The phrase “severe winter storm” encapsulates several types of natural hazards, including snowfall, wind, ice, sleet, and freezing rain hazards. Additional natural hazards that can occur as a result of winter storms include sudden and severe drops in temperature. Winter storms can also result in flooding and the destabilization of hillsides as snow or ice melts and begins to run off. The storms can also result in significant structural damage from wind and snow load as well as human injuries and economic and infrastructure impacts.

The impact of an event would be “Limited,” with more than 10 percent of property in the affected area damaged and complete shutdown of facilities for more than 1 day possible.

Vulnerability

Society

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 that create blizzard conditions with blinding wind-driven snow, drifting snow, and extreme cold temperatures with dangerous wind chill. These events 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.

Heavy snow can immobilize a region and paralyze a community, shutting down air and rail transportation, stopping the flow of supplies, and disrupting medical and emergency services. Accumulations of snow can cause buildings to collapse and knock down trees and power lines. In rural areas, homes and farms may be isolated for days, and unprotected livestock may perish. In the mountains, heavy snow can lead to avalanches.

The impact of a severe winter storm on life, health, and safety is dependent upon several factors, including the severity of the event and whether or not adequate warning time was provided to residents. 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. The entire population of Orange is exposed to severe winter weather events.

Vulnerable Populations

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 winter storm 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. Residents relying on private wells could lose access to fresh drinking water and indoor plumbing during a power outage.

Table 3-17 estimates the number of vulnerable populations and households in Orange. Individuals and households may fall into multiple categories, so the numbers should not be added. Rather, the table provides Town officials and emergency response personnel with information to help plan for responding to the needs of Orange residents during a severe winter storm event.

Table 3-17: Estimated Vulnerable Populations in Orange		
Vulnerable Population Category	Number	Percent of Total Population*
Population Age 65 Years and Over	1,308	17%

Population with a Disability	1,437	19%
Population who Speak English Less than "Very Well"	75	1%
Vulnerable Household Category	Number	Percent of Total Households*
Low Income Households (annual income less than \$35,000)	1,242	40%
Householder Age 65 Years and Over Living Alone	426	14%
Households Without Access to a Vehicle	273	9%

*Total population = 7,682; Total households = 3,137

Note: Individuals and households may be counted under multiple categories.

Source: U.S. Census American Community Survey 2013-2017 Five-Year Estimates.

Health Impacts

Cold weather, which is a component of a severe winter storm, increases the risk of hypothermia and frostbite. Exposure to cold conditions can also exacerbate pre-existing respiratory and cardiovascular conditions. In addition to temperature-related dangers, however, severe winter storms also present other potential health impacts. For example, individuals may use generators in their homes if the power goes out or may use the heat system in their cars if they become trapped by snow. Without proper ventilation, both of these activities can result in carbon monoxide buildup that can be fatal. Loss of power can also lead to hypothermia. After Hurricane Sandy, the number of cases of cold exposure in New York City was three times greater than the same time period in previous years.¹⁹ Driving during severe snow and ice conditions can also be very dangerous, as roads become slick and drivers can lose control of their vehicle. During and after winter storms, roads may be littered with debris, presenting a danger to drivers. Health impacts on people include the inability to travel to receive needed medical services and isolation in their homes. Additionally, natural gas-fueled furnaces, water heaters, and clothes dryers, and even automobile exhaust pipes, may become blocked by snow and ice, which can lead to carbon monoxide poisoning.

Economic Impacts

The entire building stock inventory in Orange is exposed to the severe winter weather hazard. In general, structural impacts include damage to roofs and building frames rather than building content. Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communication and power networks can be disrupted for days while utility companies work to repair the extensive damage.

¹⁹Fink, Sheri. 2012. Hypothermia and Carbon Monoxide Poisoning Cases Soar in the City After Hurricane. New York Times. November 28.2012

Even small accumulations of ice may cause extreme hazards to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces. A specific area that is vulnerable to the winter storm hazard is the floodplain. Snow and ice melt can cause both riverine and urban flooding. The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain local financial resources. The potential secondary impacts from winter storms, including loss of utilities, interruption of transportation corridors, loss of business functions, and loss of income for many individuals during business closures, also impact the local economy.

Similar to hurricanes and tropical storms, nor'easter events can greatly impact the economy, with impacts that include the loss of business functions (e.g., tourism and recreation), damage to inventories or infrastructure (the supply of fuel), relocation costs, wage losses, and rental losses due to the repair or replacement of buildings.

Infrastructure

All infrastructure and other elements of the built environment in Orange are exposed to the severe winter weather hazard. Potential structural damage to the facilities themselves may include damage to roofs and building frames. These facilities may not be fully operational if workers are unable to travel to ensure continuity of operations prior and after a severe winter event. Disruptions to key public services such as electricity, transportation, schools, and health care may become more common.²⁰ Table 3-18 identifies the assessed value of all residential, open space, commercial, and industrial land uses in Town, and the losses that would result from 1%, 5%, and 10% damage to this inventory as a result of a severe winter storm.

Table 3-18: Estimated Potential Loss by Tax Classification in Orange				
Tax Classification	Total Assessed Value FY2019	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Residential	\$411,495,092	\$4,114,951	\$20,574,755	\$41,149,509
Open Space	\$0	\$0	\$0	\$0
Commercial	\$48,380,085	\$483,801	\$2,419,004	\$4,838,009
Industrial	\$28,201,350	\$282,014	\$1,410,068	\$2,820,135
Total	\$488,076,527	\$4,880,765	\$24,403,826	\$48,807,653

Source: Massachusetts Department of Revenue - Division of Local Services, Municipal Databank/Local Aid Section.

²⁰ Resilient MA 2018

Agriculture

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.

Energy

Severe weather can cause power outages from trees that fall during heavy snow and strong wind events. Severe ice events can take down transmission and distribution lines. The severe weather can impair a utility's ability to rapidly repair and recover the system.

Public Health

Severe winter weather presents many health hazards, as previously described in the discussion of the severe winter storm/nor'easter hazard profile. Severe winter storms and events with extended power outages may overburden hospitals and emergency shelters.

Public Safety

Public safety buildings may experience direct loss (damage) from downed trees, heavy snowfall, and high winds. Full functionality of critical facilities, such as police, fire and medical facilities, is essential for response during and after a winter storm event. Because power interruptions can occur, backup power is recommended for critical facilities and infrastructure. The ability of emergency responders to respond to calls may be impaired by heavy snowfall, icy roads, and downed trees.

Transportation

Other infrastructure elements at risk for this hazard include roadways, which can be obstructed by snow and ice accumulation or by windblown debris. Additionally, over time, roadways can be damaged from the application of salt and the thermal expansion and contraction from alternating freezing and warming conditions. Other types of infrastructure, including rail, aviation, port, and waterway infrastructure (if temperatures are cold enough to cause widespread freezing), can be impacted by winter storm conditions.

Water Infrastructure

Water infrastructure that is exposed to winter conditions may freeze or be damaged by ice.

Environment

Although winter storms are a natural part of the Massachusetts climate, and native ecosystems and species are well adapted to these events, changes in the frequency or severity of winter

storms could increase their environmental impacts. Environmental impacts of severe winter storms can include direct mortality of individual plants and animals and felling of trees, 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 or die 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 and flooding. These impacts can include direct damage to species and ecosystems, habitat destruction, and the distribution of contaminants and hazardous materials throughout the environment.

Vulnerability Summary

Based on the above assessment, Orange faces a “High” vulnerability from severe snow storms and ice storms. Severe Winter Storms/Ice Storms occur frequently in Orange. However, the severity of impact is minor to limited, except for impact to population, which could be critical. The following problem statements summarize Orange’s areas of greatest concern regarding severe winter storms.



Severe Winter Storm Hazard Problem Statements
<ul style="list-style-type: none"> • Ice jams on the Millers River in Athol are of concern, as they result in localized flood events in Orange. Regular dredging of the river is needed in order to prevent ice jams.
<ul style="list-style-type: none"> • Many of the Town’s evacuation routes may be impacted by a severe winter storm. There are areas of Town where residents might become isolated if roads, bridges, or culverts were blocked or damaged during a storm.
<ul style="list-style-type: none"> • New initiatives are needed to improve household disaster preparedness Town-wide and to better reach vulnerable populations, including seniors and disabled residents with lessened mobility or medical needs, as well as homeless or transient people who may be difficult to reach in the event of an emergency. The Town may need to review and update evacuation planning for vulnerable populations in its CEMP, explore additional sheltering options, and pursue supportive partnerships for sheltering in the community.
<ul style="list-style-type: none"> • Emergency shelters may not be adequately staffed or supplied with water, food, and first aid supplies. There is a need to inventory the supplies currently available at Orange shelters.
<ul style="list-style-type: none"> • Although the Town has a Reverse 911 Warning System (CodeRED) with a large percentage of residents subscribing to the service, there is a need to continue to increase subscription among residents and businesses. Education and outreach are needed to ensure that all residents are aware of emergency situations and have access to evacuation and sheltering instructions,

Severe Winter Storm Hazard Problem Statements	
	including options for residents with specialized medical needs, and pet sheltering options.
•	Many residents live in isolated locations with unreliable cell service, which can decrease access to emergency services.
•	Destructive winds and ice associated with severe winter and wind storms can cause widespread road closures by taking down trees and utility lines throughout town, further exacerbating communication and access to emergency services and information for residents already facing isolation
•	Existing communication infrastructure issues and vulnerabilities could be exacerbated by severe winter storm hazards impacts.
•	An estimated 61% of homes in Orange were built prior to the first State building code in 1975, potentially making them more vulnerable to damages from high winds during a severe winter storm.

3.4 HURRICANES / TROPICAL STORMS

Potential Effects of Climate Change

A 2017 U.S. Climate Science Special Report noted that there has been an upward trend in North Atlantic hurricane activity since 1970. The report forecasts that future hurricanes formed in the North Atlantic will drop more rain and may have higher wind speeds. This is because a warmer atmosphere will hold more water, and hurricanes are efficient at wringing water out of the atmosphere and dumping it on land. When extreme storms like Tropical Storm Irene travel over inland areas, they may release large quantities of precipitation and cause rivers to overtop their banks. Irene dumped more than 10 inches of rain in western Massachusetts. Buildings floated downriver in Shelburne Falls, flooded highways were closed, and 400,000 utility customers lost power (resilient MA, 2018). Figure 3-5 displays the potential effects of climate change on hurricanes and tropical storms from the Massachusetts State Hazard Mitigation and Climate Adaptation Plan.

Figure 3-5: Effects of Climate Change on Hurricanes and Tropical Storms		
Potential Effects of Climate Change		
	EXTREME WEATHER AND RISING TEMPERATURES ➔ LARGER, STRONGER STORMS	As warmer oceans provide more energy for storms, both past events and models of future conditions suggest that the intensity of tropical storms and hurricanes will increase.
	CHANGES IN PRECIPITATION ➔ INCREASED RAINFALL RATES	Warmer air can hold more water vapor, which means the rate of rainfall will increase. One study found that hurricane rainfall rates were projected to rise 7 percent for every degree Celsius increase in tropical sea surface temperature.

Source: Massachusetts State Hazard Mitigation and Climate Adaptation Plan. September 2018

Hazard Description

Hurricanes can range from as small as 50 miles across to as much as 500 miles across; Hurricane Allen in 1980 took up the entire Gulf of Mexico. There are generally two source regions for storms that have the potential to strike New England: (1) off the Cape Verde Islands near the west coast of Africa, and (2) in the Bahamas. The Cape Verde storms tend to be very large in diameter, since they have a week or more to traverse the Atlantic Ocean and grow. The Bahamas storms tend to be smaller, but they can also be just as powerful, and their effects can reach New England in only a day or two.

Tropical systems customarily come from a southerly direction and when they accelerate up the East Coast of the U.S., most take on a distinct appearance that is different from a typical hurricane. Instead of having a perfectly concentric storm with heavy rain blowing from one

direction, then the calm eye, then the heavy rain blowing from the opposite direction, our storms (as viewed from satellite and radar) take on an almost winter-storm-like appearance. Although rain is often limited in the areas south and east of the track of the storm, these areas can experience the worst winds and storm surge. Dangerous flooding occurs most often to the north and west of the track of the storm. An additional threat associated with a tropical system making landfall is the possibility of tornado generation. Tornadoes would generally occur in the outer bands to the north and east of the storm, a few hours to as much as 15 hours prior to landfall.

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.

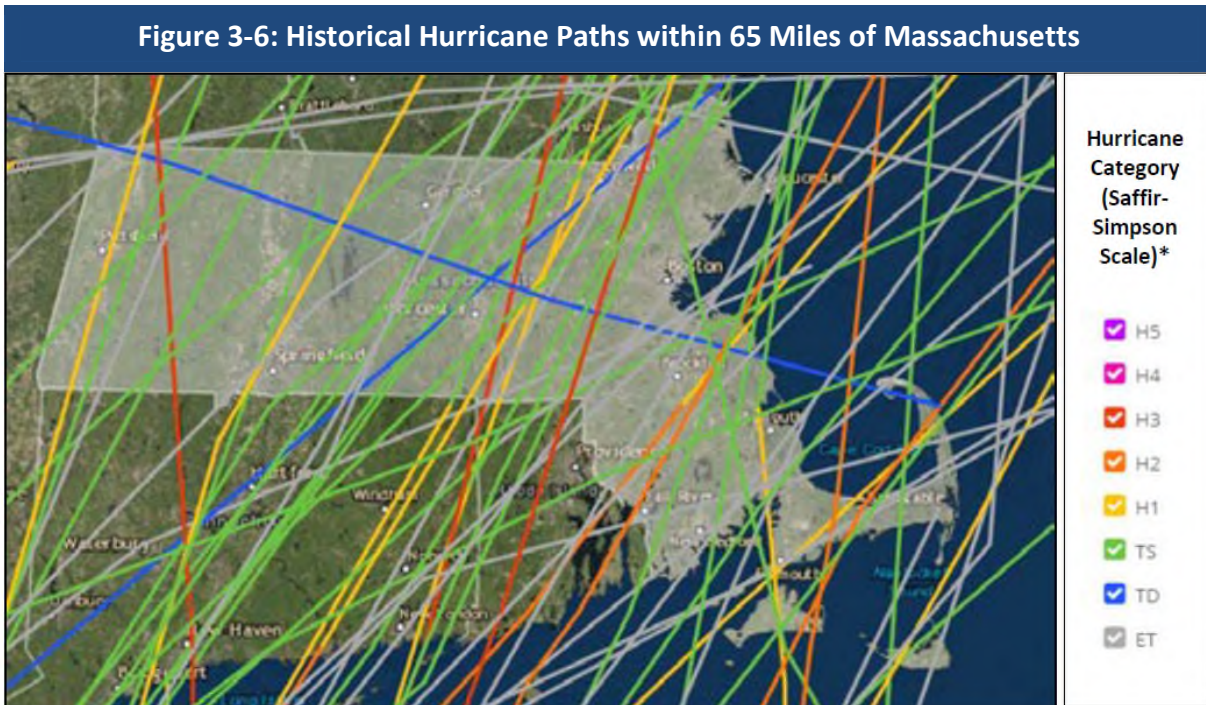
Tropical Storms

A tropical storm system is characterized by a low-pressure center and numerous thunderstorms that produce strong winds and heavy rain (winds are at a lower speed than hurricane-force winds, thus gaining its status as a tropical storm versus a hurricane). Tropical storms strengthen when water evaporated from the ocean is released as the saturated air rises, resulting in condensation of water vapor contained in the moist air. They are fueled by a different heat mechanism than other cyclonic windstorms, such as nor'easters and polar lows. The characteristic that separates tropical cyclones from other cyclonic systems is that at any height in the atmosphere, the center of a tropical cyclone will be warmer than its surroundings—a phenomenon called “warm core” storm systems.

The term “tropical” refers both to the geographical origin of these systems, which usually form in tropical regions of the globe, and to their formation in maritime tropical air masses. The term “cyclone” refers to such storms’ cyclonic nature, with counterclockwise wind flow in the Northern Hemisphere and clockwise wind flow in the Southern Hemisphere.

Location

Because of the hazard's regional nature, all of Orange is at risk from hurricanes and tropical storms, with a "Large" location of occurrence with over 50 percent of land area affected. Ridge tops are more susceptible to wind damage. 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.



Source: NOAA, n.d. * TS=Tropical Storm, TD=Tropical Depression

NOAA's Historical Hurricane Tracks tool is a public interactive mapping application that displays Atlantic Basin and East-Central Pacific Basin tropical cyclone data. This interactive tool tracks tropical cyclones from 1842 to 2017. According to this resource, over the time frame tracked, 63 events categorized as an extra-tropical storm or higher occurred within 65 nautical miles of Massachusetts. The tracks of these storms are shown in Figure 3-6. As this figure shows, the paths of these storms vary across the Commonwealth, but are more likely to occur toward the coast.

Extent

Hurricanes are measured according to the Saffir-Simpson scale, which 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 from a hurricane landfall.

Wind speed is the determining factor in the scale. All winds are assessed using the U.S. 1-minute average, meaning the highest wind that is sustained for 1 minute. The Saffir-Simpson Scale described in Table 3-19 gives an overview of the wind speeds and range of damage caused by different hurricane categories.

Table 3-19: Saffir-Simpson Scale		
Scale No. (Category)	Winds (mph)	Potential Damage
1	74 – 95	Minimal: Damage is primarily to shrubbery and trees, mobile homes, and some signs. No real damage is done to structures.
2	96 – 110	Moderate: Some trees topple; some roof coverings are damaged; and major damage is done to mobile homes.
3	111 – 130	Extensive: Large trees topple; some structural damage is done to roofs; mobile homes are destroyed; and structural damage is done to small homes and utility buildings.
4	131 – 155	Extreme: Extensive damage is done to roofs, windows, and doors; roof systems on small buildings completely fail; and some curtain walls fail.
5	> 155	Catastrophic: Roof damage is considerable and widespread; window and door damage is severe; there are extensive glass failures; and entire buildings could fail.
Additional Classifications		
Tropical Storm	39-73	NA
Tropical Depression	< 38	NA

Source: NOAA, n.d. Note: mph = miles per hour, NA = not applicable

Tropical storms and tropical depressions, while generally less dangerous than hurricanes, can be deadly. The winds of tropical depressions and tropical storms are usually not the greatest threat; rather, the rains, flooding, and severe weather associated with the tropical storms are what customarily cause more significant problems. Serious power outages can also be associated with these types of events. After Hurricane Irene passed through the region as a tropical storm in late August 2011, many areas of the Commonwealth were without power for more than 5 days.

While tropical storms can produce extremely powerful winds and torrential rain, they are also able to produce high waves, damaging storm surge, and tornadoes. They develop over large bodies of warm water and lose their strength if they move over land due to increased surface friction and loss of the warm ocean as an energy source. Heavy rains associated with a tropical storm, however, can produce significant flooding inland, and storm surges can produce extensive coastal flooding up to 25 miles from the coastline.

One measure of the size of a tropical cyclone is determined by measuring the distance from its center of circulation to its outermost closed isobar. If the radius is less than 2 degrees of latitude, or 138 miles, then the cyclone is “very small.” A radius between 3 and 6 degrees of latitude, or 207 to 420 miles, is considered “average-sized.” “Very large” tropical cyclones have a radius of greater than 8 degrees, or 552 miles.

Previous Occurrences

According to NOAA’s Historical Hurricane Tracker tool, 63 hurricane or tropical storm events have occurred in the vicinity of Massachusetts between 1842 and 2016. The Commonwealth was impacted by tropical storms Jose and Phillipe in 2017. Therefore, there is an average of one storm every other year or 0.5 storms per year. Storms severe enough to receive FEMA disaster declarations, however, are far rarer, occurring every 9 years on average. The Commonwealth has not been impacted by any Category 4 or 5 hurricanes; however, Category 3 storms have historically caused widespread flooding. Winds have caused sufficient damage to impair the ability of individuals to remain in their homes.

In Massachusetts, major hurricanes occurred in 1904, 1938, 1954, 1955, 1960 and 1976, 1985, 1991 and 2010. The Great New England Hurricane of 1938, a Category 3 hurricane which occurred on September 21, 1938, was one of the most destructive and powerful storms ever to strike Southern New England. Sustained hurricane force winds occurred throughout most of Southern New England. Extensive damage occurred to roofs, trees and crops. Widespread power outages occurred, which in some areas lasted several weeks. Rainfall from this hurricane resulted in severe river flooding across sections of Massachusetts and Connecticut. The combined effects from a frontal system several days earlier and the hurricane produced rainfall of 10 to 17 inches across most of the Connecticut River Valley. This resulted in some of the worst flooding ever recorded in this area. The most recent hurricane to make landfall in Franklin County was Hurricane Bob, a weak category 2 hurricane, which made landfall in New England in August 1991. In Franklin County, Hurricane Bob caused roughly \$5,555,556 in property and crop damages. No hurricane has tracked directly through the Town of Orange.

Historic data for hurricane and tropical storm events indicate one hurricane and 17 tropical storms have been recorded in Franklin County. Hurricane Bob in 1991 caused over \$5.5 million in property damage in the county, and over \$500,000 in crop damage. In 2011, Tropical Storm Irene caused over \$26 million in property damage in Franklin County, mostly from flooding impacts.

Probability of Future Events

A 2017 U.S. Climate Science Special Report noted that there has been an upward trend in North Atlantic hurricane activity since 1970. The report forecasts that future hurricanes formed in the North Atlantic will drop more rain and may have higher wind speeds. This is because a warmer atmosphere will hold more water, and hurricanes are efficient at wringing water out of the atmosphere and dumping it on land.²¹

Orange's location in western Massachusetts reduces the risk of extremely high winds that are associated with hurricanes, although it can experience some high wind events. Based upon past occurrences, Orange has a Moderate probability, or a 2%-25% chance, of experiencing a hurricane or tropical storm event in a given year.

Impact

While historically there have been no Hurricane events that have impacted Orange, the Vulnerability Assessment revealed an occurrence could critically impact the Town, with potential multiple injuries to citizens possible and with a potential of more than 25% of property damaged or destroyed.

Vulnerability

The entire town would be vulnerable to the impact of a hurricane or tropical storm. Areas prone to flooding are particularly vulnerable. Additionally high winds could impact the town's communication and energy infrastructure.

Society

Vulnerable Populations

Among the exposed populations, 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 or not 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. During and after an event, rescue workers and utility workers are vulnerable to impacts from high water, swift currents, rescues, and submerged debris.

²¹ ResilientMA: Climate Change Clearing House for the Commonwealth: <http://resilientma.org/changes/extreme-weather>. Accessed January 11, 2019.

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.

Table 3-20 estimates the number of vulnerable populations and households in Orange. Individuals and households may fall into multiple categories, so the numbers should not be added. Rather, the table provides Town officials and emergency response personnel with information to help plan for responding to the needs of Orange residents during a hurricane or tropical storm event.

Table 3-20: Estimated Vulnerable Populations in Orange		
Vulnerable Population Category	Number	Percent of Total Population*
Population Age 65 Years and Over	1,308	17%
Population with a Disability	1,437	19%
Population who Speak English Less than "Very Well"	75	1%
Vulnerable Household Category	Number	Percent of Total Households*
Low Income Households (annual income less than \$35,000)	1,242	40%
Householder Age 65 Years and Over Living Alone	426	14%
Households Without Access to a Vehicle	273	9%

*Total population = 7,682; Total households = 3,137

Note: Individuals and households may be counted under multiple categories.

Source: U.S. Census American Community Survey 2013-2017 Five-Year Estimates.

Health Impacts

The health impacts from hurricanes and tropical storms can generally be separated into impacts from flooding and impacts from wind. The potential health impacts of flooding are extensive, and are discussed in detail in the Flooding section. In general, some of the most serious flooding-related health threats include floodwaters sweeping away individuals or cars, downed power lines, and exposure to hazards in the water, including dangerous animals or infectious organisms. Contact with contaminated floodwaters can cause gastrointestinal illness.

Wind-related health threats associated with hurricanes are most commonly caused by projectiles propelled by the storm's winds. Wind- and water-caused damage to residential structures can also increase the risk of threat impacts by leaving residents more exposed to the

elements. Hurricanes that occur later in the year also increase the risk of hypothermia.

Economic Impacts

In addition to the human costs that extreme storms deliver when they permanently or temporarily displace people, the repair and reconstruction costs after storm damage can be enormous for homeowners and businesses. When bridges and culverts have been washed away and roads damaged, municipal and state agencies must secure the resources for expensive recovery projects in limited municipal budgets and from Federal disaster grant programs that are increasingly over-subscribed. Electrical grid, power plants and wastewater infrastructure repair costs are all expected to increase in the future.²²

Infrastructure

Hurricanes and tropical storms could critically impact the Town, with a potential of more than 25% of property in affected area damaged or destroyed. Residential and commercial buildings built along rivers may be vulnerable to severe damage. Potential structural damage to the facilities themselves may include damage to roofs and building frames. These facilities may not be fully operational if workers are unable to travel to ensure continuity of operations prior and after a severe winter event. Table 3-21 identifies the assessed value of all residential, open space, commercial, and industrial land uses in Town, and the losses that would result from 1%, 5%, and 10% damage to this inventory as a result of a hurricane or tropical storm.

Table 3-21: Estimated Potential Loss by Tax Classification in Orange				
Tax Classification	Total Assessed Value FY2019	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Residential	\$411,495,092	\$4,114,951	\$20,574,755	\$41,149,509
Open Space	\$0	\$0	\$0	\$0
Commercial	\$48,380,085	\$483,801	\$2,419,004	\$4,838,009
Industrial	\$28,201,350	\$282,014	\$1,410,068	\$2,820,135
Total	\$488,076,527	\$4,880,765	\$24,403,826	\$48,807,653

Source: Massachusetts Department of Revenue - Division of Local Services, Municipal Databank/Local Aid Section.

Energy

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.

²² ResilientMA: Climate Change Clearing House for the Commonwealth: <http://resilientma.org/changes/extreme-weather>. Accessed January 29, 2019.

Public Health

Combined sewer overflows associated with heavy rainfall can release contaminants, chemicals, and pathogens directly into the environment and into water systems. If a mass outbreak of waterborne illness were to occur, hospitals and medical providers may lack the capacity to treat patients.

Public Safety

Critical infrastructure, including 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.

Transportation

Some roads and bridges are also considered critical infrastructure, particularly those providing ingress and egress and allowing emergency vehicles access to those in need. Costly damage to roads, bridges, and rail networks may occur as a result of hurricanes.²³

Water and Wastewater Infrastructure

Wastewater treatment centers may face elevated risks of damage and destruction from hurricanes (resilient MA, 2018). Heavy rains can lead to contamination of well water and can release contaminants from septic systems (DPH, 2014). Heavy rainfall can also overburden stormwater systems, drinking water supplies, and sewage systems.

Environment

The environmental impacts of hurricanes and tropical storms are similar to those described for other hazards, including flooding, severe winter storms and other severe weather events. As described for human health, environmental impacts can generally be divided into short-term direct impacts and long-term impacts. 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

²³ Resilient MA 2018.

example, flooding may cause scour in riverbeds and erode riverbanks, 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.

Vulnerability Summary

Based on the above analysis, Orange faces a Medium vulnerability from hurricanes and tropical storms. While historically there have been no Hurricane events in Orange, the Vulnerability Assessment revealed an occurrence could critically impact the Town, with potential multiple injuries to citizens possible and with a potential of more than 25% of property in affected area damaged or destroyed. The following problem statements summarize Orange’s greatest areas of concern regarding hurricanes and tropical storms.

Hurricane / Tropical Storm Hazard Problem Statements
<ul style="list-style-type: none"> Orange’s waste water treatment plant is located within the flood plain and is not adequately flood proofed, and is therefore vulnerable to hazards that include heavy rain events.
<ul style="list-style-type: none"> Culvert maintenance and bridge maintenance is needed throughout the Town. Culverts on Fairman Road, Mountain Road, and East Main Street are of top priority for repair.
<ul style="list-style-type: none"> Orange does not yet have a comprehensive list of GIS mapping of culverts throughout Town.
<ul style="list-style-type: none"> There is an issue with flooding at Orange’s Town hall due to storm water runoff coming from the hill behind it. The Town is currently working to build a trench in the back of the building to promote drainage. Other projects located upland of the Town Hall should be explored to mitigate storm water runoff.
<ul style="list-style-type: none"> Drainage infrastructure on North Main Street/in downtown Orange is not sufficient, and there are several businesses that experience flooding during heavy rain events.
<ul style="list-style-type: none"> The Fire Station located on Tully Road can become isolated during hazard events, especially if key bridges go out. This station also does not have cell service, and power outages cause the station to lose internet access and cable, which further isolates emergency responders during severe weather.
<ul style="list-style-type: none"> Many bridges in Orange have low weight limits, which complicates access routes for emergency vehicles.
<ul style="list-style-type: none"> Many of the Town’s evacuation routes may be impacted by flooding. There are areas of Town where residents might become isolated if roads, bridges, or culverts were blocked or damaged during a flood.
<ul style="list-style-type: none"> New initiatives are needed to improve household disaster preparedness Town-wide and to better

Hurricane / Tropical Storm Hazard Problem Statements

reach vulnerable populations, including seniors and disabled residents with lessened mobility or medical needs, as well as homeless or transient people who may be difficult to reach in the event of an emergency. The Town may need to review and update evacuation planning for vulnerable populations in its CEMP, explore additional sheltering options, and pursue supportive partnerships for sheltering in the community.

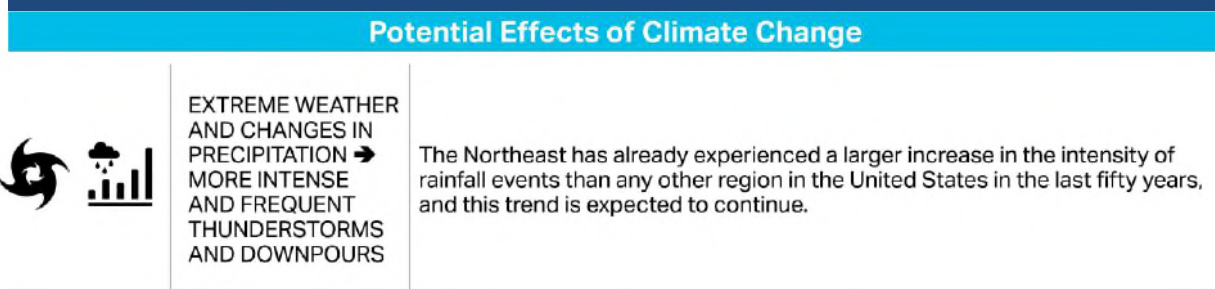
- Emergency shelters may not be adequately staffed or supplied with water, food, and first aid supplies. There is a need to inventory the supplies currently available at Orange shelters.
- Although the Town has a Reverse 911 Warning System (CodeRED) with a large percentage of residents subscribing to the service, there is a need to continue to increase subscription among residents and businesses. Education and outreach are needed to ensure that all residents are aware of emergency situations and have access to evacuation and sheltering instructions, including options for residents with specialized medical needs, and pet sheltering options.
- Destructive winds and ice associated with hurricanes can cause widespread road closures by taking down trees and utility lines throughout town, further exacerbating communication and access to emergency services and information for residents already facing isolation.
- An estimated 61% of homes in Orange were built prior to the first State building code in 1975, potentially making them more vulnerable to damages from high winds.
- Some of Orange's residents rely on private wells, placing them at risk during prolonged power outages caused by flooding.

3.5 SEVERE THUNDERSTORMS / WIND / MICROBURSTS

Potential Effects of Climate Change

Climate change is expected to increase extreme weather events across the globe and in Massachusetts. Climate change leads to extreme weather because of warmer air and ocean temperatures and changing air currents. Warmer air leads to more evaporation from large water bodies and holds more moisture, so when clouds release their precipitation, there is more of it. In addition, changes in atmospheric air currents like jet streams and ocean currents can cause changes in the intensity and duration of stormy weather. While it is difficult to connect one storm to a changing climate, scientists point to the northeastern United States as one of the regions that is most vulnerable to an increase in extreme weather driven by climate change.²⁴

Figure 3-7: Effects of Climate Change on Severe Thunderstorms, Wind, and Microbursts



Source: Massachusetts State Hazard Mitigation and Climate Adaptation Plan. September 2018

Hazard Description

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. According to the National Weather Service, 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.

Every thunderstorm has an updraft (rising air) and a downdraft (sinking air). Sometimes strong downdrafts known as downbursts can cause tremendous wind damage that is similar to that of a tornado. A small (less than 2.5 mile path) downburst is known as a “microburst” and a larger downburst is called a “macro-burst.” An organized, fast-moving line of microbursts traveling

²⁴ ResilientMA: Climate Change Clearing House for the Commonwealth: <http://resilientma.org/changes/extreme-weather>. Accessed January 29, 2019.

across large areas is known as a “derecho.” These occasionally occur in Massachusetts. Winds exceeding 100 mph have been measured from downbursts in Massachusetts.

Wind is air in motion relative to surface of the earth. For non-tropical events over land, the NWS issues a Wind Advisory (sustained winds of 31 to 39 mph for at least 1 hour or any gusts 46 to 57 mph) or a High Wind Warning (sustained winds 40+ mph or any gusts 58+ mph). For non-tropical events over water, the NWS issues a small craft advisory (sustained winds 25-33 knots), a gale warning (sustained winds 34-47 knots), a storm warning (sustained winds 48 to 63 knots), or a hurricane force wind warning (sustained winds 64+ knots). For tropical systems, the NWS issues a tropical storm warning for any areas (inland or coastal) that are expecting sustained winds from 39 to 73 mph. A hurricane warning is issued for any areas (inland or coastal) that are expecting sustained winds of 74 mph. 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. High winds are also a hazard for aircraft.

Location

The entire town of Orange is at risk for severe thunderstorms, wind and microbursts.














Extent

An average thunderstorm is 15 miles across and lasts 30 minutes; severe thunderstorms can be much larger and longer. The severity of thunderstorms can vary widely, from commonplace and short-term events to large-scale storms that result in direct damage and flooding.

Thunderstorms can cause hail, wind, and flooding, with widespread flooding 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. Southern New England typically experiences 10 to 15 days per year with severe thunderstorms.

Microbursts are typically less than three miles across. They can last anywhere from a few seconds to several minutes. Microbursts cause damaging winds up to 170 miles per hour in strength and can be accompanied by precipitation.

Figure 3-8: Beaufort Wind Scale				
Beaufort number	Wind Speed (mph)	Seaman's term		Effects on Land
0	Under 1	Calm		Calm; smoke rises vertically.
1	1-3	Light Air		Smoke drift indicates wind direction; vanes do not move.
2	4-7	Light Breeze		Wind felt on face; leaves rustle; vanes begin to move.
3	8-12	Gentle Breeze		Leaves, small twigs in constant motion; light flags extended.
4	13-18	Moderate Breeze		Dust, leaves and loose paper raised up; small branches move.
5	19-24	Fresh Breeze		Small trees begin to sway.
6	25-31	Strong Breeze		Large branches of trees in motion; whistling heard in wires.
7	32-38	Moderate Gale		Whole trees in motion; resistance felt in walking against the wind.
8	39-46	Fresh Gale		Twigs and small branches broken off trees.
9	47-54	Strong Gale		Slight structural damage occurs; slate blown from roofs.
10	55-63	Whole Gale		Seldom experienced on land; trees broken; structural damage occurs.
11	64-72	Storm		Very rarely experienced on land; usually with widespread damage.
12	73 or higher	Hurricane Force		Violence and destruction.

Source: Developed in 1805 by Sir Francis Beaufort

Orange 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 in a hurricane are measured using the Saffir-Simpson scale. Another scale developed for measuring wind is the Beaufort wind scale (see Figure 3-8).

Previous Occurrences

Since 1996, a total of 13 high wind events occurred in Franklin County (Table 3-22), causing a total of \$288,000 in property damages. High winds are defined by the National Weather Service 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. 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.

Table 3-22: High Wind Events in Franklin County			
Year	# of High Wind Events	Annual Property Damage	Annual Crop Damage
1996	2	\$0	\$0
1999	1	\$0	\$0
2003	2	\$130,000	\$0
2004	1	\$30,000	\$0
2005	1	\$10,000	\$0
2006	3	\$68,000	\$0
2011	1	\$15,000	\$0
2013	2	\$35,000	\$0
Total	13	\$288,000	\$0

Source: NOAA Storm Events Database: <https://www.ncdc.noaa.gov/stormevents/>

Thunderstorm winds are defined by the National Weather Service as winds arising from convection (occurring within 30 minutes of lightning being observed or detected) with speeds of at least 50 knots (58 mph), or winds of any speed (non-severe thunderstorm winds below 50 knots) producing a fatality, injury, or damage. Orange experienced fifteen thunderstorm wind events from 1994 to 2017 (Table 3-23). These storms resulted in downed trees and wires and caused \$145,000 in property damage. In one instance a large tree fell onto a car and injured three people.

Table 3-23: Thunderstorm Wind Events in Orange				
Year	# of Thunderstorm Wind Events	Annual Property Damage	Annual Crop Damage	Event Description
1994	1	\$0	\$0	Trees were reported blown down along Route 2.
1997	1	\$0	\$0	Trees were reported blown down in Northfield and Orange. A chicken coop was struck by lightning and caught fire in Orange. Also in Orange, lightning struck

Table 3-23: Thunderstorm Wind Events in Orange				
Year	# of Thunderstorm Wind Events	Annual Property Damage	Annual Crop Damage	Event Description
				the police station, resulting in damage to computers and other equipment. Several trees were downed in Hatfield and Northampton, where wind gusts were reported up to 60 mph along with pea size hail.
1998	1	\$2,000	\$0	A severe thunderstorm occurring at about the same time as the storm farther to the east resulted in wind damage in the town of Orange in Franklin County, where two trees were blown down and a third tree landed on a truck, damaging the roof and windshield.
2000	1	\$20,000	\$0	A severe thunderstorm moved through Orange, and produced a microburst of one and a half miles in length across North Orange. The microburst was a little over one half mile wide at the west end, and about one and a half miles wide at the east end. Dozens of trees up to at least three and a half feet in diameter were downed, most in a west to east direction. Some were uprooted and others were snapped off at various heights. Three people were injured when a large tree fell on their vehicle. A large shed used to house a motor home was totally destroyed, with debris strewn over 50 yards. Wind speeds were estimated between 80 and 90 mph based upon the damage observed.
2005	1	\$10,000	\$0	Scattered thunderstorms, with embedded severe thunderstorms, produced lightning and severe wind gusts that damaged property and brought down trees and power lines across Massachusetts. The hardest hit were Franklin, Hampshire, Worcester, Essex, and Plymouth counties. Various lightning strikes downed power lines

Table 3-23: Thunderstorm Wind Events in Orange				
Year	# of Thunderstorm Wind Events	Annual Property Damage	Annual Crop Damage	Event Description
				and trees, set fires to homes, and caused multiple injuries.
2007	1	\$0	\$0	Trees were downed.
2010	2	\$0	\$0	The Automated Surface Observing System at Orange Municipal Airport (KORE) recorded a wind gust of 67 mph. No associated damage was reported, though damage was reported elsewhere in Franklin County. In a separate storm, a tree on Main Street was downed onto a house on Main Street.
2014	2	\$30,000	\$0	Wires were downed onto a car on Horton Road by thunderstorm winds. In a separate event, numerous trees and wires were downed throughout Orange.
2015	2	\$15,000	\$0	Trees and wires were downed by thunderstorm winds, and a tree on Daniel Shays Highway was downed by thunderstorm winds.
2016	2	\$20,000	\$0	A tree and wires on Royalston Road were downed by thunderstorm winds. In a separate event, trees and wires were downed on Route 78, East Road, and East River Street by thunderstorm winds.
2017	1	\$50,000	\$0	At 619 PM EST, multiple trees were reported down on Wheeler Avenue in Orange. On Summer Street and on Stone Road, trees were down on houses causing structural damage. A large tree was down on cars on River Street. Power lines were down on East River Street. A tree and utility pole were down on a car in the town hall parking lot. A power pole and wires were down on Prospect Street.
Total	15	\$145,000	\$0	

Source: NOAA Storm Events Database: <https://www.ncdc.noaa.gov/stormevents/>



Aftermath of the microburst that struck Orange in June of 2017. This storm included bouts of intense rain and hail, and caused thousands to lose power. Photos courtesy of The Recorder.

More recently in October of 2019, Orange was struck by a “bomb cyclone.” This type of storm is also referred to as a “winter hurricane” and is formed when masses of warm and cold air meet.²⁵ Participants in the MVP workshop discussed the storm and mentioned that it affected many residents throughout Town, and reported that key emergency access routes were blocked by downed trees.

Secondary hazards of thunderstorms and severe weather include lightning and hail. In Franklin County, 22 lightning events since 1997 caused a total of \$835,500 in property damages (Table 3-24).

Year	# of Lightning Events	Annual Property Damage	Annual Crop Damage
1997	1	\$3,000	\$0
2001	1	\$20,000	\$0
2002	1	\$15,000	\$0
2004	1	\$35,000	\$0
2005	1	\$50,000	\$0
2008	1	\$10,000	\$0
2010	2	\$25,000	\$0
2012	1	\$500,000	\$0
2013	4	\$49,000	\$0
2014	3	\$93,000	\$0
2018	6	\$35,500	\$0
Total	22	\$835,500	\$0

Source: NOAA Storm Events Database: <https://www.ncdc.noaa.gov/stormevents/>

²⁵ Barry, Ellen. 2019. Northeast ‘Bomb Cyclone’: Powerful Winds Knock Out Power to 500,000. <https://www.nytimes.com/2019/10/17/us/northeast-bomb-cyclone.html>

A total of 42 hail events have been reported in Franklin County since 1998 (Table 3-25). Property damage was only recorded for one event, in the amount of \$5,000. One hail event in 2008 resulted in \$50,000 in crop damages. Pea to marble size hail fell in a swath from Colrain to Shelburne damaging apple and peach orchards. An estimated 45 acres of apples and two to three acres of peaches were damaged by the hail.

Table 3-25: Hail Events in Franklin County			
Year	# of Hail Events	Annual Property Damage	Annual Crop Damage
1998	4	\$0	\$0
2000	1	\$0	\$0
2001	1	\$0	\$0
2003	1	\$0	\$0
2004	2	\$0	\$0
2005	3	\$5,000	\$0
2007	5	\$0	\$0
2008	7	\$0	\$50,000
2009	2	\$0	\$0
2010	4	\$0	\$0
2011	4	\$0	\$0
2012	1	\$0	\$0
2013	3	\$0	\$0
2017	3	\$0	\$0
2018	1	\$0	\$0
Total	42	\$5,000	\$50,000

Source: NOAA Storm Events Database: <https://www.ncdc.noaa.gov/stormevents/>

Probability of Future Events

According to the National Weather Service, Massachusetts experiences between 20 to 30 thunderstorm days each year. Based on past occurrences, there is a “Very High” probability (50% - 100% chance) of a severe thunderstorm or winds affecting the town in a given year. Climate change is expected to increase the frequency and intensity of thunderstorms and other severe weather.

Impact

The entire town of Orange is vulnerable to high winds that can cause extensive damage. The U.S. is divided into four wind zones. States located in Wind Zone IV have experienced the greatest number of tornadoes and the strongest tornadoes. The Commonwealth is located within Wind Zone II, which includes wind speeds up to 180 mph. The entire Commonwealth is

also located within the hurricane-susceptible region, and the western portion of the Commonwealth is located within the special wind region, in which wind-speed anomalies are present and additional consideration of the wind hazard is warranted. The entire town of Orange can experience the effect and impact from severe thunderstorms, microbursts, and hail. The magnitude of impact of a severe thunderstorm event is likely “Limited,” with more than 10% of property in the affected area damaged or destroyed.

Vulnerability

Society

The entire population of Orange 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. Populations located outdoors are considered at risk and more vulnerable to many storm impacts, particularly lightning strikes, compared to those who are located inside. Moving to a lower risk location will decrease a person’s vulnerability.

Vulnerable Populations

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.

Table 3-26 estimates the number of vulnerable populations and households in Orange. Individuals and households may fall into multiple categories, so the numbers should not be added. Rather, the table provides Town officials and emergency response personnel with information to help plan for responding to the needs of Orange residents during a severe weather event.

Table 3-26: Estimated Vulnerable Populations in Orange		
Vulnerable Population Category	Number	Percent of Total Population*
Population Age 65 Years and Over	1,308	17%
Population with a Disability	1,437	19%

Population who Speak English Less than "Very Well"	75	1%
Vulnerable Household Category	Number	Percent of Total Households*
Low Income Households (annual income less than \$35,000)	1,242	40%
Householder Age 65 Years and Over Living Alone	426	14%
Households Without Access to a Vehicle	273	9%

*Total population = 7,682; Total households = 3,137

Note: Individuals and households may be counted under multiple categories.

Source: U.S. Census American Community Survey 2013-2017 Five-Year Estimates.

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.

Health Impacts

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.²⁶ Much of this phenomenon is attributed to the stress and anxiety that many individuals, particularly children, experience during severe thunderstorms. The combination of wind, rain, and lightning from thunderstorms with pollen and mold spores can exacerbate asthma. 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.

Economic Impacts

Wind storms and severe thunderstorms events may impact the economy, including direct building losses and the cost of repairing or replacing the damage caused to the building. Additional economic impacts may include loss of business functions, water supply system damage, inventory damage, relocation costs, wage losses, and rental losses due to the

²⁶ Andrews, L.W. 2012. How Thunderstorms Affect Health. Psychology Today. June 2, 2012.

<https://www.psychologytoday.com/blog/minding-the-body/201206/how-thunderstorms-affect-health>

repair/replacement of buildings. Agricultural losses due to lightning and the resulting fires can be extensive. 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.

Recovery and clean-up costs can also be costly, resulting in further economic impacts. Prolonged obstruction of major routes due to secondary hazards such as landslides, debris, or floodwaters can disrupt the shipment of goods and other commerce. Large, prolonged storms can have negative economic impacts on an entire region.

Because of differences in building construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. Wood and masonry buildings in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings. Mobile homes are the most vulnerable to damage, even if tied down, and offer little protection to people inside.

Infrastructure

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,²⁷ 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.

Massachusetts is divided into three design wind speeds for four risk categories, the limits of which are defined by the Massachusetts State Building Code (9th Edition). National wind data prepared by the American Society of Civil Engineers serve as the basis of these wind design requirements (“Minimum Design Loads for Buildings and Other Structures,” American Society of Civil Engineers ASCE-7). Generally speaking, structures should be designed to withstand the total wind load of their location. Orange falls within the 90 mph wind load zone. Refer to the State Building Code (9th Edition [780 CMR] Chapter 16 Structural Design, as amended by Massachusetts) for appropriate reference wind pressures, wind forces on roofs, and similar data.

²⁷ <https://www.fema.gov/hazus-mh-hurricane-wind-model>

All elements of the built environment are exposed to severe weather events such as high winds and thunderstorms. Table 3-27 identifies the assessed value of all residential, open space, commercial, and industrial land uses in Town, and the losses that would result from 1%, 5%, and 10% damage to this inventory as a result of high winds or a severe thunderstorm.

Table 3-27: Estimated Potential Loss by Tax Classification in Orange				
Tax Classification	Total Assessed Value FY2019	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Residential	\$411,495,092	\$4,114,951	\$20,574,755	\$41,149,509
Open Space	\$0	\$0	\$0	\$0
Commercial	\$48,380,085	\$483,801	\$2,419,004	\$4,838,009
Industrial	\$28,201,350	\$282,014	\$1,410,068	\$2,820,135
Total	\$488,076,527	\$4,880,765	\$24,403,826	\$48,807,653

Source: Massachusetts Department of Revenue - Division of Local Services, Municipal Databank/Local Aid Section.

Agriculture

Forestry species and agricultural crops, equipment, and infrastructure may be directly impacted by high winds. Trees are also vulnerable to lightning strikes.

Energy

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. 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

Public safety facilities and equipment may experience a direct loss (damage) from high winds.

Transportation

Roads may become impassable due to flash or urban flooding, downed trees and power lines, or due to landslides caused by heavy, prolonged rains. Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting) transportation needs.

Water & Wastewater Infrastructure

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.

Environment

As described under other hazards, such as hurricanes and severe winter storms, 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 the Flooding section, 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.

Vulnerability Summary

Based on the above assessment, Orange has a “High” vulnerability to severe thunderstorms and wind events. Thunderstorms are common in New England, and can impact property, crops, utilities and the population of Orange. Microbursts are less common, but can cause significant damage when they do occur. The cascade effects of severe storms include utility losses and transportation accidents and flooding. Particular areas of vulnerability include low-income and elderly populations, trailer homes, and infrastructure such as roadways and utilities that can be damaged by such storms and the low-lying areas that can be impacted by flooding. The following problem statements summarize Orange’s areas of greatest concern regarding severe thunderstorms and wind events.

Severe Thunderstorm / Wind Hazard Problem Statements


- Orange’s waste water treatment plant is located within the flood plain and is not adequately flood proofed, and is therefore vulnerable to hazards that include heavy rain events.
- Culvert maintenance and bridge maintenance is needed throughout the Town. Culverts on Fairman Road, Mountain Road, and East Main Street are of top priority for repair.
- Orange does not yet have a comprehensive list of GIS mapping of culverts throughout Town.
- There is an issue with flooding at Orange’s Town hall due to storm water runoff coming from the hill behind it. The Town is currently working to build a trench in the back of the building to promote drainage. Other projects located upland of the Town Hall should be explored to mitigate storm water runoff.
- The bridge going over the East Branch of Tully River is noted to be of concern – emergency vehicles may not be able to cross the bridge during an emergency.
- Drainage infrastructure on North Main Street/in downtown Orange is not sufficient, and there are several businesses that experience flooding during heavy rain events.
- The Fire Station located on Tully Road can become isolated during hazard events, especially if key bridges go out. This station also does not have cell service, and power outages cause the station to lose internet access and cable, which further isolates emergency responders during severe weather.
- Many bridges in Orange have low weight limits, which complicates access routes for emergency vehicles.
- Many of the Town’s evacuation routes may be impacted by flooding. There are areas of Town where residents might become isolated if roads, bridges, or culverts were blocked or damaged during a flood.
- Emergency shelters may not be adequately staffed or supplied with water, food, and first aid supplies. There is a need to inventory the supplies currently available at Orange shelters.
- Destructive winds and ice associated with severe wind can cause widespread road closures by taking down trees and utility lines throughout town, further exacerbating communication and access to emergency services and information for residents already facing isolation.
- An estimated 61% of homes in Orange were built prior to the first State building code in 1975, potentially making them more vulnerable to damages from high winds.
- Some of Orange’s residents rely on private wells, placing them at risk during prolonged power outages caused by flooding.

3.6 TORNADOES

Potential Impacts of Climate Change

Climate change is expected to increase the frequency and intensity of severe weather, which can include tornadoes. However, tornadoes are too small to be simulated well by climate models. Therefore, specific predictions about how this hazard will change are not possible, given current technical limitations. As discussed in other sections in this Plan, the conditions that are conducive to tornadoes (which are also conducive to other weather phenomena, such as hurricanes and tropical storms) are expected to become more severe under global warming.

Figure 3-9: Impacts of Climate Change on Tornadoes

Potential Effects of Climate Change		
	EXTREME WEATHER → INCREASE IN FREQUENCY AND INTENSITY OF SEVERE THUNDERSTORMS	Future environmental changes may result in an increase in the frequency and intensity of severe thunderstorms, which can include tornadoes. However, the resolution of current climate models is too coarse to accurately simulate tornado formation and the confidence on model details associated with this potential increase is low.

Source: Massachusetts State Hazard Mitigation and Climate Adaptation Plan. September 2018

Hazard Description

A tornado is a narrow, violently rotating column of air that extends from the base of a cumulonimbus cloud to the ground. The observable aspect of a tornado is the rotating column of water droplets, with dust and debris caught in the column. Tornadoes are the most violent of all atmospheric storms.

The following are common factors in tornado formation:

- Very strong winds in the middle and upper levels of the atmosphere
- Clockwise turning of the wind with height (i.e., from southeast at the surface to west aloft)
- Increasing wind speed in the lowest 10,000 feet of the atmosphere (i.e., 20 mph at the surface and 50 mph at 7,000 feet)
- Very warm, moist air near the ground, with unusually cooler air aloft
- A forcing mechanism such as a cold front or leftover weather boundary from previous shower or thunderstorm activity

Tornadoes can form from individual cells within severe thunderstorm squall lines. They can also form from an isolated supercell thunderstorm. They can be spawned by tropical cyclones or the remnants thereof, and weak tornadoes can even occur from little more than a rain shower if air is converging and spinning upward. Most tornadoes occur in the late afternoon and evening

hours, when the heating is the greatest. The most common months for tornadoes to occur are June, July, and August, although the Conway, Massachusetts, tornado (2017) occurred in February.

A tornadic waterspout is a rapidly rotating column of air extending from the cloud base (typically a cumulonimbus thunderstorm) to a water surface, such as a bay or the ocean. They can be formed in the same way as regular tornadoes, or can form on a clear day with the right amount of instability and wind shear. Tornadic waterspouts can have wind speeds of 60 to 100 mph, but since they do not move very far, they can often be navigated around. They can become a threat to land if they drift onshore.

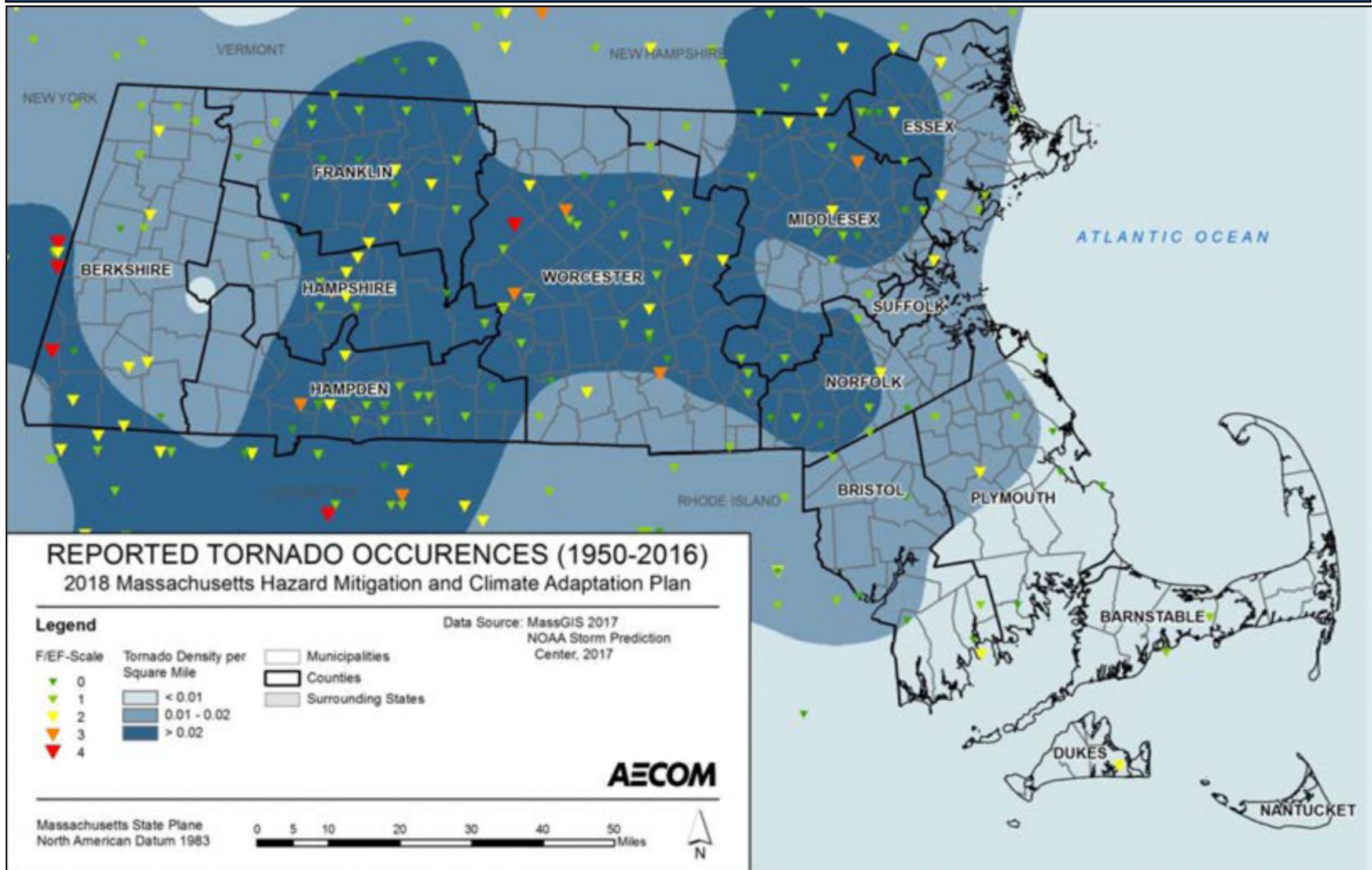
Location

Figure 3-10 illustrates the reported tornado occurrences, based on all-time initial touchdown locations across the Commonwealth as documented in the NOAA NCDC Storm Events Database. ArcGIS was used to calculate an average score per square mile. The analysis indicated that the area at greatest risk for a tornado touchdown runs from central to northeastern Massachusetts, and includes Orange and much of Franklin County. Tornadoes are rated as having an Area of Occurrence of “Isolated.” If a tornado were to occur in Orange, it would likely impact less than 10% of the Town.

Extent







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. Figure 3-11 provides guidance from NOAA about the impacts of a storm with each rating.

Figure 3-10: Density of Reported Tornadoes per Square Mile



Source: NOAA Storm Prediction Center (SPC), as presented in the Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018.

Figure 3-11: Enhanced Fujita Scale & Guide to Tornado Severity

Scale	Wind Speed Estimate		Potential damage	Example of Damage
	mph	km/h		
EF0	65–85	105–137	Minor damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e., those that remain in open fields) are always rated EF0.	
EF1	86–110	138–177	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.	
EF2	111–135	178–217	Considerable damage. Roofs torn off from well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.	
EF3	136–165	218–266	Severe damage. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations are badly damaged.	
EF4	166–200	267–322	Devastating damage. Well-constructed and whole frame houses completely leveled; some frame homes may be swept away; cars and other large objects thrown and small missiles generated.	
EF5	>200	>322	Incredible damage. Strong-framed, well-built houses leveled off foundations and swept away; steel-reinforced concrete structures are critically damaged; tall buildings collapse or have severe structural deformations; cars, trucks, and trains can be thrown approximately 1 mile (1.6 km).	

Source: Wikipedia: https://en.wikipedia.org/wiki/Enhanced_Fujita_scale

Previous Occurrences

On June 1, 2011, thunderstorms forming ahead of a cold front across Southern New England organized into discrete supercells in an environment highly favorable for tornado formation. A tornado evaluated to be an EF-3 tornado entered Hampden County from the Berkshires, touched down in Westfield, and continued on a 38-mile-long trek through West Springfield, Springfield, Wilbraham, Monson, Brimfield, and Sturbridge. This tornado was on the ground for an estimated 70 minutes. About two hours later, another supercell tracked just to the north of the storm track of the EF3 tornado. While its rotation was not as strong, it produced brief tornadoes in Wilbraham (EF1), North Brimfield (EF1), and Sturbridge (EF0). While the focus was on the tornadoes and their damage, damaging winds, large hail up to two inches in diameter, and some flash flooding also occurred across southern New England.

Since the 1950s, there have been over twenty tornadoes in Franklin County. In the last two decades, five tornadoes have been reported in Franklin County, in the Cities of Heath, Charlemont, Wendell, New Salem, and Conway (Table 3-28). The February 2017 tornado in the center of Conway was the most destructive, impacting forests and causing major property damage to several homes, barns, and a church that subsequently had to be torn down. Miraculously, no deaths or serious injuries were reported.

Table 3-28: Tornado Events in Franklin County				
Date	Severity	Property Damage	Crop Damage	Event Narrative
7/3/1997	F1	\$50,000	\$0	A tornado touched down just west of Number Nine Road in Heath and then skipped along a path which ended about a mile into northwest Colrain. Many large trees were uprooted or snapped at their mid levels. A silo was destroyed and part of the roof of an attached barn was peeled back. A hay tractor was flipped over with its wheels in the air. Doors to a garage were blown in and the roof was partially ripped off. The tornado affected mostly wooded terrain and did extensive tree damage when it passed through a state forest. The path width was up to 100 yards. There were no injuries.
7/3/1997	F1	\$50,000	\$0	A tornado touched down in the eastern part of Charlemont and travelled east causing damage to a campground. Fifteen trailers were damaged from falling trees and flying debris. Two of the trailers were severely damaged and one was destroyed with seven trees falling on top of it. Eyewitnesses reported rotation in the clouds and debris. The tornado then moved through the higher terrain of the Catamount State Forest. The path was discontinuous and ranged in width from 50 to 100 yards. The tornado path ended in the Copeland Hills section of Colrain. There were no direct injuries reported.

Table 3-28: Tornado Events in Franklin County				
Date	Severity	Property Damage	Crop Damage	Event Narrative
7/11/2006	F2	\$200,000	\$0	Brief F2 touchdown in Wendell
9/1/2013	EF0	\$0	\$0	A Massachusetts Department of Conservation and Recreation employee observed a waterspout on Quabbin Reservoir in New Salem, MA. He was able to snap two pictures of the storm, one showing a funnel and another showing the funnel extended down to the water. The waterspout was very short lived, never hit land, and did no damage and injured no people. Winds aloft were not conducive for tornadic development, but the environment was unstable and a surface front was moving through the region.
2/25/2017	EF1	\$400,000	\$0	This tornado touched down at 7:23 pm on Main Poland Road in western Conway, Massachusetts. The path width started at 50 yards, with a sharp gradient evident of damage versus no damage. Large sections of forest had thick pine trees snapped at mid-tree. Numerous power lines were downed along the path into downtown Conway. The path width grew, reaching a maximum width of 200 yards near the town hall. Several houses were severely damaged on Whately Road, southeast of the town hall. Roofs were blown off, and in one case the side walls of a house were missing with the interior of the house exposed. On Hill View Road a large barn collapsed. One injury occurred when a tree landed on a house on South Deerfield Road east of town. That was where the visible damage path ended.

Source: NOAA Storm Events Database: <https://www.ncdc.noaa.gov/stormevents/>

Probability of Future Events

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. Based on past occurrences, there is a “Very Low” probability (less than a 1% chance) of a tornado affecting the town in a given year.

Impact

Tornadoes are potentially the most dangerous of local storms. If a major tornado were to strike in the populated areas of Orange, damage could be widespread. Fatalities could be high; 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 severity of impact of a tornado event is likely “Limited,” with more than 10% of property in the affected area damaged or destroyed.

Vulnerability

Society

The entire town of Orange has the potential for tornado formation, and is located in the area within Massachusetts described above as having higher-than-average tornado frequency. Residents of impacted areas may be displaced or require temporary to long-term shelter due to severe weather events. In addition, downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss of life.

Vulnerable Populations

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

An estimated 2,191 housing units in Orange, or 61% of all housing units in town, were built prior to the 1970s when the first building code went into effect in Massachusetts. An estimated 299 mobile homes are located in Orange, accounting for 8% of the total housing stock.²⁸ Table 3-29 estimates the number of vulnerable populations and households in Orange. Individuals and households may fall into multiple categories, so the numbers should not be added. Rather, the table provides Town officials and emergency response personnel with information to help plan for responding to the needs of Orange residents during a tornado event.

²⁸ U.S. Census Bureau 2013-2017 American Community Survey five-year estimates.

Table 3-29: Estimated Vulnerable Populations in Orange		
Vulnerable Population Category	Number	Percent of Total Population*
Population Age 65 Years and Over	1,308	17%
Population with a Disability	1,437	19%
Population who Speak English Less than "Very Well"	75	1%
Vulnerable Household Category	Number	Percent of Total Households*
Low Income Households (annual income less than \$35,000)	1,242	40%
Householder Age 65 Years and Over Living Alone	426	14%
Households Without Access to a Vehicle	273	9%

*Total population = 7,682; Total households = 3,137

Note: Individuals and households may be counted under multiple categories.

Source: U.S. Census American Community Survey 2013-2017 Five-Year Estimates.

Health Impacts

The primary health hazard associated with tornadoes is the threat of direct injury from flying debris or structural collapse as well as the potential for an individual to be lifted and dropped by the tornado's winds. After the storm has subsided, tornadoes can present unique challenges to search and rescue efforts because of the extensive and widespread distribution of debris. The distribution of hazardous materials, including asbestos-containing building materials, can present an acute health risk for personnel cleaning up after a tornado disaster and for residents in the area. The duration of exposure to contaminated material may be far longer if drinking water reservoir or groundwater aquifers are contaminated. According to the EPA, properly designed storage facilities for hazardous materials can reduce the risk of those materials being spread during a tornado. Many of the health impacts described for other types of storms, including lack of access to a hospital, carbon monoxide poisoning from generators, and mental health impacts from storm-related trauma, could also occur as a result of tornado activity.

Economic Impacts

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.

Because of differences in building construction, residential structures are generally more susceptible to tornado damage than commercial and industrial structures. Wood and masonry buildings in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings. Mobile homes are the most vulnerable to damage, even if tied down, and offer little protection to people inside.

Infrastructure

All critical facilities and infrastructure in Orange are exposed to tornado events. Table 3-30 identifies the assessed value of all residential, open space, commercial, and industrial land uses in Town, and the losses that would result from 1%, 5%, and 10% damage to this inventory as a result of a tornado.

Table 3-30: Estimated Potential Loss by Tax Classification in Orange				
Tax Classification	Total Assessed Value FY2019	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Residential	\$411,495,092	\$4,114,951	\$20,574,755	\$41,149,509
Open Space	\$0	\$0	\$0	\$0
Commercial	\$48,380,085	\$483,801	\$2,419,004	\$4,838,009
Industrial	\$28,201,350	\$282,014	\$1,410,068	\$2,820,135
Total	\$488,076,527	\$4,880,765	\$24,403,826	\$48,807,653

Source: Massachusetts Department of Revenue - Division of Local Services, Municipal Databank/Local Aid Section.

Agriculture

Forestry species and agricultural crops, equipment, and infrastructure may be directly impacted by tornadoes.

Energy

High winds could down power lines and poles adjacent to roads. Damage to above-ground transmission infrastructure can result in extended power outages.

Public Safety

Public safety facilities and equipment may experience direct loss (damage) from tornadoes. Shelters and other critical facilities that provide services for people whose property is uninhabitable following a tornado may experience overcrowding and inadequate capacity to provide shelter space and services.

Transportation

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. Prolonged obstruction of major routes due to secondary hazards, such as landslides, debris, or floodwaters, can disrupt the shipment of goods and other commerce. If the tornado is strong enough to transport large debris or knock out infrastructure, it can create serious impacts on power and aboveground communication lines.

Water & Wastewater Infrastructure

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. 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.

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.

Vulnerability Summary

Overall, Orange has a “Low” vulnerability to tornadoes. Tornadoes are not common occurrences in Orange, but can cause significant damage when they do occur. The cascade effects of tornadoes include utility losses and transportation accidents and flooding. Losses associated with the flood hazard are discussed earlier in this section. Particular areas of vulnerability include low-income and elderly populations, mobile homes, and infrastructure such as roadways and utilities that can be damaged by such storms and the low-lying areas that can be impacted by flooding. The following problem statements summarize Orange’s areas of greatest concern regarding tornadoes.

Tornado Hazard Problem Statements
<ul style="list-style-type: none">• The REPC is working to identify options for regional and local debris management. The regional plan approved by MassDEP several years ago was never implemented because the communities that would serve as regional sites did not execute MOUs. The Town is being urged by MassDEP to select and provide disaster debris storage/disposal location(s).
<ul style="list-style-type: none">• The bridge going over the East Branch of Tully River is noted to be of concern – emergency vehicles may not be able to cross the bridge during an emergency.
<ul style="list-style-type: none">• The Fire Station located on Tully Road can become isolated during hazard events, especially if key bridges go out. This station also does not have cell service, and power outages cause the station to lose internet access and cable, which further isolates emergency responders during severe weather.
<ul style="list-style-type: none">• Many bridges in Orange have low weight limits, which complicates access routes for emergency vehicles.
<ul style="list-style-type: none">• New initiatives are needed to improve household disaster preparedness Town-wide and to better reach vulnerable populations, including seniors and disabled residents with lessened mobility or medical needs, as well as homeless or transient people who may be difficult to reach in the event of an emergency. The Town may need to review and update evacuation planning for vulnerable populations in its CEMP, explore additional sheltering options, and pursue supportive partnerships for sheltering in the community.
<ul style="list-style-type: none">• Emergency shelters may not be adequately staffed or supplied with water, food, and first aid supplies. There is a need to inventory the supplies currently available at Orange shelters.
<ul style="list-style-type: none">• Although the Town has a Reverse 911 Warning System (CodeRED) with a large percentage of residents subscribing to the service, there is a need to continue to increase subscription among residents and businesses. Education and outreach are needed to ensure that all residents are aware of emergency situations and have access to evacuation and sheltering instructions, including options for residents with specialized medical needs, and pet sheltering options.
<ul style="list-style-type: none">• Many residents live in isolated locations with unreliable cell service, which can decrease access to emergency services.

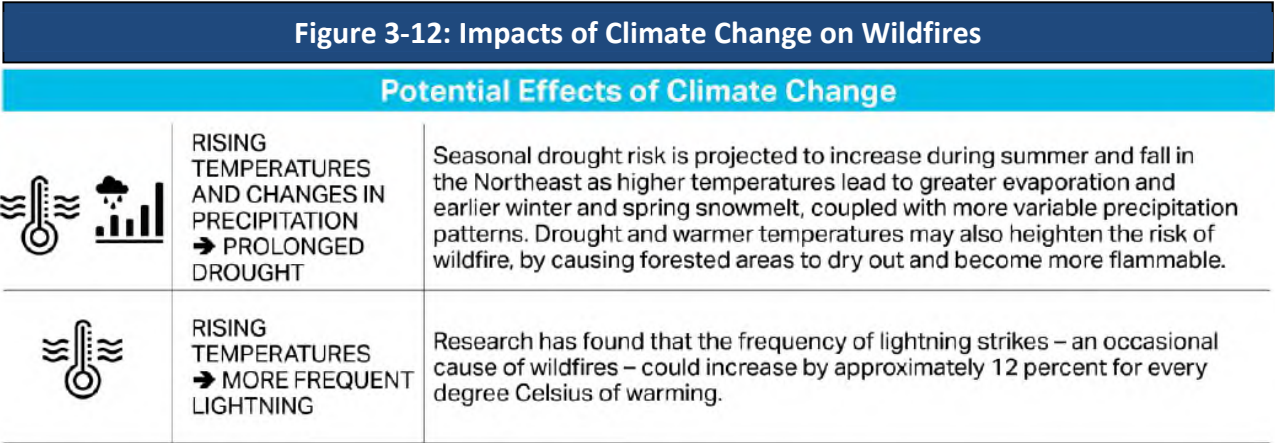
- Destructive winds and ice associated with tornadoes can cause widespread road closures by taking down trees and utility lines throughout town, further exacerbating communication and access to emergency services and information for residents already facing isolation.
- Existing communication infrastructure issues and vulnerabilities could be exacerbated by severe winter storm hazards impacts.
- An estimated 61% of homes in Orange were built prior to the first State building code in 1975, potentially making them more vulnerable to damages from high winds.
- The parking lot pavement at the Orange Airport (a designated Point of Distribution by MEMA and FEMA) is in poor condition. The deteriorating pavement makes it difficult to plow the lot without digging up pavement and creating holes. As an emergency POD site, the parking lot needs to be plowed and maintained so that it is in a serviceable condition at all times.

3.7 WILDFIRE

Potential Impacts of Climate Change

Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Periods of hot, dry weather create the highest fire risk. Therefore, the predicted increase in average and extreme temperatures in the Commonwealth may intensify wildfire danger by warming and drying out vegetation. A recent study published in *the Proceedings of the National Academy of Sciences* found that climate change has likely been a significant contributor to the expansion of wildfires in the western U.S., which have nearly doubled in extent in the past three decades.²⁹ Another study found that the frequency of lightning strikes—an occasional cause of wildfires—could increase by approximately 12 percent for every degree Celsius of warming.³⁰ Finally, the year-round increase in temperatures is likely to expand the duration of the fire season.

Climate change is also interacting with existing stressors to forests, making them more vulnerable to wildfire. Drought, invasive species, and extreme weather events, all can lead to more dead, downed, or dying trees, increasing the fire load in a forest.



Source: Massachusetts State Hazard Mitigation and Climate Adaptation Plan. September 2018

Hazard Description

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. The wildfire season in Massachusetts

²⁹ Abatzoglou, J.T. and Williams, A.P. 2016. Impact of anthropogenic climate change on wildfire across western US forests 2016 113 (42) 11770-11775; published ahead of print October 10, 2016, doi:10.1073/pnas.1607171113
³⁰ Roms, D.M. et al. 2014. Projected increase in lightning strikes in the United States due to global warming. Science. November 14, 2014. <http://science.sciencemag.org/content/346/6211/851>

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.

Fire Ecology and Wildfire Behavior

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, as described below.

- 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.

The wildland-urban interface is the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. There are a number of reasons that the wildland-urban interface experiences an increased risk of wildfire damage. Access and fire suppression issues on private property in the wildland-urban interface can make protecting structures from wildfires difficult. This zone also faces increased risk because structures are built in densely wooded areas, so fires started on someone's property are more easily spread to the surrounding forest.

Fire is also used extensively as a land management tool to replicate natural fire cycles, and it has been used to accomplish both fire-dependent ecosystem restoration and hazard fuel mitigation objectives on federal, state, municipal, and private lands in Massachusetts since the 1980s. For example, over the past 16 years, the Massachusetts Division of Fisheries and Wildlife (MassWildlife) has used a combination of tree harvesting, shrub mowing, and prescribed burning to benefit rare species and to reduce the risk of a catastrophic wildfire in the Montague Plains Wildlife Management Area, a rare pitch pine-scrub oak forest in Montague. Approximately 880 acres have been treated since 2004 to restore woodland and shrubland habitats. MassWildlife has cooperative agreements with the Department of Conservation and Recreation and the Town of Montague Conservation Commission to restore sandplain habitats on their inholdings within the plains, and works closely with local fire departments and the DCR Bureau of Fire Control to ensure that firefighters have adequate access in the event of a wildfire and are familiar with the changes in vegetation and fuels resulting from habitat management activities.³¹

In Massachusetts, the DCR Bureau of Forest Fire Control is the state agency responsible for protecting 3.5 million acres of state, public, and private wooded land and for providing aid, assistance, and advice to the Commonwealth's cities and towns. The Bureau coordinates efforts with a number of entities, including fire departments, local law enforcement agencies, the Commonwealth's county and statewide civil defense agencies, and mutual aid assistance organizations.

Bureau units respond to all fires that occur on state-owned forestland and are available to

³¹ "Background information on Montague Plains Wildlife Management Area," MA Division of Fisheries and Wildlife, as published in the *2018 Montague Open Space and Recreation Plan*.

municipal fire departments for mutual assistance. Bureau firefighters are trained in the use of forestry tools, water pumps, brush breakers, and other motorized equipment, as well as in fire behavior and fire safety. Massachusetts also benefits from mutual aid agreements with other state and federal agencies. The Bureau is a member of the Northeastern Forest Fire Protection Commission, a commission organized in 1949 by the New England states, New York, and four eastern Canadian Provinces to provide resources and assistance in the event of large wildfires. Massachusetts DCR also has a long-standing cooperative agreement with the U.S. Department of Agriculture's Forest Service both for providing qualified wildfire-fighters for assistance throughout the U.S. and for receiving federal assistance within the Commonwealth. Improved coordination and management efforts seem to be reducing the average damage from wildfire events. According to the Bureau's website, in 1911, more than 34 acres were burned on average during each wildfire. As of 2017, that figure has been reduced to 1.17 acres.

Location

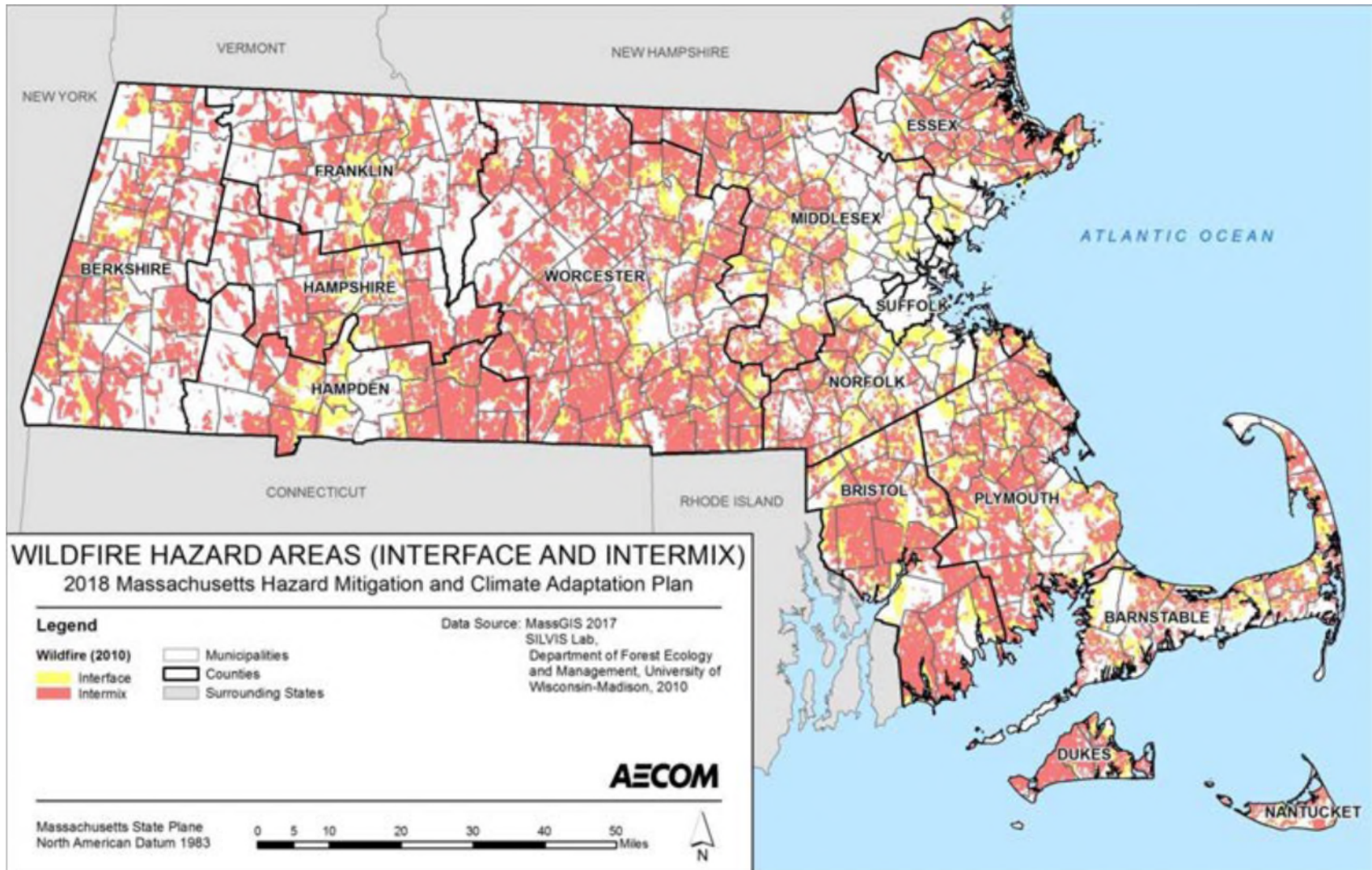
The ecosystems that are most susceptible to the wildfire hazard are pitch pine, scrub oak, and oak forests, as these areas contain the most flammable vegetative fuels. Other portions of the Commonwealth are also susceptible to wildfire, particularly at the urban-wildland interface. The SILVIS Lab at the University of Wisconsin-Madison Department of Forest Ecology and Management classifies exposure to wildfire hazard as "interface" or "intermix." Intermix communities are those where housing and vegetation intermingle and where the area includes more than 50 percent vegetation and has a housing density greater than one house per 16 hectares (approximately 6.5 acres). Interface communities are defined as those in the vicinity of contiguous vegetation, with more than one house per 40 acres and less than 50 percent vegetation, and within 1.5 miles of an area of more than 500 hectares (approximately 202 acres) that is more than 75 percent vegetated. These areas are shown in Figure 3-13. Inventoried assets (population, building stock, and critical facilities) were overlaid with these data to determine potential exposure and impacts related to this hazard. Orange has several areas of "intermix" zones within town.

The Northeast Wildfire Risk Assessment Geospatial Work Group completed a geospatial analysis of fire risk in the 20-state U.S. Forest Service Northeastern Area. The assessment is comprised of three components—fuels, wildland-urban interface, and topography (slope and aspect)—that are combined using a weighted overlay to identify wildfire-prone areas where hazard mitigation practices would be most effective. Figure 3-14 illustrates the areas identified for the Commonwealth. Orange mostly falls within the "High" wildfire risk area. The entire town of Orange, which is approximately 77% forested, is at risk for wildfire.

Early detection of wildfires is a key part of the Bureau's overall effort. Early detection is

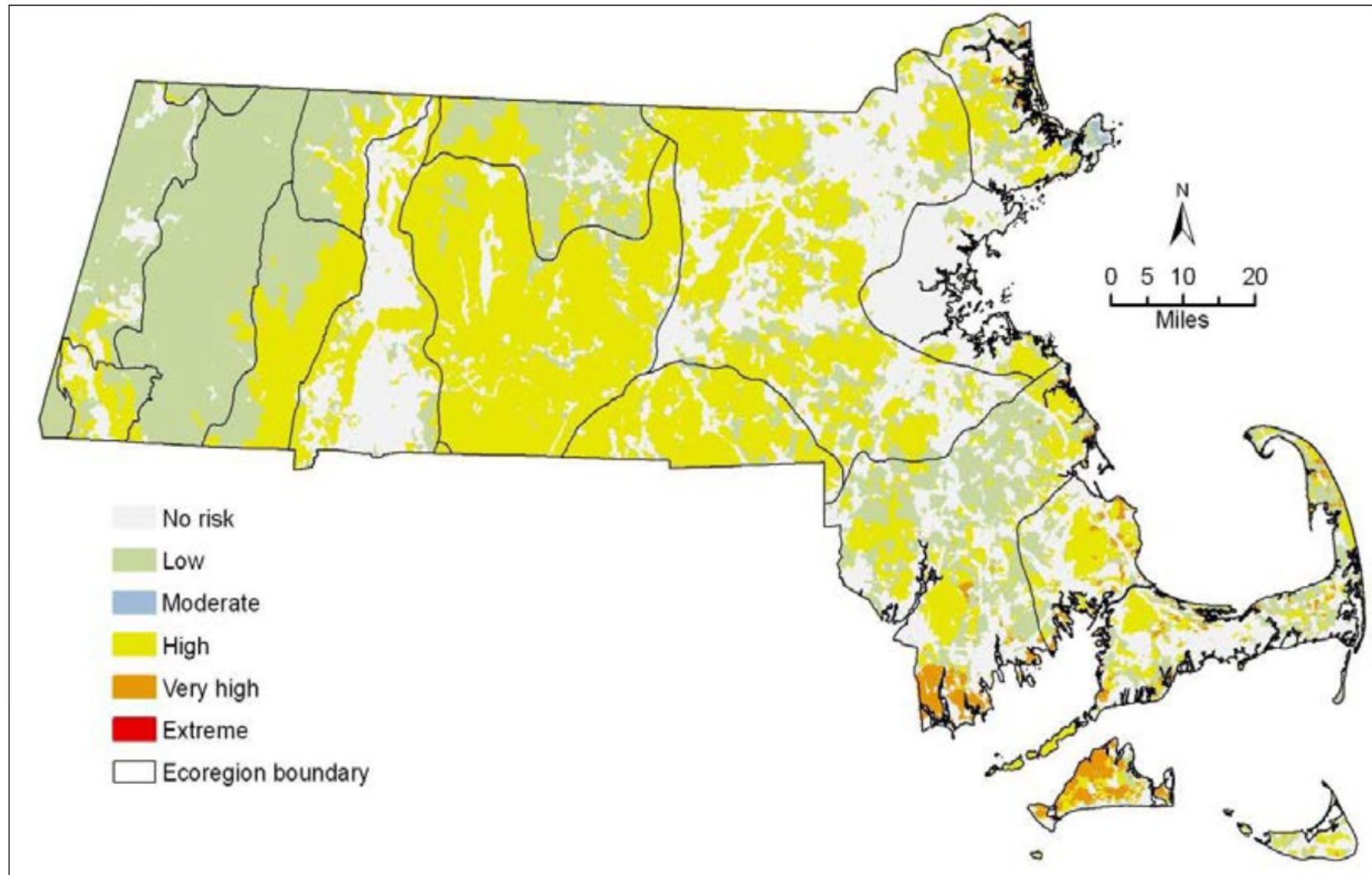
achieved by trained Bureau observers who staff the statewide network of 42 operating fire towers. During periods of high fire danger, the Bureau conducts county-based fire patrols in forested areas. These patrols assist cities and towns in prevention efforts and allow for the quick deployment of mobile equipment for suppression of fires during their initial stage. Figure 3-15 displays the Bureau's fire control districts and fire towers in Massachusetts.

Figure 3-13: Wildland-Urban Interface and Intermix for the Commonwealth of Massachusetts



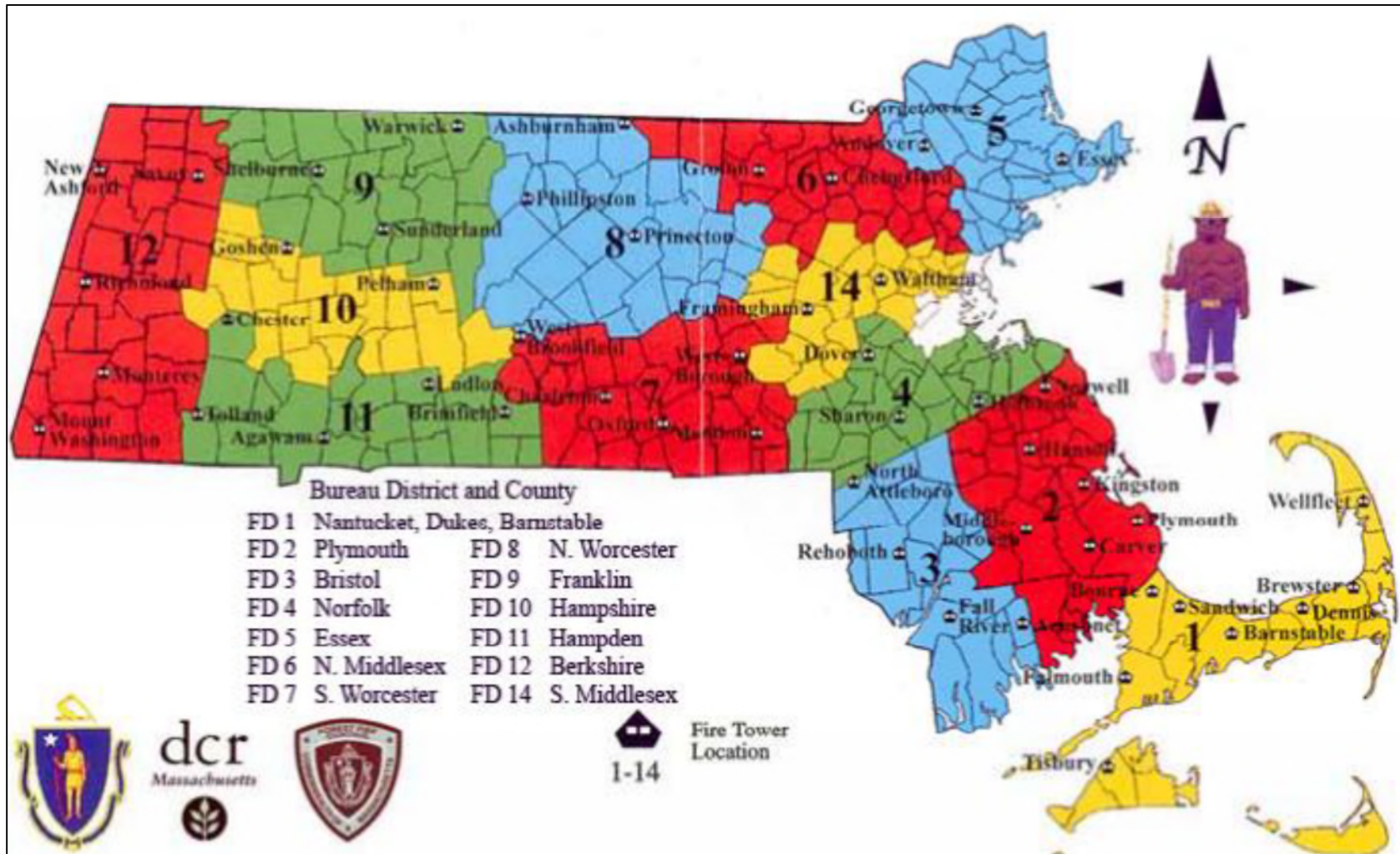
Source: Massachusetts State Hazard Mitigation and Climate Adaptation Plan. September 2018

Figure 3-14: Wildfire Risk Areas for the Commonwealth of Massachusetts



Source: Northeast Wildfire Risk Assessment Geospatial Work Group, 2009, as presented in the Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018.

Figure 3-15: Massachusetts Bureau of Forest Fire Control Districts and Tower Network



Source: Massachusetts Department of Conservation and Recreation, Bureau of Forest Fire Control, 2018, as presented in the Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018.

Extent

The National Wildfire Coordinating Group defines seven classes of wildfires:

- Class A: 0.25 acre or less
- Class B: more than 0.25 acre, but less than 10 acres
- Class C: 10 acres or more, but less than 100 acres
- Class D: 100 acres or more, but less than 300 acres
- Class E: 300 acres or more, but less than 1,000 acres
- Class F: 1,000 acres or more, but less than 5,000 acres
- Class G: 5,000 acres or more.

Unfragmented and heavily forested areas of the state are vulnerable to wildfires, particularly during droughts. The greatest potential for significant damage to life and property from fire exists in areas designated as wildland-urban interface areas. A wildland-urban interface area defines the conditions where highly flammable vegetation is adjacent to developed areas. Fires can be classified by physical parameters such as their fireline intensity, or Byram's intensity, which is the rate of energy per unit length of the fire front (BTU [British thermal unit] per foot of fireline per second). Wildfires are also measured by their behavior, including total heat release during burnout of fuels (BTU per square foot) and whether they are crown-, ground-, or surface-burning fires. Following a fire event, the severity of the fire can be measured by the extent of mortality and survival of plant and animal life aboveground and belowground and by the loss of organic matter.³²

If a fire breaks out and spreads rapidly, residents may need to evacuate within days or hours. A fire's peak burning period generally is between 1 p.m. and 6 p.m. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications in recent years has further contributed to a significant improvement in warning time.

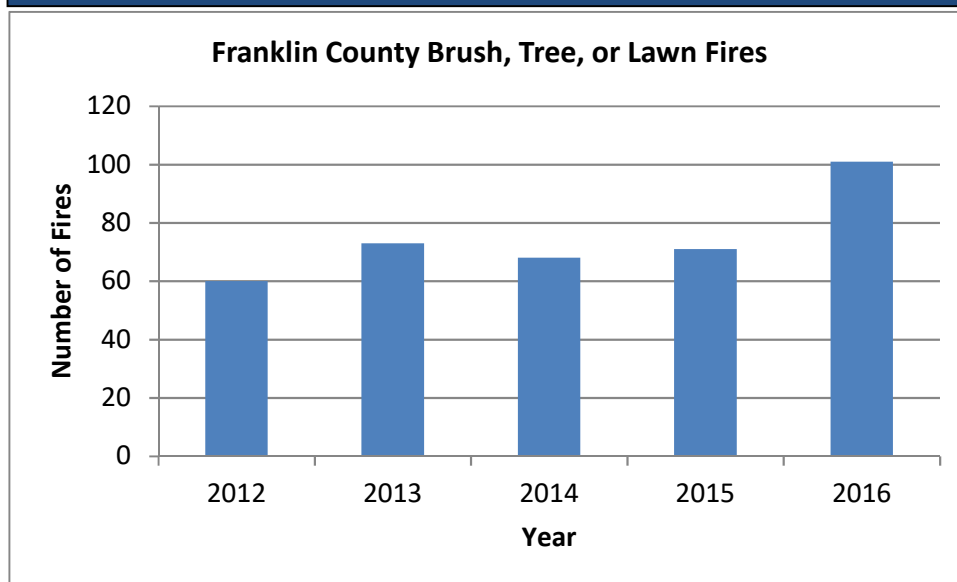
Previous Occurrences

In the last five years (2012 – 2016) Franklin County has averaged 75 brush, tree, or lawn fires a year, with the highest reported number of fires occurring in 2016 (Figure 3-16). During 2016,

³² National Parks Service (NPS), compiled by George Wooten. n.d. Fire and fuels management: Definitions, ambiguous terminology and references. <https://www.nps.gov/olymp/learn/management/upload/fire-wildfire-definitions-2.pdf>

Franklin County and Massachusetts experienced one of the worst droughts in the last 50 years.

Figure 3-16: Outdoor Vegetation Fires in Franklin County 2012 - 2016



Source: Massachusetts Fire Incident Reporting System County Profiles.

While wildfires have not been a significant problem in Orange there is always a possibility that changing land use patterns and weather conditions will increase a community's vulnerability. For example, drought conditions can make forests and other open, vegetated areas more vulnerable to ignition. While moderate drought conditions were experienced in the western half of the state in July 2011, they were back to normal by October. Historically, drought has not been a problem in the Town of Orange. Once the fire starts, it will burn hotter and be harder to extinguish. Soils and root systems starved for moisture are also vulnerable to fire. Residential growth in rural, forested areas increases the total area that is vulnerable to fire and places homes and neighborhoods closer to areas where wildfires are more likely to occur.

Lightning can also be a cause of wildfires, brush fires, and structural fires. In 2006 fifteen acres burned on Walnut Hill. In 2009, over thirty acres along Tully Road burned.

Probability of Future Events

It is difficult to predict the likelihood of wildfires in a probabilistic manner because a number of factors affect fire potential and because some conditions (e.g., ongoing land use development patterns, location, and fuel sources) exert changing pressure on the wildland-urban interface zone. However, based on the frequency of past occurrences, Orange has a "Very High" probability (50% to 100% chance) that it will experience a wildfire in a given year.

Impact

Unfragmented and heavily forested areas of Orange are vulnerable to wildfires, particularly during droughts. The greatest potential for significant damage to life and property from fire exists in areas designated as wildland-urban interface areas. A wildland-urban interface area defines the conditions where highly flammable vegetation is adjacent to developed areas. The greatest impact in Orange from a wildfire is to the natural environment, which faces a “Minor” impact from wildfires, with minor property in the affected area damaged or destroyed.

Vulnerability***Society***

As demonstrated by historical wildfire events, potential losses from wildfire include human health and the lives of residents and responders. The most vulnerable populations include emergency responders and those within a short distance of the interface between the built environment and the wildland environment.

Vulnerable Populations

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.

Table 3-31 estimates the number of vulnerable populations and households in Orange. Individuals and households may fall into multiple categories, so the numbers should not be added. Rather, the table provides Town officials and emergency response personnel with information to help plan for responding to the needs of Orange residents during a wildfire event.

Table 3-31: Estimated Vulnerable Populations in Orange		
Vulnerable Population Category	Number	Percent of Total Population*
Population Age 65 Years and Over	1,308	17%
Population with a Disability	1,437	19%
Population who Speak English Less than "Very Well"	75	1%
Vulnerable Household Category	Number	Percent of Total Households*
Low Income Households (annual income less than \$35,000)	1,242	40%
Householder Age 65 Years and Over Living Alone	426	14%
Households Without Access to a Vehicle	273	9%

*Total population = 7,682; Total households = 3,137

Note: Individuals and households may be counted under multiple categories.

Source: U.S. Census American Community Survey 2013-2017 Five-Year Estimates.

Health Impacts

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.

Economic Impacts

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.

Infrastructure

For the purposes of this planning effort, all elements of the built environment located in the wildland interface and intermix areas are considered exposed to the wildfire hazard. Table 3-32 identifies the assessed value of all residential, open space, commercial, and industrial land uses in Town, and the losses that would result from 1%, 5%, and 10% damage to this inventory as a result of a wildfire.

Table 3-32: Estimated Potential Loss by Tax Classification in Orange				
Tax Classification	Total Assessed Value FY2019	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Residential	\$411,495,092	\$4,114,951	\$20,574,755	\$41,149,509
Open Space	\$0	\$0	\$0	\$0
Commercial	\$48,380,085	\$483,801	\$2,419,004	\$4,838,009
Industrial	\$28,201,350	\$282,014	\$1,410,068	\$2,820,135
Total	\$488,076,527	\$4,880,765	\$24,403,826	\$48,807,653

Source: Massachusetts Department of Revenue - Division of Local Services, Municipal Databank/Local Aid Section.

Agriculture

While Massachusetts does not experience wildfires at the same magnitude as those in western states, wildfires do occur and are a threat to the agriculture sector. The forestry industry is especially vulnerable to wildfires. Barns, other wooden structures, and animals and equipment in these facilities are also susceptible to wildfires.

Energy

Distribution lines are subject to wildfire risk because most poles are made of wood and susceptible to burning. Transmission lines are at risk to faulting during wildfires, which can result in a broad area outage. In the event of a wildfire, pipelines could provide a source of fuel and lead to a catastrophic explosion.

Public Health

As discussed in the Populations section of the wildfire hazard profile, wildfires impact air quality and public health. Widespread air quality impairment can lead to overburdened hospitals.

Public Safety

Wildfire is a threat to emergency responders and all infrastructure within the vicinity of a wildfire.

Transportation

Most road and railroads would be without damage except in the worst scenarios. However, fires can create conditions that block or prevent access, and they can isolate residents and emergency service providers. The wildfire hazard typically does not have a major direct impact on bridges, but wildfires can create conditions in which bridges are obstructed.

Water Infrastructure

In addition to potential direct losses to water infrastructure, wildfires may result in significant withdrawal of water supplies. Coupled with the increased likelihood that drought and wildfire will coincide under the future warmer temperatures associated with climate change, this withdrawal may result in regional water shortages and the need to identify new water sources.

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.

Vulnerability Summary

Based on the above assessment, Orange faces a “Low” vulnerability from wildfire and

brushfires. While wildfires have caused minimal damage, injury and loss of life to date in Orange, their potential to destroy property and cause injury or death exists. Existing and future mitigation efforts should continue to be developed and employed that will enable Orange to be prepared for these events when they occur. Wildfires can also cause utility disruption and air-quality problems. Particular areas of vulnerability include low-income and elderly populations, and residents living in the interface area adjacent to large areas of unfragmented forests. The following problem statements summarize the areas of greatest concern to Orange regarding wildfires.

Wildfire Hazard Problem Statements
<ul style="list-style-type: none"> • The bridge going over the East Branch of Tully River is noted to be of concern – emergency vehicles may not be able to cross the bridge during an emergency.
<ul style="list-style-type: none"> • The Fire Station located on Tully Road can become isolated during hazard events, especially if key bridges go out. This station also does not have cell service, and power outages cause the station to lose internet access and cable, which further isolates emergency responders during severe hazards.
<ul style="list-style-type: none"> • Many bridges in Orange have low weight limits, which complicates access routes for emergency vehicles.
<ul style="list-style-type: none"> • New initiatives are needed to improve household disaster preparedness Town-wide and to better reach vulnerable populations, including seniors and disabled residents with lessened mobility or medical needs, as well as homeless or transient people who may be difficult to reach in the event of an emergency. The Town may need to review and update evacuation planning for vulnerable populations in its CEMP, explore additional sheltering options, and pursue supportive partnerships for sheltering in the community.
<ul style="list-style-type: none"> • Emergency shelters may not be adequately staffed or supplied with water, food, and first aid supplies. There is a need to inventory the supplies currently available at Orange shelters.
<ul style="list-style-type: none"> • Although the Town has a Reverse 911 Warning System (CodeRED) with a large percentage of residents subscribing to the service, there is a need to continue to increase subscription among residents and businesses. Education and outreach are needed to ensure that all residents are aware of emergency situations and have access to evacuation and sheltering instructions, including options for residents with specialized medical needs, and pet sheltering options.
<ul style="list-style-type: none"> • Many residents live in isolated locations with unreliable cell service, which can decrease access to emergency services.
<ul style="list-style-type: none"> • Existing communication infrastructure issues and vulnerabilities could be exacerbated by a wildfire.
<ul style="list-style-type: none"> • Extreme heat may worsen risk of wildfires and the availability of local water supplies for firefighting. Firefighters may already lack sufficient water volume, pressure, and/or infrastructure across town to fight wildfires.
<ul style="list-style-type: none"> • Most towns in the region rely on volunteer fire departments and mutual aid to assist in

Wildfire Hazard Problem Statements

firefighting; during dry spells or drought, firefighting resources in Orange and surrounding towns can be strained if multiple wildfires break out at the same time.

- Orange's forests make up approximately 77% of the town and are vulnerable to extended drought, which could also increase the risk to other hazards including wildfire and pests.
- Orange does not have a forest stewardship plan that includes climate change considerations, such as drought.
- Some residents in Orange live within or adjacent to heavily forested areas in "intermix" and "interface" zones. This increases the risk of impacts to the population from a wildfire.

3.8 EARTHQUAKES

Potential Impacts of Climate Change

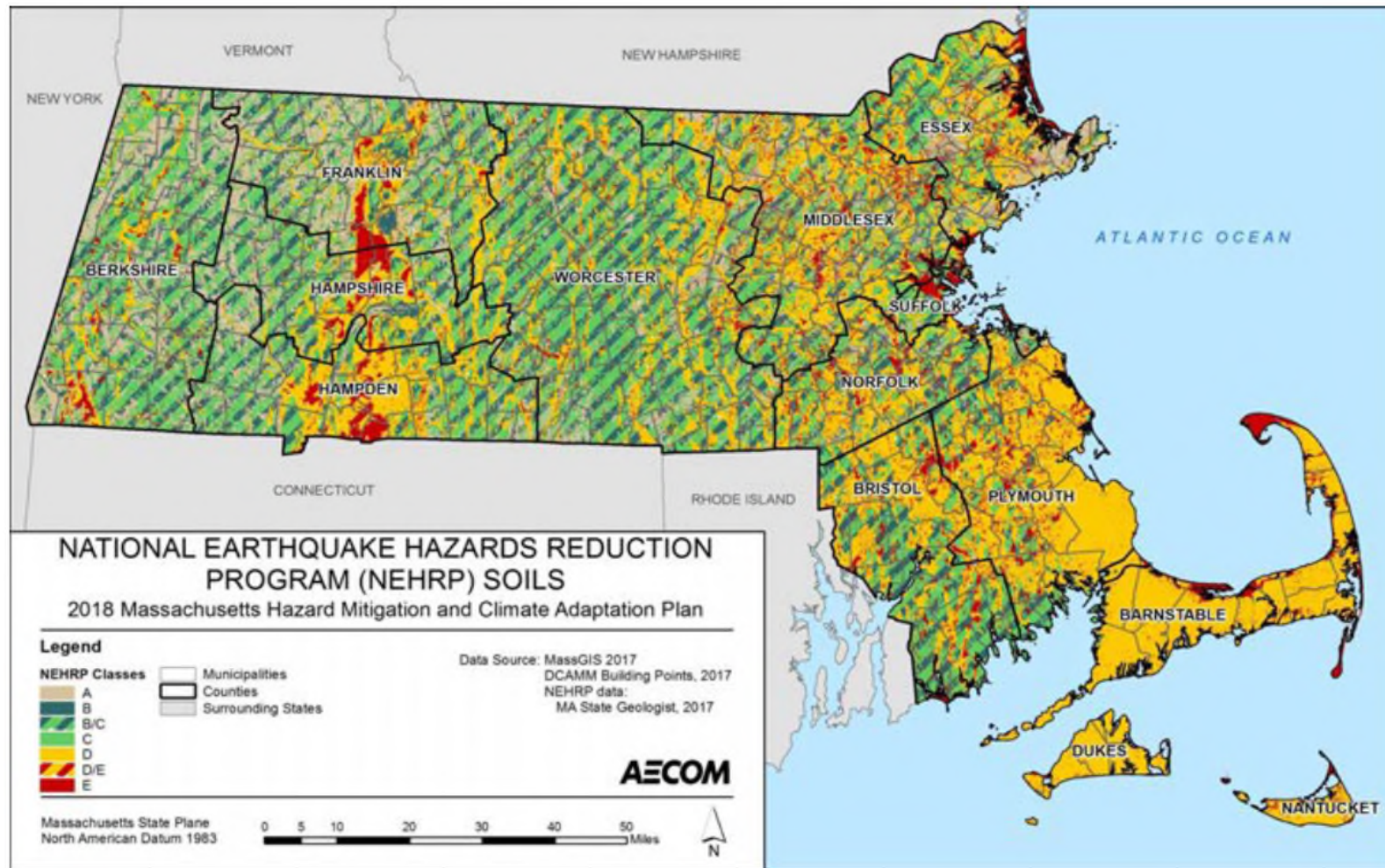
The State Hazard Mitigation and Climate Adaptation Plan does not identify any effects of climate change on the earthquake hazard in Massachusetts.

Hazard Description

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. New England, on the other hand, 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.

Ground shaking is the primary cause of earthquake damage to man-made structures. This damage can be increased due to the fact that soft soils amplify ground shaking. A contributor to site amplification is the velocity at which the rock or soil transmits shear waves (S waves). The National Earthquake Hazards Reduction Program (NEHRP) developed five soil classifications, which are defined by their S-wave velocity, that impact the severity of an earthquake. The soil classification system ranges from A to E, where A represents hard rock that reduces ground motions from an earthquake and E represents soft soils that amplify and magnify ground shaking and increase building damage and losses. These soil types are shown in Figure 3-17.

Figure 3-17: National Earthquake Hazards Reduction Program Soil Types in Massachusetts



Note: This map should be viewed as a first-order approximation of the NEHRP soil classifications. They are not intended for site-specific engineering design or construction. The map is provided only as a guide for use in estimating potential damage from earthquakes. The maps do not guarantee or predict seismic risk or damage. However, the maps certainly provide a first step by highlighting areas that may warrant additional, site-specific investigation if high seismic risk coincides with critical facilities, utilities, or roadways. Sources: Mabey and Duncan, 2017; Preliminary NEHRP Soil Classification Map of Massachusetts, as presented in the Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018.

Location

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.

In addition to earthquakes occurring within the Commonwealth, earthquakes in other parts of New England can impact widespread areas. This is due in part to the fact that earthquakes in the eastern U.S. are felt over a larger area than those in the western U.S. The difference between seismic shaking in the East versus the West is primarily due to the geologic structure and rock properties that allow seismic waves to travel farther without weakening.³³

Because of the regional nature of the hazard, the entire town is susceptible to earthquakes, and the location of occurrence would be "large," with over 50% of the town affected.

Extent

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

³³ U.S. Geological Survey (USGS). 2012. New Evidence Shows Power of East Coast Earthquakes. Accessed May 6, 2013. <http://www.usgs.gov/newsroom/article.asp?ID=3447>

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). Tables 3-33 and 3-34 summarize the Richter scale magnitudes, Modified Mercalli Intensity scale, and associated damage.

Table 3-33: Richter Scale Magnitudes and Effects	
Magnitude	Effects
< 3.5	Generally not felt, but recorded.
3.5 - 5.4	Often felt, but rarely causes damage.
5.4 - 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1 - 6.9	Can be destructive in areas up to about 100 kilometers across where people live.
7.0 - 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or >	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

Source: US Federal Emergency Management Agency

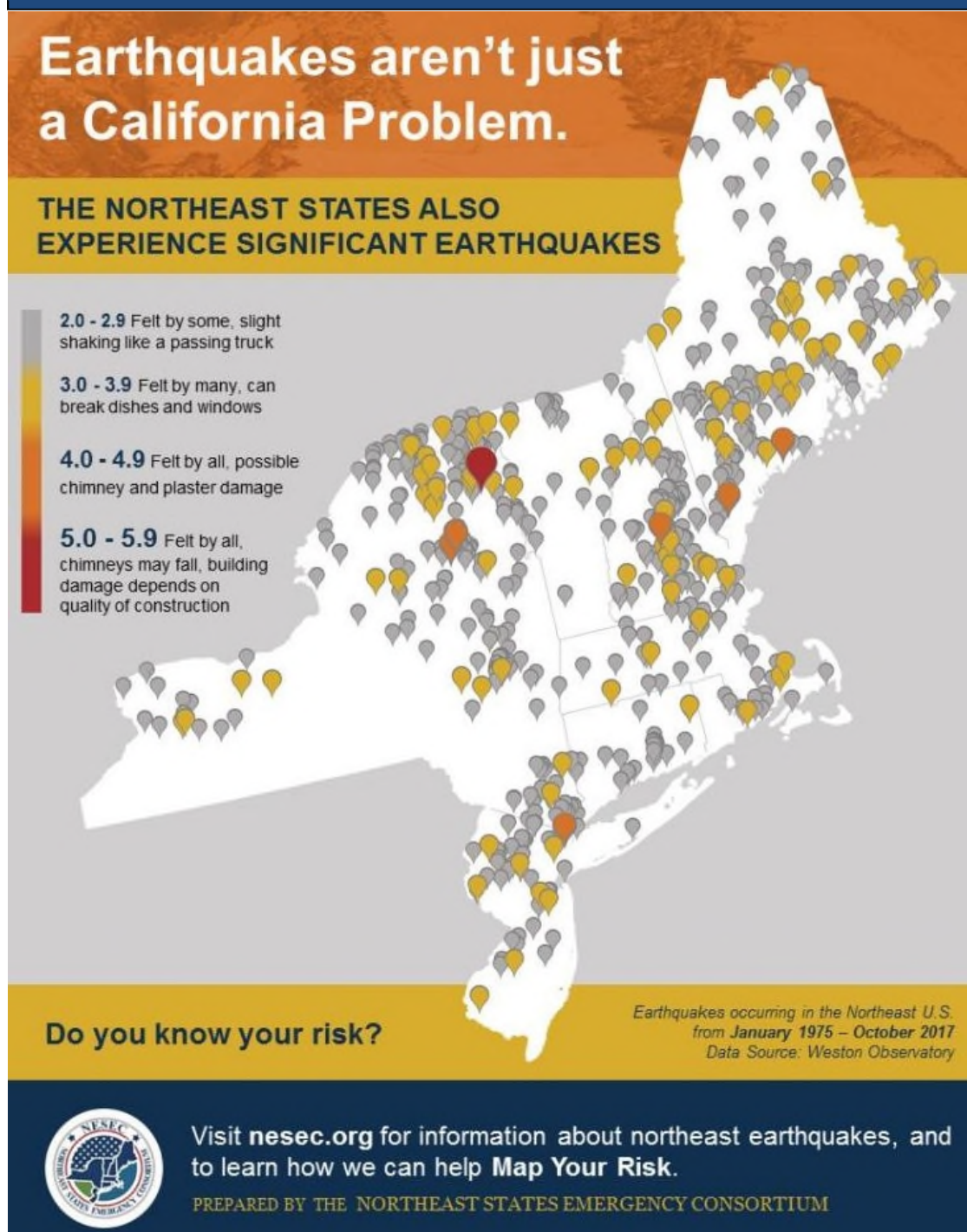
Table 3-34: Modified Mercalli Intensity Scale for and Effects			
Scale	Intensity	Description of Effects	Corresponding Richter Scale Magnitude
I	Instrumental	Detected only on seismographs.	
II	Feeble	Some people feel it.	< 4.2
III	Slight	Felt by people resting; like a truck rumbling by.	
IV	Moderate	Felt by people walking.	
V	Slightly Strong	Sleepers awake; church bells ring.	< 4.8
VI	Strong	Trees sway; suspended objects swing, objects fall off shelves.	< 5.4
VII	Very Strong	Mild alarm; walls crack; plaster falls.	< 6.1
VIII	Destructive	Moving cars uncontrollable; masonry fractures, poorly constructed buildings damaged.	
IX	Ruinous	Some houses collapse; ground cracks; pipes break open.	< 6.9
X	Disastrous	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread.	< 7.3
XI	Very Disastrous	Most buildings and bridges collapse; roads, railways, pipes and cables destroyed; general triggering of other hazards.	< 8.1
XII	Catastrophic	Total destruction; trees fall; ground rises and falls in waves.	> 8.1

Source: US Federal Emergency Management Agency

Previous Occurrences

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 (Figure 3-15). Damaging earthquakes have taken place historically in New England (Table 3-34). 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. The most recent earthquakes in the region that could have affected the Town of Orange are shown in Figure 3-18. There is no record of any damage to the Town of Orange as a result of these earthquakes.

Figure 3-18: Earthquakes Occurring in the Northeast from 1975 - 2017



Source: Northeast States Emergency Consortium (NESEC) <http://nsec.org/earthquakes-hazards/>.

Table 3-35: Northeast States Record of Historic Earthquakes			
State	Years of Record	Number of Earthquakes	Years with Damaging Earthquakes
Connecticut	1678 - 2016	115	1791
Maine	1766 - 2016	454	1973, 1904
Massachusetts	1668 - 2016	408	1727, 1755
New Hampshire	1638 - 2016	320	1638, 1940
Rhode Island	1766 - 2016	34	
Vermont	1843 - 2016	50	
New York	1737 - 2016	551	1737, 1929, 1944, 1983, 2002
<i>Total Number of Earthquakes felt: 1,932</i>			

Source: Northeast States Emergency Consortium website, <http://nesec.org/earthquakes-hazards/>

Probability of Future Events

Earthquakes cannot be predicted and may occur at any time. However, 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 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. Based on past events, Orange has “Very Low” probability, or less than 1% chance in a given year, of being impacted by an earthquake.

Impact

Ground shaking from earthquakes can rupture gas mains and disrupt other utility service, damage buildings, bridges and roads, and trigger other hazardous events such as avalanches, flash floods (dam failure) and fires. Un-reinforced masonry buildings, buildings with foundations that rest on filled land or unconsolidated, unstable soil, and mobile homes not tied to their foundations are at risk during an earthquake. Massachusetts introduced earthquake design requirements into the building code in 1975 and improved building code for seismic reasons in the 1980s. However, these specifications apply only to new buildings or to extensively-modified existing buildings. Buildings, bridges, water supply lines, electrical power lines and facilities built before the 1980s may not have been designed to withstand the forces of an earthquake. The seismic standards have also been upgraded with the 1997 revision of the State Building Code.

Liquefaction of the land near water could also lead to extensive destruction.

Orange faces potentially “Catastrophic” impacts from earthquakes, with more than 50% of property damaged in the affected area.

Vulnerability

Society

The entire population of Orange 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 residents. 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.

Vulnerable Populations

The populations most vulnerable to an earthquake event include people over the age of 65 (17% of Orange’s population) and those living below the poverty level (40% of Orange’s population). 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. Residents living in homes built prior to the 1970s when the State building code first went into effect, and residents living in mobile homes, are also more vulnerable to earthquakes. An estimated 2,191 housing units in Orange, or 61% of all housing units in town, were built prior to the 1970s. An estimated 299 mobile homes are located in Orange, accounting for 8% of the total housing stock.³⁴

Additionally, local fault lines run along East Road and Tully Road in North Orange, and along Fall Hill and Walnut Hill near downtown. In addition, a major fault line runs north/south along the entire Connecticut River Valley, just west of Orange.

Health Impacts

The most immediate health risk presented by the earthquake hazard is trauma-related injuries

³⁴ U.S. Census Bureau 2013-2017 American Community Survey five-year estimates.

and fatalities, either from structural collapse, impacts from nonstructural items such as furniture, or the secondary effects of earthquakes, such as landslides and fires. Following a severe earthquake, health impacts related to transportation impediments and lack of access to hospitals may occur, as described for other hazards. If ground movement causes hazardous material (in storage areas or in pipelines) to enter the environment, additional health impacts could result, particularly if surface water, groundwater, or agricultural areas are contaminated.

Economic Impacts

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. Lifeline-related losses include the direct repair cost for transportation and utility systems. Additionally, economic losses include the business interruption losses associated with the inability to operate a business due to the damage sustained during the earthquake as well as temporary living expenses for those displaced.

Infrastructure

All elements of the built environment in Orange are exposed to the earthquake hazard. Table 3-36 identifies the assessed value of all residential, open space, commercial, and industrial land uses in Town, and the losses that would result from 1%, 5%, and 10% damage to this inventory as a result of an earthquake.

Table 3-36: Estimated Potential Loss by Tax Classification in Orange				
Tax Classification	Total Assessed Value FY2019	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Residential	\$411,495,092	\$4,114,951	\$20,574,755	\$41,149,509
Open Space	\$0	\$0	\$0	\$0
Commercial	\$48,380,085	\$483,801	\$2,419,004	\$4,838,009
Industrial	\$28,201,350	\$282,014	\$1,410,068	\$2,820,135
Total	\$488,076,527	\$4,880,765	\$24,403,826	\$48,807,653

Source: Massachusetts Department of Revenue - Division of Local Services, Municipal Databank/Local Aid Section.

In addition to these 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.

Agriculture

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.

Energy

Earthquakes can damage power plants, gas lines, liquid fuel storage infrastructure, transmission lines, utility 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.

Public Health

A significant earthquake may result in numerous injuries that could overburden hospitals.

Public Safety

Police stations, fire stations, and other public safety infrastructure can experience direct losses (damage) from earthquakes. The capability of the public safety sector is also vulnerable to damage caused by earthquakes to roads and the transportation sector.

Transportation

Earthquakes can impact many aspects of the transportation sector, including causing damage to roads, bridges, vehicles, and storage facilities and sheds. Damage to road networks and bridges can cause widespread disruption of services and impede disaster recovery and response.

Water and Wastewater Infrastructure

Due to their extensive networks of aboveground and belowground infrastructure—including pipelines, pump stations, tanks, administrative and laboratory buildings, reservoirs, chemical storage facilities, and treatment facilities—water and wastewater utilities are vulnerable to earthquakes. Additionally, sewer and water treatment facilities are often built on ground that is subject to liquefaction, increasing their vulnerability. Earthquakes can cause ruptures in storage and process tanks, breaks in pipelines, and building collapse, resulting in loss of water and loss of pressure, and contamination and disruption of drinking water services. Damage to wastewater infrastructure can lead to sewage backups and releases of untreated sewage into the environment.

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 the Wildfire section. 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 the landowner or forestry businesses 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.

Vulnerability Summary

Based on this analysis, Orange has a "Low" vulnerability to earthquakes. The following problem statements summarize Orange's areas of greatest concern regarding earthquakes.

Earthquake Hazard Problem Statements
<ul style="list-style-type: none"> • The Fire Station located on Tully Road can become isolated during hazard events, especially if key bridges go out. This station also does not have cell service, and power outages cause the station to lose internet access and cable, which further isolates emergency responders during severe weather.
<ul style="list-style-type: none"> • Many bridges in Orange have low weight limits, which complicates access routes for emergency vehicles.
<ul style="list-style-type: none"> • New initiatives are needed to improve household disaster preparedness Town-wide and to better reach vulnerable populations, including seniors and disabled residents with lessened mobility or medical needs, as well as homeless or transient people who may be difficult to reach in the event of an emergency. The Town may need to review and update evacuation planning for vulnerable populations in its CEMP, explore additional sheltering options, and pursue supportive partnerships for sheltering in the community.
<ul style="list-style-type: none"> • Emergency shelters may not be adequately staffed or supplied with water, food, and first aid supplies. There is a need to inventory the supplies currently available at Orange shelters
<ul style="list-style-type: none"> • Although the Town has a Reverse 911 Warning System (CodeRED) with a large percentage of residents subscribing to the service, there is a need to continue to increase subscription among residents and businesses. Education and outreach are needed to ensure that all residents are aware of emergency situations and have access to evacuation and sheltering instructions, including options for residents with specialized medical needs, and pet sheltering options.
<ul style="list-style-type: none"> • Many residents live in isolated locations with unreliable cell service, which can decrease access to emergency services.
<ul style="list-style-type: none"> • Existing communication infrastructure issues and vulnerabilities could be exacerbated by severe

Earthquake Hazard Problem Statements	
winter storm hazards impacts.	
<ul style="list-style-type: none">• An estimated 61% of homes in Orange were built prior to the first State building code in 1975, potentially making them more vulnerable to damages from high winds or earthquakes.• The parking lot pavement at the Orange Airport (a designated Point of Distribution by MEMA and FEMA) is in poor condition. The deteriorating pavement makes it difficult to plow the lot without digging up pavement and creating holes. As an emergency POD site, the parking lot needs to be plowed and maintained so that it is in a serviceable condition at all times.	

3.9 DAM FAILURE

Potential Impacts of Climate Change

The State Hazard Mitigation and Climate Adaptation Plan does not identify any effects of climate change on the dam failure hazard in Massachusetts.

Hazard Description

Dams and levees and their associated impoundments provide many benefits to a community, such as water supply, recreation, hydroelectric power generation, and flood control. However, they also pose a potential risk to lives and property. Dam or levee failure is not a common occurrence, but dams do represent a potentially disastrous hazard. When a dam or levee fails, the potential energy of the stored water behind the dam is released rapidly. Most dam or levee failures occur when floodwaters above overtop and erode the material components of the dam. Often dam or levee breeches lead to catastrophic consequences as the water rushes in a torrent downstream, flooding an area engineers refer to as an “inundation area.” The number of casualties and the amount of property damage will depend upon the timing of the warning provided to downstream residents, the number of people living or working in the inundation area, and the number of structures in the inundation area.

Many dams in Massachusetts were built during the 19th Century without the benefit of modern engineering design and construction oversight. Dams of this age can fail because of structural problems due to age and/or lack of proper maintenance, as well as from structural damage caused by an earthquake or flooding.

The Massachusetts Department of Conservation and Recreation Office of Dam Safety is the agency responsible for regulating dams in the state (M.G.L. Chapter 253, Section 44 and the implementing regulations 302 CMR 10.00). The regulations apply to dams that are in excess of 6 feet in height (regardless of storage capacity) or have more than 15 acre feet of storage capacity (regardless of height). Dam safety regulations enacted in 2005 transferred significant responsibilities for dams from the State of Massachusetts to dam owners, including the responsibility to conduct dam inspections.

Location

There are nine dams in town considered to be Significant Hazard, five considered Low Hazard, and nine that are non-jurisdictional, meaning they do not fall under the Office of Dam Safety regulatory authority. There is one dam located in the Town of Orange that comes under FERC

supervision, the New Home Sewing Machine Company Dam, a privately-owned hydroelectric dam. This dam is considered a Low Hazard Dam by FERC and as such, is not required to have an Emergency Management Plan or inundation mapping. The DCR provided a list of all dams in Orange to the Town during the update of the last Hazard Mitigation plan in 2014, which is shown in Table 3-37.

Table 3-37: Dams in the Town of Orange		
Name of Dam	Owner	Office of Dam Safety Hazard Rating
Lake Mattawa Dam South	Town of Orange	Significant
Lake Mattawa Dam North	Town of Orange	Significant
Tully Pond Dam	Town of Orange	Significant
Packard Pond Dam	Privately owned	Significant
North Pond Brook Dam	Town of Orange	Significant
Haskins Pond Dam	Privately Owned	Significant
Vorces Pond Dam	Town of Orange	Significant
Gale Brothers Dam	Town of Orange	Significant
New Home Sewing Machine Co. Dam	Privately Owned	Low
Orange Water District Reservoir Dam	Town of Orange	Low
Whites Pond Dam	Unknown	Low
Johnsonian Pond Dam	Privately owned	Low
Williams Pond Dam	Town of Orange	Low
Pumping Station Dam	Town of Orange	N/A
Plazas Pond Dam	Mass Department of Fish and Game	N/A
Minute Tapioca Upper Pond Dam	Unknown	N/A
Minute Tapioca Lower Pond Dam	Unknown	N/A
Boston Fiber Co. Dam	Privately owned	N/A
Diversion Dam	Privately owned	N/A
Eagleville Dam	Unknown	N/A
Fire Pond Dam	Privately owned	N/A
Randall Pond Dam	Orange Economic Development Commission	N/A

The Orange Water Department is looking at the potential to remove the Vorces Pond dam and the Orange Water District Reservoir dam. The Water District Dam was previously ranked as a

significant hazard, but has had work done that decreased its hazard ranking. The Dam cannot be completely removed until further work is completed to upgrade Well #1, which should be completed within the next five years.³⁵ At that point, the Water Department would like to fully remove both the Vorces Pond dam and the Orang Water District Reservoir dam. Removal of these dams would eliminate the need to maintain the dams, and could have environmental benefits. Removal would also eliminate any dam failure hazard potential in these areas.

The committee expressed concern with the inspection of privately owned dams, now that owners are responsible for inspections. Some owners may not be aware that they own a dam, or in some cases the owner may be deceased.

There are two dams located in Royalston, Massachusetts that could impact persons and property within Orange and other towns were a catastrophic failure to either dam to occur: Birch Hill and Tully Lake dams. According to inundation maps of the U.S. Army Corps of Engineers, the areas that would be impacted independent of which dam failed include the following areas: southeast of Little Tully Mountain, and the neighborhoods in the vicinity of East River Street and East Main Street. Other areas in Orange that could be impacted by failures of either of these dams include neighborhoods of Orange Center and Route 2A west of the center. The Lake Rohunta Dam in Athol would also impact Orange if it failed. In the 1930s water crested the dam, causing flooding that reached all the way to the center of Town.

The 100-year floodplain covers about five percent, or approximately 1,132 acres of the town, including an estimated twenty-five acres of developed residential land, thirteen acres of industrial land, six acres of commercial land, and one acre of public/institutional land. The Committee noted that there are several houses below privately owned dams that are in poor condition, and are of high concern.

An inundation area due to dam failure would cover substantially more acreage. There are also several critical facilities located either within or near the 100-year floodplain including the town's wastewater treatment facility, the town transfer station, town offices, the Mahar Regional School, one of the Town's fire stations, and a number of bridges.

As described in the Flooding section, there are some beaver dams in Orange. The Committee noted that in recent history the beaver dam behind the Dexter Park Farm School failed, and almost destroyed a culvert on West Main Street. Other locations are described in the section on flooding.

³⁵ Personal Communication, Kenneth Wysk, Orange Water Department Superintendent. August 25, 2020.

Extent

Often dam or levee breaches lead to catastrophic consequences as the water ultimately rushes in a torrent downstream flooding an area engineers refer to as an “inundation area.” The number of casualties and the amount of property damage will depend upon the timing of the warning provided to downstream residents, the number of people living or working in the inundation area, and the number of structures in the inundation area.

Dams in Massachusetts are assessed according to their risk to life and property. The state has three hazard classifications for dams:

- *High Hazard:* Dams located where failure or improper operation will likely cause loss of life and serious damage to homes, industrial or commercial facilities, important public utilities, main highways, or railroads.
- *Significant Hazard:* Dams located where failure or improper operation may cause loss of life and damage to homes, industrial or commercial facilities, secondary highways or railroads or cause interruption of use or service of relatively important facilities.
- *Low Hazard:* Dams located where failure or improper operation may cause minimal property damage to others. Loss of life is not expected.

Owners of dams are required to hire a qualified engineer to inspect and report results using the following inspection schedule:

- Low Hazard Potential dams – 10 years
- Significant Hazard Potential dams – 5 years
- High Hazard Potential dams – 2 years

The time intervals represent the maximum time between inspections. More frequent inspections may be performed at the discretion of the state. As noted previously, dams and reservoirs licensed and subject to inspection by the Federal Energy Regulatory Commission (FERC) are excluded from the provisions of the state regulations provided that all FERC-approved periodic inspection reports are provided to the DCR. FERC inspections of high and significant hazard projects are conducted on a yearly basis. All other dams are subject to the regulations unless exempted in writing by DCR.

Previous Occurrences

To date, there have been no known dam or levee failures in Orange.

Probability of Future Events

Currently the frequency of dam failures is “Moderate” with a less than 2%-25% percent chance of a dam failing in any given year.

Dams are designed partly based on assumptions about a river’s flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hydrograph 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. Such early releases of increased volumes can increase flood potential downstream.

Throughout the western United States, communities downstream of dams are already seeing increases in stream flows from earlier releases from dams. Dams are constructed with safety features known as “spillways.” 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 will not increase the probability of catastrophic dam failure, it may increase the probability of design failures.

Impact

A dam failure in Orange is likely to have a Critical impact, with multiple injuries possible, more than 25% of property in the affected area damaged or destroyed, and a possible complete shutdown of facilities for more than one week.

Vulnerability

Dam failures, while rare, can destroy roads, structures, facilities, utilities, and impact the population of Orange. Existing and future mitigation efforts should continue to be developed and employed that will enable Orange to be prepared for these events when they occur. Particular areas of vulnerability include low-income and elderly populations, buildings in the floodplain or inundation areas, and infrastructure such as roadways and utilities that can be damaged by such events.

Society

Vulnerable Populations

The most vulnerable members of the population are those living or working within the floodplain or dam inundation areas, and in particular, those who would be unable to evacuate

quickly, including people over the age of 65, households with young children under the age of 5, people with mobility limitations, people with low socioeconomic status, and people with low English fluency who may not understand emergency instructions provided in English.

Economic Impacts

Economic impacts are not limited to assets in the inundation area, but may extend to infrastructure and resources that serve a much broader area. In addition to direct damage from dam failure, economic impacts include the amount of time required to repair or replace and reopen businesses, governmental and nonprofit agencies, and industrial facilities damaged by the dam failure.³⁶

Infrastructure

Structures that lie in the inundation area of each of the dams in Orange are vulnerable to a dam failure. Buildings located within the floodplain are also vulnerable to dam failure in Orange. Table 3–12 in the Flooding section provides the 2011 assessed value for the wastewater treatment plant in town, which is a significant structure partially or completely located in the floodplain in Orange.

Environment

Examples of environmental impacts from a dam failure include:

- Pollution resulting from septic system failure, back-up of sewage systems, petroleum products, pesticides, herbicides, or solvents
- Pollution of the potable water supply or soils
- Exposure to mold or bacteria during cleanup
- Changes in land development patterns
- Changes in the configuration of streams or the floodplain
- Erosion, scour, and sedimentation
- Changes in downstream hydro-geomorphology
- Loss of wildlife habitat or biodiversity
- Degradation to wetlands
- Loss of topsoil or vegetative cover
- Loss of indigenous plants or animals³⁷

³⁶ *Assessing the Consequences of Dam Failure: A How-To Guide*. Federal Emergency Management Agency (FEMA). March 2012.

<https://damsafety.org/sites/default/files/files/FEMA%20TM%20AssessingtheConsequencesofDamFailure%20March2012.pdf>

³⁷ *Assessing the Consequences of Dam Failure: A How-To Guide*. Federal Emergency Management Agency (FEMA). March 2012.

Vulnerability Summary

The Committee determined the Town has a "Medium" vulnerability from dam or levee failure.

Dam Failure Hazard Problem Statements
<ul style="list-style-type: none">• Inundation zones for the Mattawa North Dam and the Mattawa South Dam in Orange have not yet been mapped. Without the inundation mapping, the Town is not able to assess potential losses due to dam failure.
<ul style="list-style-type: none">• There are many high hazard dams throughout Orange, and several are in poor condition. Residents with homes below/near these dams are particularly vulnerable to hazard events.
<ul style="list-style-type: none">• Inspections and Emergency Action Plans (EAPs) for many dams are out of date. This is especially of concern for high hazard dams that are privately owned. Funding for updating EAPs should be pursued. Once available, this information should be shared with Orange town officials, EMD, and affected residents.
<ul style="list-style-type: none">• The REPC is working to identify options for regional and local debris management. The regional plan approved by MassDEP several years ago was never implemented because the communities that would serve as regional sites did not execute MOUs. The Town is being urged by MassDEP to select and provide disaster debris storage/disposal location(s).
<ul style="list-style-type: none">• Beaver activity is occurring throughout Town and causing damage to culverts. Continued monitoring and risk assessment is needed to mitigate damage from a potential beaver dam failure.
<ul style="list-style-type: none">• Private wells located close to floodways may be vulnerable to flooding and contamination.
<ul style="list-style-type: none">• Many of the Town's evacuation routes may be impacted by flooding. There are areas of Town where residents might become isolated if roads, bridges, or culverts were blocked or damaged during a flood.
<ul style="list-style-type: none">• New initiatives are needed to improve household disaster preparedness Town-wide and to better reach vulnerable populations, including seniors and disabled residents with lessened mobility or medical needs, as well as homeless or transient people who may be difficult to reach in the event of an emergency. The Town may need to review and update evacuation planning for vulnerable populations in its CEMP, explore additional sheltering options, and pursue supportive partnerships for sheltering in the community.
<ul style="list-style-type: none">• Emergency shelters may not be adequately staffed or supplied with water, food, and first aid supplies. There is a need to inventory the supplies currently available at Orange shelters.
<ul style="list-style-type: none">• Although the Town has a Reverse 911 Warning System (CodeRED) with a large percentage of residents subscribing to the service, there is a need to continue to increase subscription among residents and businesses. Education and outreach are needed to ensure that all residents are

<https://damsafety.org/sites/default/files/files/FEMA%20TM%20AssessingtheConsequencesofDamFailure%20March2012.pdf>



Dam Failure Hazard Problem Statements	
	aware of emergency situations and have access to evacuation and sheltering instructions, including options for residents with specialized medical needs, and pet sheltering options.
<ul style="list-style-type: none">• Existing communication infrastructure issues and vulnerabilities could be exacerbated by severe winter storm hazards impacts.	

3.10 DROUGHT

Potential Impacts of Climate Change

Although total annual precipitation is anticipated to increase over the next century, seasonal precipitation is predicted to include more severe and unpredictable dry spells. More rain falling over shorter time periods will reduce groundwater recharge, even in undeveloped areas, as the ground becomes saturated and unable to absorb the same amount of water if rainfall were spread out. The effects of this trend will be exacerbated by the projected reduction in snowpack, which can serve as a significant water source during the spring melt to buffer against sporadic precipitation. Also, the snowpack melt is occurring faster than normal, resulting not only in increased flooding but a reduced period in which the melt can recharge groundwater and the amount of water naturally available during the spring growing period.

Reduced recharge can in turn affect base flow in streams that are critical to sustain ecosystems during dry periods and groundwater-based water supply systems. Reservoir-based water supply systems will also need to be assessed to determine whether they can continue to meet projected demand by adjusting their operating rules to accommodate the projected changes in precipitation patterns and associated changes in hydrology. Finally, rising temperatures will also increase evaporation, exacerbating drought conditions.

Figure 3-19: Impacts of Climate Change on Drought		
Potential Effects of Climate Change		
	RISING TEMPERATURES AND CHANGES IN PRECIPITATION → PROLONGED DROUGHT	The frequency and intensity of droughts are projected to increase during summer and fall in the Northeast as higher temperatures lead to greater evaporation and earlier winter and spring snowmelt, and precipitation patterns become more variable and extreme.
	RISING TEMPERATURES AND CHANGES IN PRECIPITATION → REDUCED SNOWPACK	Due to climate change, the proportion of precipitation falling as snow and the extent of time snowpack remains are both expected to decrease. This reduces the period during which snowmelt can recharge groundwater supplies, bolster streamflow, and provide water for the growing period.

Source: Massachusetts State Hazard Mitigation and Climate Adaptation Plan. September 2018

Hazard Description

Droughts can vary widely in duration, severity, and local impact. They may have widespread social and economic significance that requires the response of numerous parties, including water suppliers, firefighters, farmers, and residents. Droughts are often defined as periods of deficient precipitation. How this deficiency is experienced can depend on factors such as land use change, the existence of dams, and water supply withdrawals or diversions. For example, impervious surfaces associated with development can exacerbate the effects of drought due to

decreased groundwater recharge.

Drought is a natural phenomenon, but its impacts are exacerbated by the volume and rate of water withdrawn from these natural systems over time as well as the reduction in infiltration from precipitation that is available to recharge these systems. Groundwater withdrawals for drinking water can reduce groundwater levels, impacting water supplies as well as base flow (flow of groundwater) in streams. A reduction in base flow is significant, especially in times of drought, as this is often the only source of water to the stream. In extreme situations, groundwater levels can fall below stream channel bottom, and groundwater becomes disconnected from the stream, resulting in a dry channel.

Natural infiltration is reduced by impervious cover (pavement, buildings) on the land surface and by the interruption of natural small-scale drainage patterns in the landscape caused by development and drainage infrastructure. Sewer collection systems can also reduce groundwater levels when groundwater infiltrates into them. This is a common problem for wastewater collection systems in Franklin County, where many of the existing pipes were put in place over 100 years ago. Also, when drains are connected to the sanitary system, groundwater and precipitation are transported to wastewater treatment plants where effluent is typically discharged to surface water bodies and not returned to the groundwater.

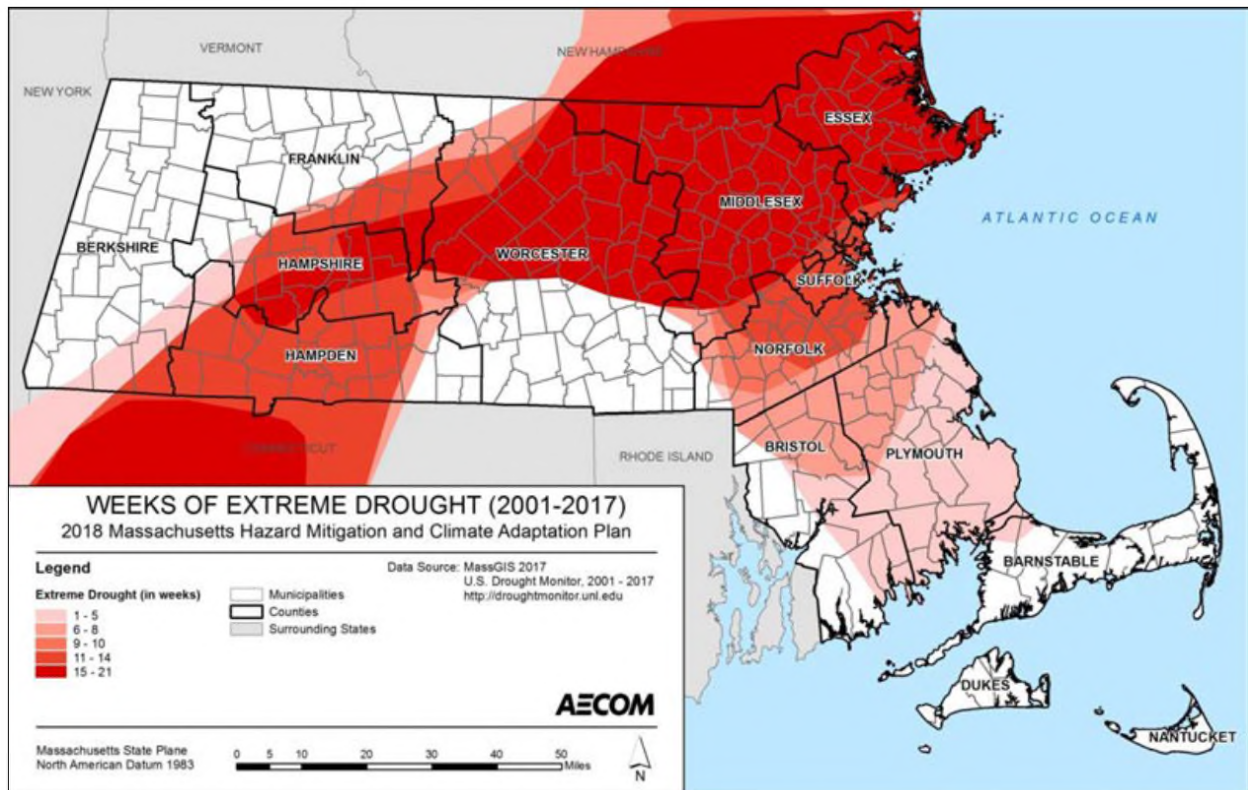
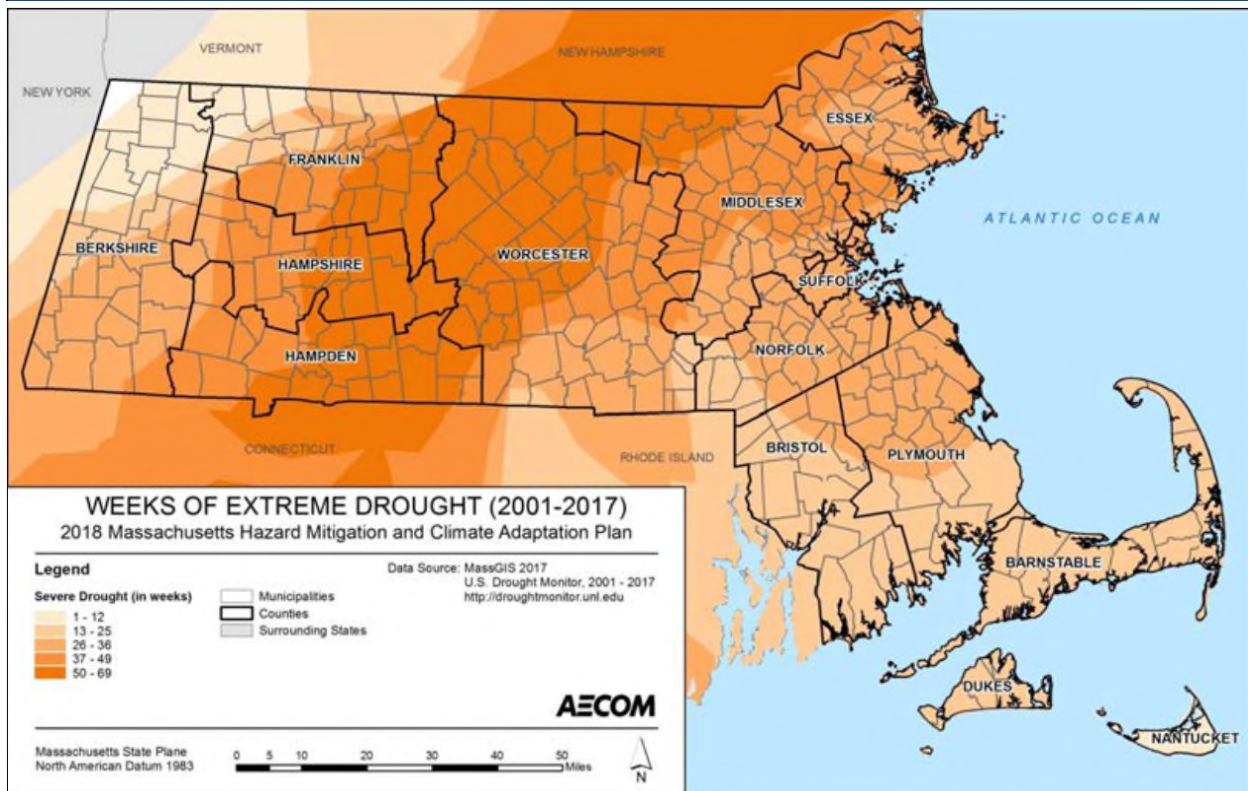
Highly urbanized areas with traditional stormwater drainage systems tend to result in higher peak flood levels during rainfall events and rapid decline of groundwater levels during periods of low precipitation. Thus, the hydrology in these areas becomes more extreme during floods and droughts.³⁸ The importance of increasing infiltration is widely recognized, and the implementation of nature-based solutions to help address this problem is discussed further in later portions of this plan.

Location

Orange falls on the edge of a region in Massachusetts that is more prone to severe and extreme drought based on the number of weeks these areas experienced drought conditions from 2001-2017 (Figure 3-20). Because of this hazard's regional nature, a drought would impact the entire town, resulting in a "large" location of occurrence, or more than 50 percent of total land area affected.

³⁸ ERG and Horsley Witten Group. 2017. Using Green Infrastructure to Improve Resilience in the Commonwealth of Massachusetts: Final Project Report.

Figure 3-20: Areas Experiencing Severe or Extreme Drought, 2001 - 2017



Source: U.S. Drought Monitor, 2017, as presented in the 2018 Massachusetts Hazard Mitigation and Climate Adaptation Plan.

Extent

The severity of a drought would determine the scale of the event and would vary among town residents depending on whether the residents' water supply is derived from a private well or the public water system. The majority of residents in Orange are served by the public water supply, which draws water from three groundwater sources (Wells #1, #2, and #3). The remaining residents depend on private wells for water. Massachusetts' wells are permitted according to their ability to meet demand for 180 days at maximum capacity with no recharge; if these conditions extended beyond the thresholds that determine supply capacity the damage from a drought could be widespread due to depleted groundwater supplies.

The U.S. Drought Monitor categorizes drought on a D0-D4 scale as shown below.

Table 3-38: U.S. Drought Monitor		
Classification	Category	Description
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered
D1	Moderate Drought	Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested
D2	Severe Drought	Crop or pasture losses likely; water shortages common; water restrictions imposed
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies

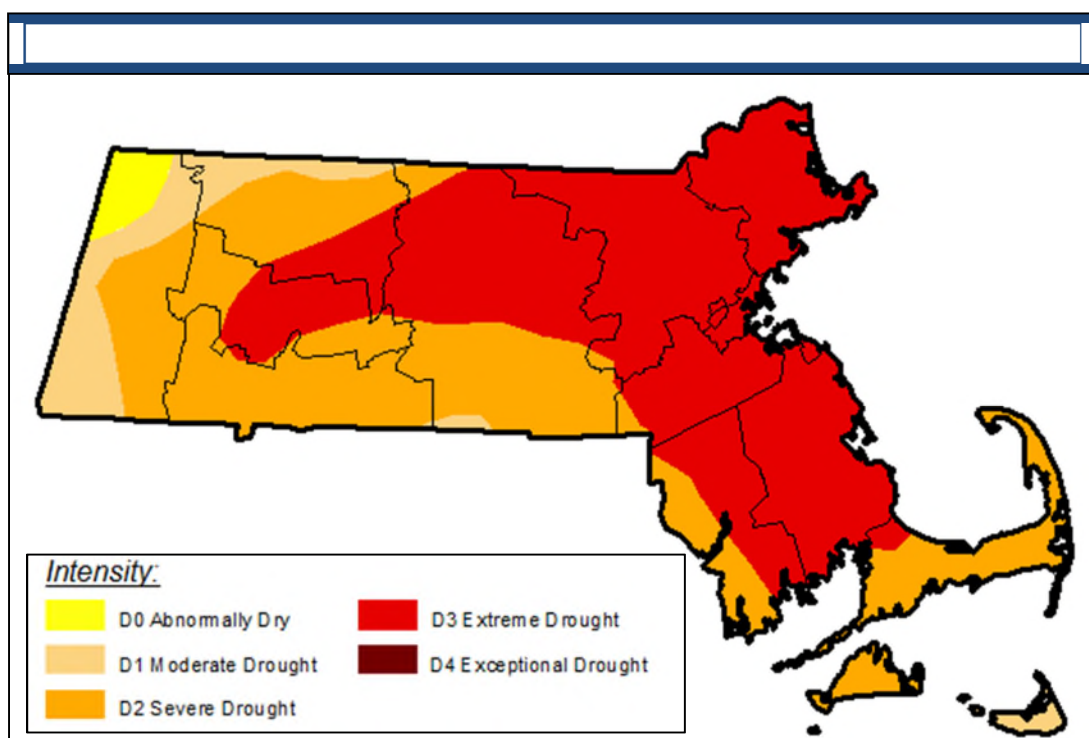
Previous Occurrences

In Massachusetts, six major droughts have occurred statewide since 1930. They range in severity and length, from three to eight years. In many of these droughts, water-supply systems were found to be inadequate.

Beginning in 1960 in western Massachusetts and in 1962 in eastern Massachusetts through 1969, Massachusetts experienced the most significant drought on record, according to the United States Geological Survey. The severity and duration of the drought caused significant impacts on both water supplies and agriculture. Although short or relatively minor droughts occurred over the next 50 years, the next long-term event began in March 2015, when Massachusetts began experiencing widespread abnormally dry conditions. In July 2016, based

on a recommendation from the Drought Management Task Force (DMTF), the Secretary of EOEEA declared a Drought Watch for Central and Northeast Massachusetts and a Drought Advisory for Southeast Massachusetts and the Connecticut River Valley. Drought warnings were issued in five out of six drought regions of the state. Many experts stated that this drought was the worst in more than 50 years.

By September 2016, 78% of Franklin County was categorized as “severe drought” (D2) or higher, and 26% of the County was categorized as “extreme drought” (D3) (Figure 3-21).³⁹ By May 2017, the entire Commonwealth had returned to “normal” due to wetter-than-normal conditions in the spring of 2017.



Source: U.S. Drought Monitor. <https://droughtmonitor.unl.edu/>

Drought was identified as an area of concern during the Orange Municipal Vulnerability Preparedness Community Building workshop in 2018. At the workshop it was noted that private wells have run dry in the past and are vulnerable to prolonged dry periods.

Probability of Future Events

According to the 2018 Massachusetts Hazard Mitigation and Climate Adaptation Plan, on a monthly basis over the 162-year period of record from 1850 to 2012, there is a 2% chance of

³⁹ U.S. Drought Monitor, accessed February 13, 2019.
<https://droughtmonitor.unl.edu/Data/DataTables.aspx?state,MA>

being in a drought warning level. As noted previously, rising temperatures and changes in precipitation due to climate change could increase the frequency of episodic droughts, like the one experienced across the Commonwealth in the summer of 2016. In Orange drought has a "Moderate" probability of future occurrence, or between a 2% and 25% chance of occurring in any given year.

Impact

Due to the water richness of western Massachusetts, Orange is unlikely to be adversely affected by anything other than a major, extended drought. The major impact to residents would be private wells running dry or being contaminated due to low water levels. Farmers could be impacted economically by the extended lack of water. Drought may increase the probability of a wildfire occurring. The prolonged lack of precipitation dries out soil and vegetation, which becomes increasingly prone to ignition as long as the drought persists. Additionally, firefighting capabilities could be compromised in a drought if aquifers, fire ponds, or rivers used for pumping water are low. As a result, the impact of a drought would be "Limited" with more than 10% of property damaged or destroyed. However, the Committee noted that the impact of a drought would likely be "Critical" for the farming community in Town.

Vulnerability

The number and type of impacts increase with the persistence of a drought as the effect of the precipitation deficit cascades down parts of the watershed and associated natural and socioeconomic assets. For example, a precipitation deficiency may result in a rapid depletion of soil moisture that may be discernible relatively quickly to farmers. The impact of this same precipitation deficit may not affect hydroelectric power production, drinking water supply availability, or recreational uses for many months.

Society

The entire population of Orange is vulnerable to drought events. However, the vulnerability of populations to this hazard can vary significantly based on water supply sources and municipal water use policies.

Vulnerable Populations

Drought conditions can cause a shortage of water for human consumption and reduce local firefighting capabilities. Public water supplies (PWS) provide water for both of these services and may struggle to meet system demands while maintaining adequate pressure for fire suppression and meeting water quality standards. The Massachusetts Department of Environmental Protection (DEP) requires all PWS to maintain an emergency preparedness plan. The Town has three surface water supplies that are reserved for use as emergency drinking

water sources by the Orange Water Department. These include Lake Mattawa, Crystal Spring Reservoir, and Vorce's Pond. However, none of these backup supplies are connected to the current distribution system. Residential well owners are as vulnerable as their ability to find an alternate short- or long-term water supply (i.e. install a new well) or temporarily relocate in the event their well runs dry.

Health Impacts

With declining groundwater levels, residential well owners may experience dry wells or sediment in their water due to the more intense pumping required to pull water from the aquifer and to raise water from a deeper depth. Wells may also develop a concentration of pollutants, which may include nitrates and heavy metals (including uranium) depending on local geology. The loss of clean water for consumption and for sanitation may be a significant impact depending on the affected population's ability to quickly drill a deeper or a new well or to relocate to unaffected areas.

During a drought, dry soil and the increased prevalence of wildfires can increase the amount of irritants (such as pollen or smoke) in the air. Reduced air quality can have widespread deleterious health impacts, but is particularly significant to the health of individuals with pre-existing respiratory health conditions like asthma. Lowered water levels can also result in direct environmental health impacts, as the concentration of contaminants in swimmable bodies of water will increase when less water is present. Stagnant water bodies may develop and increase the prevalence of mosquito breeding, thus increasing the risk for vector-borne illnesses.

Economic Impacts

The economic impacts of drought can be substantial, and would primarily affect the agriculture, recreation and tourism, forestry, and energy sectors.

Infrastructure

Agriculture

Drier summers and intermittent droughts may strain irrigation water supplies, stress crops, and delay harvests. Insufficient irrigation will impact the availability of produce, which may result in higher demand than supply. This can drive up the price of local food. Farmers with wells that are dry are advised to contact the Massachusetts Department of Agricultural Resources to explore microloans through the Massachusetts Drought Emergency Loan Fund or to seek federal Economic Injury Disaster Loans.

Water and Wastewater Infrastructure

As noted already, drought affects both groundwater sources and smaller surface water reservoir supplies. Water supplies for drinking, agriculture, and water-dependent industries may be depleted by smaller winter snowpacks and drier summers anticipated due to climate change. Reduced precipitation during a drought means that water supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. Suppliers may struggle to meet system demands while maintaining adequate water supply pressure for fire suppression requirements. Private well supplies may dry up and need to either be deepened or supplemented with water from outside sources.

Environment

Drought has a wide-ranging impact on a variety of natural systems. Some of those impacts can include the following:⁴⁰

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

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

Vulnerability Summary

Based on the above assessment, Orange has a vulnerability of "Low" from drought. The Committee separately assessed the vulnerability for farmers in Town, and noted that they have a "Medium" vulnerability from drought. While such a drought would require water saving

⁴⁰ Clark, J.S. et al. 2016. The impacts of increasing drought on forest dynamics, structure, and biodiversity in the United States. *Global Change Biology*, 22, 2329–2352. Doi: 10.1111/gcb.13160.



measures to be implemented, there would be no foreseeable damage to structures or loss of life resulting from the hazard. The following problem statements summarize Orange’s areas of greatest concern regarding droughts.

Drought Hazard Problem Statements	
•	Extreme heat may worsen risk of wildfires and the availability of local water supplies for firefighting. Firefighters may already lack sufficient water volume, pressure, and/or infrastructure across town to fight wildfires.
•	Most towns in the region rely on volunteer fire departments and mutual aid to assist in firefighting; during dry spells or drought, firefighting resources in Orange and surrounding towns can be strained if multiple wildfires break out at the same time.
•	Orange’s forests make up approximately 77% of the town and are vulnerable to extended drought, which could also increase the risk to other hazards including wildfire and pests.
•	Some of Orange’s residents are serviced by private wells that run the risk of going dry during prolonged drought.
•	Orange does not have a forest stewardship plan that includes climate change considerations, such as drought.

3.11 LANDSLIDES

Potential Impacts of Climate Change

According to the 2018 *Massachusetts State Hazard Mitigation and Climate Adaptation Plan*, slope saturation by water is already a primary cause of landslides in the Commonwealth. Regional climate change models suggest that New England will likely experience warmer, wetter winters in the future as well as more frequent and intense storms throughout the year. This increase in the frequency and severity of storm events could result in more frequent soil saturation conditions, which are conducive to an increased frequency of landslides. Additionally, an overall warming trend is likely to increase the frequency and duration of droughts and wildfire, both of which could reduce the extent of vegetation throughout the Commonwealth. The loss of the soil stability provided by vegetation could also increase the probability of landslides wherever these events occur.

Figure 3-22: Impacts of Climate Change on Landslides		
Potential Effects of Climate Change		
	CHANGES IN PRECIPITATION AND EXTREME WEATHER → SLOPE SATURATION	Regional climate change models suggest that Massachusetts will likely experience more frequent and intense storms throughout the year. This change could result in more frequent soil saturation conditions, which are conducive to an increased frequency of landslides.
	RISING TEMPERATURES → REDUCED VEGETATION EXTENT	An increased frequency of drought events is likely to reduce the extent of vegetation throughout the Commonwealth. The loss of the soil stability provided by vegetation could also increase the probability of landslides wherever these events occur.

Source: Massachusetts State Hazard Mitigation and Climate Adaptation Plan. September 2018

Hazard Description

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. Historical landslide data for the Commonwealth suggests that most landslides are preceded by two or more months of higher than normal precipitation, followed by a single, high-intensity rainfall of several inches or more.⁴¹ This precipitation can cause slopes to become saturated.

⁴¹ Mabey, S.B., Duncan, C.C. 2013. Slope Stability Map of Massachusetts. Prepared for the Massachusetts Emergency Management Agency, the Federal Emergency Management Agency and the Massachusetts

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.⁴²

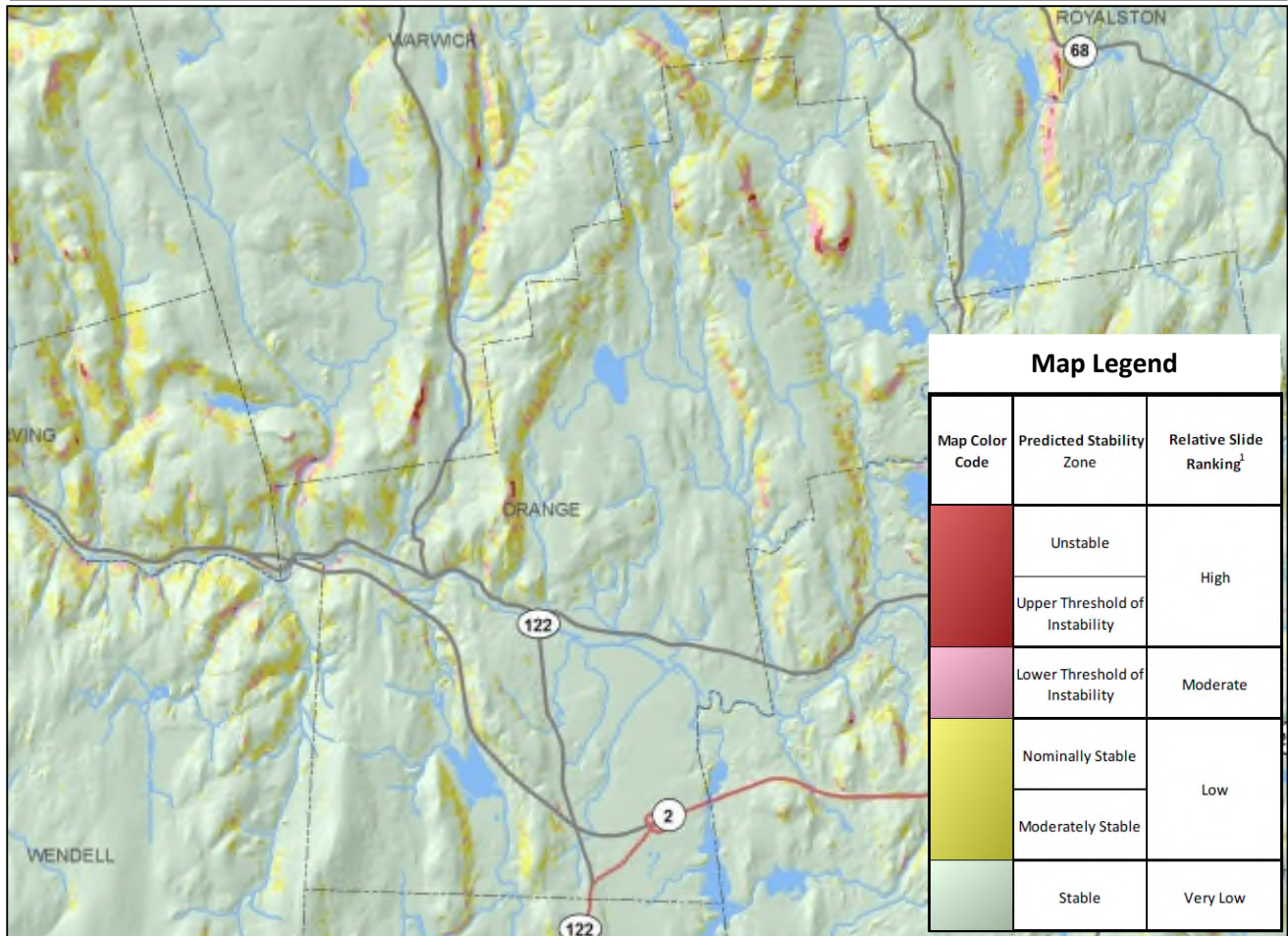
Landslides are created by human activities as well, including deforestation, cultivation and construction, which destabilize already fragile slopes. Some human activities that could cause landslides include:

- vibrations from machinery or traffic;
- blasting;
- earthwork which alters the shape of a slope, or which imposes new loads on an existing slope;
- in shallow soils, the removal of deep-rooted vegetation that binds colluvium to bedrock; and
- construction, agricultural or forestry activities (logging) which change the amount of water which infiltrates the soil.

Location

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. This project was designed to provide statewide mapping and identification of landslide hazards that can be used for community level planning as well as prioritizing high-risk areas for mitigation.

Figure 3-23: Slope Stability Map, Orange and Surrounding Towns



Source: Massachusetts Geologic Survey and UMass Amherst, 2013

Orange has areas in town with high and moderate landslide rankings. These areas are shown in Figure 3-23 and are mostly located along the steep ridges in town that run north-south in North Orange. There are also slopes running along ridges in the northeast section of town with high and moderate landslide rankings, such as those near Tully Mountain. In general, due to the relatively flat topography and soils in town, Orange has a fewer amount of unstable soils than many other towns in Franklin County.

Extent

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. As a result, estimations of the potential severity of landslides are informed by previous occurrences as well as an examination of landslide susceptibility. Information about previous landslides can 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. The distribution of susceptibility in Orange is depicted on the Slope Stability Map, with areas of higher slope instability considered to also be more susceptible to the landslide hazard.

Previous Occurrences

No significant landslide events have been observed in Orange. However, there have been recent instances of small landslide events and soil erosion at solar farms in Orange. Due to the way these solar arrays were constructed, they are susceptible to landslides during heavy rain events. Other locations throughout Orange have been disturbed due to heavy rainfall events, such as the cemetery on West Orange Road, pictured to the right.



The cemetery on West Orange Road flooded after a heavy rainstorm in August 2018. Photo courtesy of the Greenfield Recorder.

Probability of Future Events

In general, landslides are most likely during periods of higher than average rainfall. The ground must be saturated prior to the onset of a major storm for a significant landslide to occur. Increasing heavy precipitation events will increase the risk of landslides in Orange. There is a “Low” probability, or a 1%-2%% chance, of a landslide happening in the next year.

Impact

Homes located on lots with significant slopes (i.e., 10% or greater), or that are located at the bottom of steep slopes, are at greater risk of impacts from landslides. The impact of a landslide in Orange would likely be “Limited” depending on where it occurs. More than 10% of property in the affected area could be damaged or destroyed.

Vulnerability

Society

Vulnerable Populations

Populations who rely on potentially impacted roads for vital transportation needs are

considered to be particularly vulnerable to this hazard. In Orange, some residents may be vulnerable if an emergency access route was cut off or blocked by a landslide.

Health Impacts

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.

Economic Impacts

A landslide's impact on the economy and estimated dollar losses are difficult to measure. Landslides can impose direct and indirect impacts on society. Direct costs 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

Infrastructure

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.

Agriculture

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.

Energy

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.

Public Health

Landslides can result in injury and loss of life. Landslides can impact access to power and clean water and also increase exposure to vector-borne diseases.

Public Safety

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.

Transportation

Landslides can significantly impact roads and bridges. Landslides can block egress and ingress on roads, isolating neighborhoods and causing traffic problems and delays for public and private transportation. These impacts can result in economic losses for businesses. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.

The possibility of a landslide in the vicinity of a highway or major road represents a significant economic vulnerability for the Town and State. For example, the damage to a 6-mile stretch of Route 2 caused by tropical storm Irene (2011), which included debris flows, four landslides, and fluvial erosion and undercutting of infrastructure, cost \$23 million for initial repairs.

Water and Wastewater Infrastructure

Surface water bodies may become directly or indirectly contaminated by landslides. Landslides can block river and stream channels, which can result in upstream flooding and reduced downstream flow. This may impact the availability of drinking water. Water and wastewater infrastructure may be physically damaged by mass movements.

Environment

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

Vulnerability Summary

Based on the above assessment, Orange has a hazard index rating of “Low” for landslides. The following problem statements summarize Orange’s areas of greatest concern regarding landslides.



Landslide Hazard Problem Statements

- Roads, buildings, and utilities downslope of steep and unstable soils are at risk of damage due to landslides. Most of these areas are located in North Orange. An inventory is needed to determine what critical infrastructure is at the greatest risk of being damaged during a landslide.
- Residents, workers, and visitors working or recreating outdoors are vulnerable to landslides.
- Town bylaws for residential and commercial development reflect the 100 year flood plain and previous norms in precipitation. The Committee has noted that these bylaws do not adequately reflect changes in annual precipitation, and they should be updated.
- Several solar fields throughout Orange are susceptible to flooding and landslides due to the way they were sited. A landslide from one of the fields recently resulted in a road closure.
- Many of the Town's evacuation routes may be impacted by flooding. There are areas of Town where residents might become isolated if roads, bridges, or culverts were blocked or damaged during a flood.
- New initiatives are needed to improve household disaster preparedness Town-wide and to better reach vulnerable populations, including seniors and disabled residents with lessened mobility or medical needs, as well as homeless or transient people who may be difficult to reach in the event of an emergency. The Town may need to review and update evacuation planning for vulnerable populations in its CEMP, explore additional sheltering options, and pursue supportive partnerships for sheltering in the community.
- Although the Town has a Reverse 911 Warning System (CodeRED) with a large percentage of residents subscribing to the service, there is a need to continue to increase subscription among residents and businesses. Education and outreach are needed to ensure that all residents are aware of emergency situations and have access to evacuation and sheltering instructions, including options for residents with specialized medical needs, and pet sheltering options.
- Many residents live in isolated locations with unreliable cell service, which can decrease access to emergency services.
- Existing communication infrastructure issues and vulnerabilities could be exacerbated by severe hazards.

3.12 EXTREME TEMPERATURES

Potential Impacts of Climate Change

Beyond the overall warming trend associated with global warming and climate change, Orange will experience increasing days of extreme heat in the future. Generally, extreme heat is considered to be over 90 degrees Fahrenheit (°F), because at temperatures above that threshold, heat-related illnesses and mortality show a marked increase. The average summer across the Commonwealth during the years between 1971 and 2000 included 4 days over 90°F. Climate scientists project that by mid-century, the state could have a climate that resembles that of southern states today, with between 10-28 days over 90°F. By the end of the century, extreme heat could occur between 13-56 days during summer, depending on how successful we are in reducing greenhouse gas emissions.⁴³

Figure 3-24: Impacts of Climate Change on Extreme Temperatures		
Potential Effects of Climate Change		
	RISING TEMPERATURES → HIGHER EXTREME TEMPERATURES	The average summer across the Massachusetts during the years between 1971 and 2000 included 4 days over 90°F (i.e. extreme heat days). Climate scientists project that by mid-century, the state could have a climate that resembles that of southern states today, with an additional 10-28 days over 90°F during summer. By the end of the century, extreme heat could occur between 13-56 days during summer.
	RISING TEMPERATURES → HIGHER AVERAGE TEMPERATURES	Compared to an annual 1971-2000 average temperature baseline of 47.6°F, annual average temperatures in Massachusetts are projected to increase by 3.8 to 10.8 degrees (likely range) by the end of the 21st century; slightly higher in western Massachusetts.

Source: Massachusetts State Hazard Mitigation and Climate Adaptation Plan. September 2018

Hazard Description

There is no universal definition for extreme temperatures. The term is relative to the usual weather in the region based on climatic averages. Extreme heat for Massachusetts is usually defined as a period of three or more consecutive days above 90 degrees Fahrenheit (°F), but more generally as a prolonged period of excessively hot weather, which may be accompanied by high humidity. Extreme cold is also considered relative to the normal climatic lows in a region.

Massachusetts has four seasons with several defining factors, and temperature is one of the most significant. Extreme temperatures can be defined as those that are far outside the normal ranges. The average highs and lows of the hottest and coolest months in Franklin County (using Greenfield data as a proxy) are provided in Table 3-39.

⁴³ ResilientMA: Climate Change Clearing House for the Commonwealth: <http://resilientma.org/changes/rising-temperatures>. Accessed March 1, 2019.

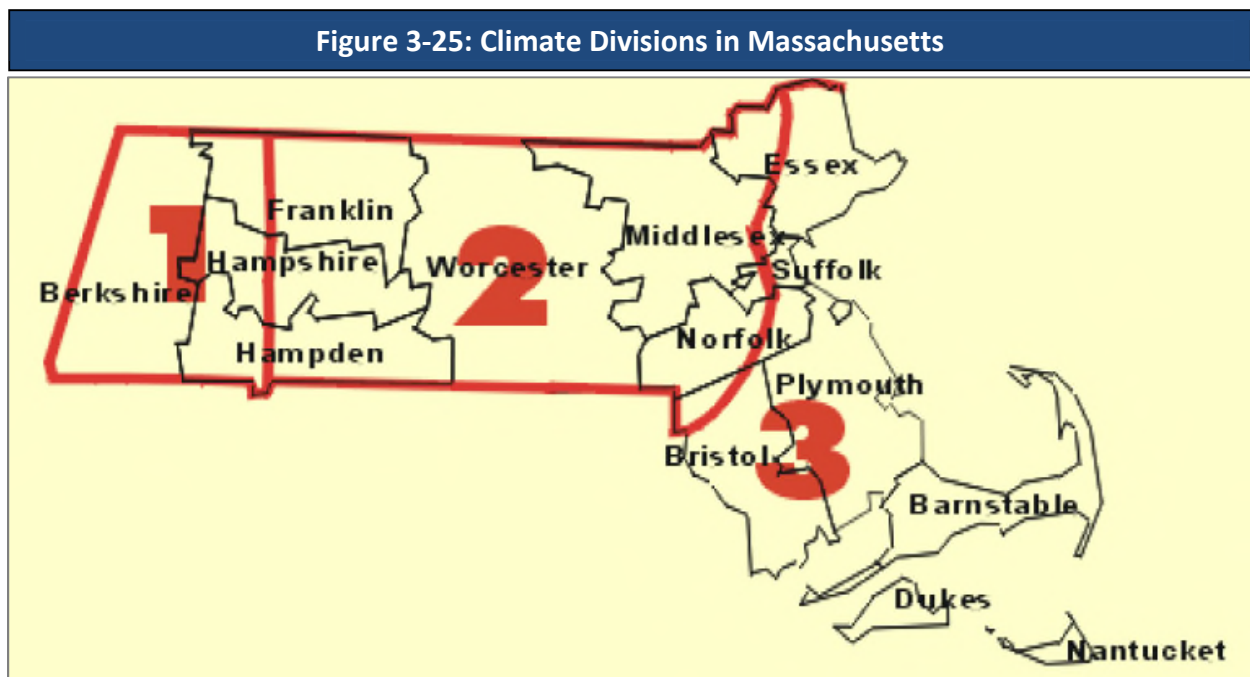
Table 3-39: Annual Average High and Low Temperatures (Greenfield)		
	July (Hottest Month)	January (Coldest Month)
Average High (°F)	81°	33°
Average Low (°F)	57°	12°

Note: Average temperatures are for the years 1981-2010.

Source: U.S. Climate Data.

Location

According to the NOAA, Massachusetts is made up of three climate divisions: Western, Central, and Coastal, as shown in Figure 3-22. Average annual temperatures vary slightly over the divisions, with annual average temperatures of around 46°F in the Western division (area labeled “1” in the figure), 49°F in the Central division (area labeled “2” in the figure) and 50°F in the Coastal division (area labeled “3” in the figure). Orange falls within the Central climate division.

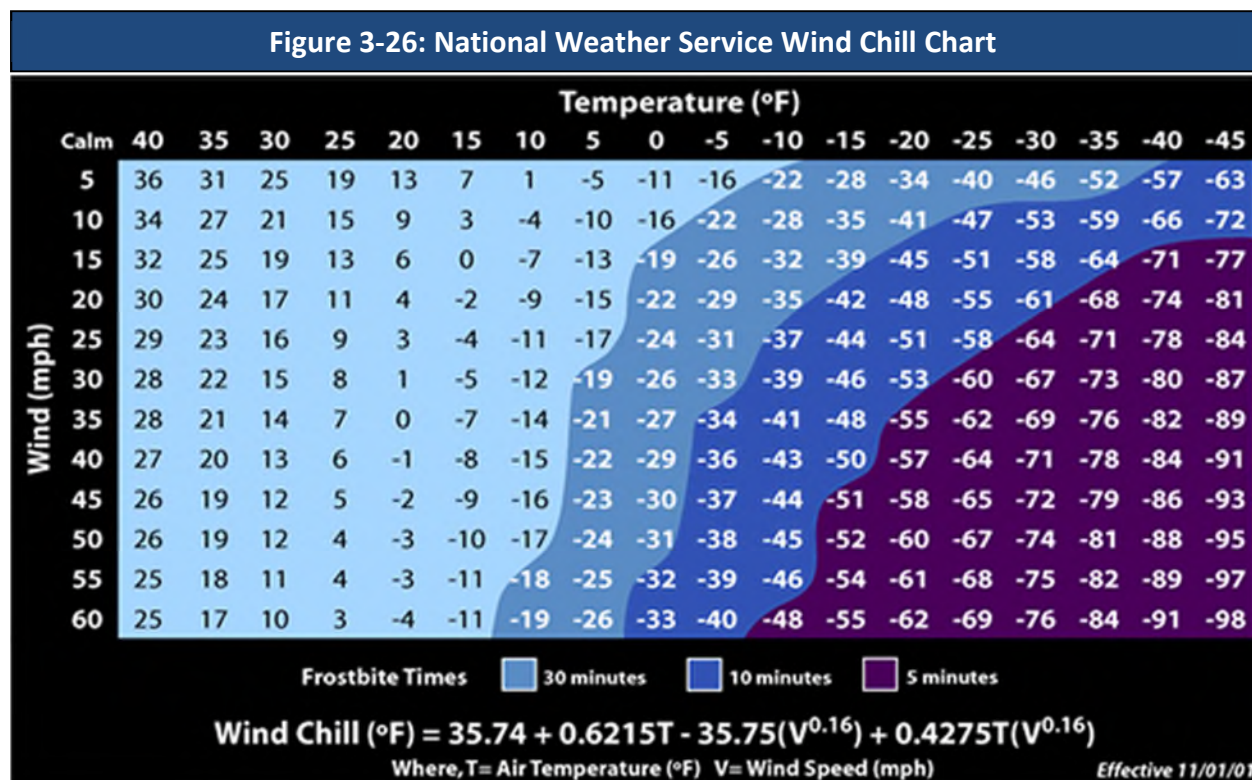


Source: NOAA, as presented in the Massachusetts State Hazard Mitigation and Climate Adaptation Plan, September 2018

Extreme temperature events occur more frequently and vary more in the inland regions of the State where temperatures are not moderated by the Atlantic Ocean. The severity of extreme heat impacts, however, is greater in densely developed urban areas like Boston than in suburban and rural areas, due to the urban “heat island” effect, described in more detail in the Impacts sub-section.

Extent

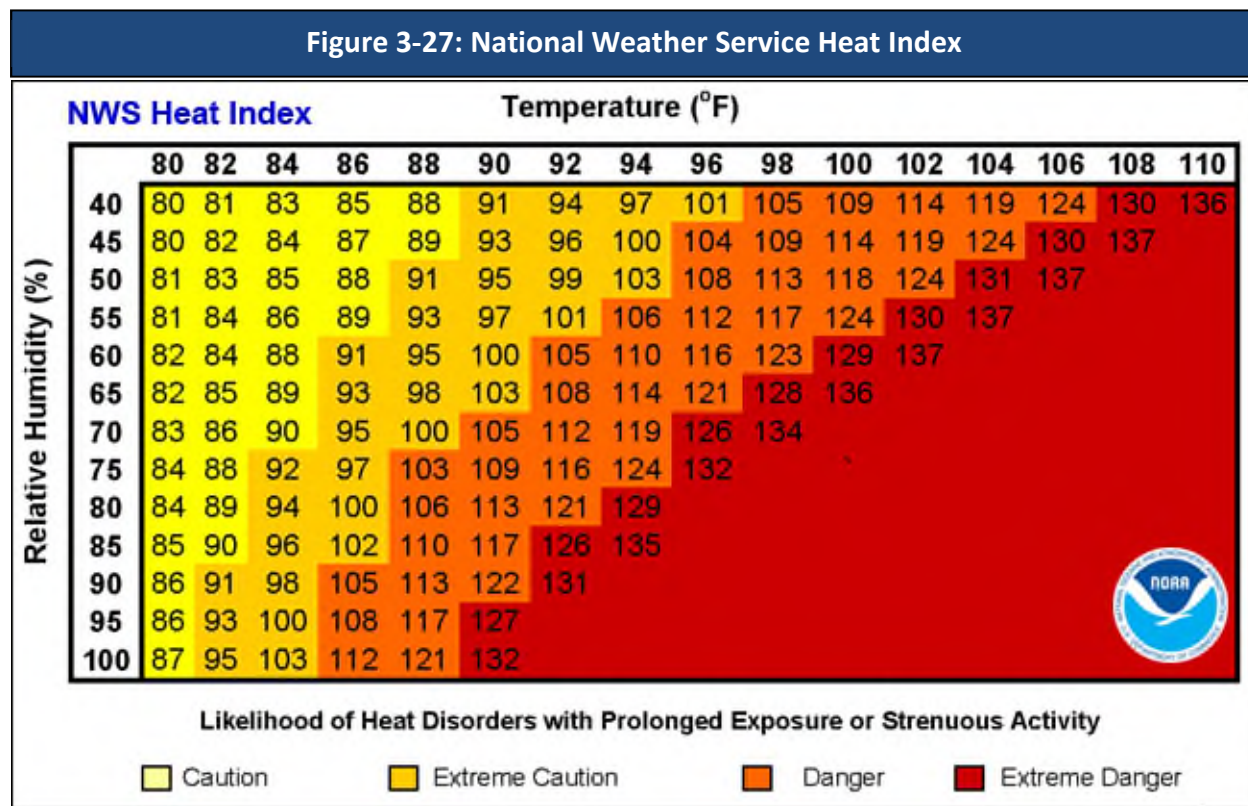
The extent (severity or magnitude) of extreme cold temperatures is generally measured through the Wind Chill Temperature Index. Wind Chill Temperature is the temperature that people and animals feel when they are outside, and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. As the wind increases, the body loses heat at a faster rate, causing the skin's temperature to drop. The National Weather Service (NWS) issues a Wind Chill Advisory if the Wind Chill Index is forecast to dip to -15°F to -24°F for at least three hours, 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 three 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. Figure 3-26 shows the Wind Chill Temperature Index.



Source: National Weather Service: <https://www.weather.gov/safety/cold-wind-chill-chart>

The NWS issues a Heat Advisory when the NWS Heat Index is forecast to reach 100 to 104°F for two or more hours. The NWS issues an Excessive Heat Warning if the Heat Index is forecast to reach 105°F or higher for two or more hours. The NWS Heat Index is based both on temperature and relative humidity, and describes a temperature equivalent to what a person would feel at a baseline humidity level. It is scaled to the ability of a person to lose heat to their environment. The relationship between these variables and the levels at which the NWS considers various health hazards to become relevant are shown in Figure 3-27. 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. In addition, strong winds, particularly with very hot, dry air, can increase the risk of heat-related impacts.



Source: National Weather Service: <https://www.weather.gov/safety/heat-index>

Previous Occurrences

Since 1994, there have been 33 cold weather events within the Commonwealth, ranging from Cold/Wind Chill to Extreme Cold/Wind Chill events. Information on severe cold weather events in Orange and Franklin County was not available prior to 2015. However, detail on recent extreme events is provided below.

In February 2015, a series of snowstorms piled nearly 60 inches on the city of Boston in 3 weeks and caused recurrent blizzards across eastern Massachusetts. While Orange and western Massachusetts was not impacted as much from the snow, temperature gauges across the Commonwealth measured extreme cold, with wind chills as low as -31°F. Wind chills as low as 28 below zero were recorded at the Orange Municipal Airport.

In February 2016, one cold weather event broke records throughout the state. Arctic high pressure brought strong northwest winds and extremely cold wind chills to southern New England. Wind chills as low as 38 below zero were reported in Orange.

According to the NOAA's Storm Events Database, there have been 43 warm weather events (ranging from Record Warmth/Heat to Excessive Heat events) since 1995 in Massachusetts. Excessive heat results from a combination of temperatures well above normal and high humidity. Whenever the heat index values meet or exceed locally or regionally established heat or excessive heat warning thresholds, an event is reported in the database. Information on excessive heat was not available for Orange or Franklin County prior to 2018.

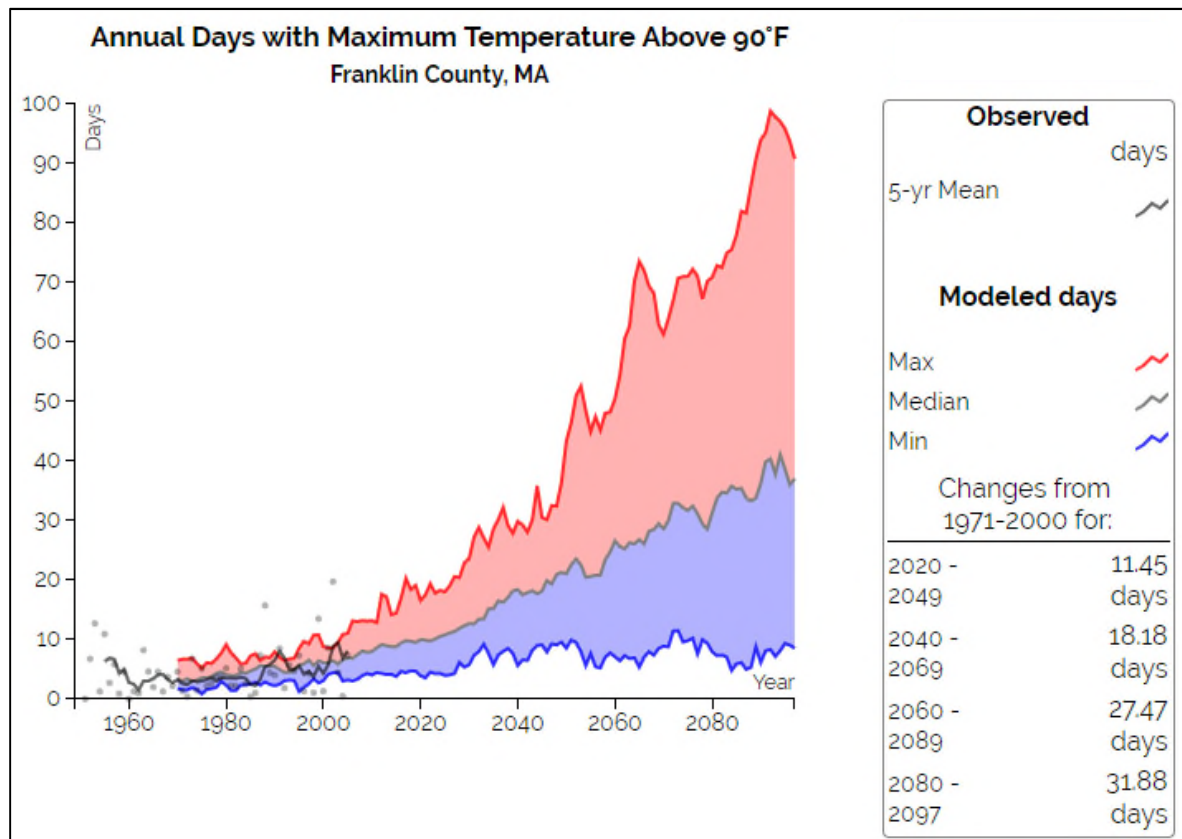
In 2012, Massachusetts temperatures broke 27 heat records. Most of these records were broken between June 20 and June 22, 2012, during the first major heat wave of the summer to hit Massachusetts and the East Coast. In July 2013, a long period of hot and humid weather occurred throughout New England. One fatality occurred on July 6, when a postal worker collapsed as the Heat Index reached 100°F. In Franklin County, excessive heat was recorded for July 1, 2018, when a heat index of 107°F was observed at the Orange Municipal Airport from 1:00 PM to 5:00 PM.

Probability of Future Events

There are a number of climatic phenomena that determine the number of extreme weather events in a specific year. However, there are significant long-term trends in the frequency of extreme hot and cold events. In the last decade, U.S. daily record high temperatures have occurred twice as often as record lows (as compared to a nearly 1:1 ratio in the 1950s). Models suggest that this ratio could climb to 20:1 by midcentury, if GHG emissions are not significantly reduced. The data support the trends of an increased frequency of extreme hot weather events and a decreased frequency of extreme cold weather events.

The average, maximum, and minimum temperatures in Franklin County are likely to increase significantly over the next century (resilient MA, 2018). This gradual change will put long-term stress on a variety of social and natural systems, and will exacerbate the influence of discrete events. Significant increases in maximum temperatures are anticipated, particularly under a higher GHG emissions scenario. Figure 3-28 displays the projected increase in the number of days per year over 90°F. The number of days per year with daily maximum temperatures over 90°F is projected to increase by 18 days by the 2050s, and by 32 days by the end of the century (for a total of 36 days over 90°F), compared to the average observed range from 1971 to 2000 of 4 days per year. Under a high emissions scenario, however, there could be as many as 100 days with a maximum temperature above 90°F by the end of the century.

Figure 3-28: Projected Annual Days with a Maximum Temperature Above 90°F



Source: resilient MA, 2018.

Impact

Extreme Cold

Extreme cold is a dangerous situation that can result in health emergencies for susceptible people, such as those without shelter or who are stranded or who live in homes that are poorly insulated or without heat. Extreme cold events are events when temperatures drop well below normal in an area. Extreme cold temperatures are characterized by the ambient air temperature dropping to approximately 0°F or below.

When winter temperatures drop significantly below normal, staying warm and safe can become a challenge. Extremely cold temperatures often accompany a winter storm, which may also cause power failures and icy roads. During cold months, carbon monoxide may be high in some areas because the colder weather makes it difficult for car emission control systems to operate effectively, and temperature inversions can trap the resulting pollutants closer to the ground.

Staying indoors as much as possible can help reduce the risk of car crashes and falls on the ice,

but cold weather also can present hazards indoors. Many homes may be too cold, either due to a power failure or because the heating system is not adequate for the weather. Exposure to cold temperatures, whether indoors or outside, can cause other serious or life-threatening health problems. Power outages may also result in inappropriate use of combustion heaters, cooking appliances, and generators in indoor or poorly ventilated areas, leading to increased risk of carbon monoxide poisoning or fire.

Extreme Heat

A heat wave is defined as three or more days of temperatures of 90°F or above. A basic definition of a heat wave implies that it is an extended period of unusually high atmosphere-related heat stress, which causes temporary modifications in lifestyle and which may have adverse health consequences for the affected population. Heat waves cause more fatalities in the U.S. than the total of all other meteorological events combined.

Heat impacts can be particularly significant in urban areas. Buildings, roads, and other infrastructure replace open land and vegetation. Dark-colored asphalt and roofs also absorb more of the sun's energy. These changes cause urban areas to become warmer than the surrounding areas. This forms "islands" of higher temperatures, often referred to as "heat islands." The term "heat island" describes built-up areas that are hotter than nearby rural or shaded areas. Heat islands occur on the surface and in the atmosphere. On a hot, sunny day, the sun can heat dry, exposed urban surfaces to temperatures 50°F to 90°F hotter than the air. Heat islands can affect communities by increasing peak energy demand during the summer, air conditioning costs, air pollution and GHG emissions, heat-related illness and death, and water quality degradation.

Extreme heat events can also have impacts on air quality. Many conditions associated with heat waves or more severe events—including high temperatures, low precipitation, strong sunlight and low wind speeds—contribute to a worsening of air quality in several ways. High temperatures can increase the production of ozone from volatile organic compounds and other aerosols. Weather patterns that bring high temperatures can also transport particulate matter air pollutants from other areas of the continent. Additionally, atmospheric inversions and low wind speeds allow polluted air to remain in one location for a prolonged period of time.

Vulnerability

The entire town of Orange is vulnerable to extreme temperatures.

Society

Vulnerable Populations

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

An additional element of vulnerability to extreme temperature events is homelessness, as homeless individuals have a limited capacity to shelter from dangerous temperatures. Two homeless people died from exposure to extreme cold in January 2019 in Greenfield.

Table 3-40 estimates the number of vulnerable populations and households in Orange. Individuals and households may fall into multiple categories, so the numbers should not be added. Rather, the table provides Town officials and emergency response personnel with information to help plan for responding to the needs of Orange residents during an extreme temperature event.

Table 3-40: Estimated Vulnerable Populations in Orange		
Vulnerable Population Category	Number	Percent of Total Population*
Population Age 65 Years and Over	1,308	17%
Population with a Disability	1,437	19%
Population who Speak English Less than "Very Well"	75	1%
Vulnerable Household Category	Number	Percent of Total Households*
Low Income Households (annual income less than \$35,000)	1,242	40%
Householder Age 65 Years and Over Living Alone	426	14%

Households Without Access to a Vehicle	273	9%
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*Total population = 7,682; Total households = 3,137

Note: Individuals and households may be counted under multiple categories.

Source: U.S. Census American Community Survey 2013-2017 Five-Year Estimates.

Health Impacts

When people are exposed to extreme heat, they can suffer from potentially deadly illnesses, such as heat exhaustion and heat stroke. Heat is the leading weather-related killer in the U.S., even though most heat-related deaths are preventable through outreach and intervention. 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.⁴⁴ 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.⁴⁵ 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.⁴⁶

Hot temperatures can contribute to deaths from 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

⁴⁴ Hattis, D. et al. 2012. The Spatial Variability of Heat-Related Mortality in Massachusetts. *Applied Geography*. 33(2012) pg 45-52. <http://wordpress.clarku.edu/yogneva/files/2012/04/Hattis-et-al-2011-The-spatial-variability-of-heat-related-mortality-in-Massachusetts.pdf>

⁴⁵ Madrigano J, Mittleman MA, Baccarelli A, Goldberg R, Melly S, von Klot S, Schwartz J. Temperature, myocardial infarction, and mortality: effect modification by individual- and area-level characteristics. *Epidemiology*. 2013 May;24(3):439-46.

⁴⁶ Shi L. et al. 2015. Impacts of temperature and its variability on mortality in New England. *Nature Climate Change*. Volume 5. November 2015.

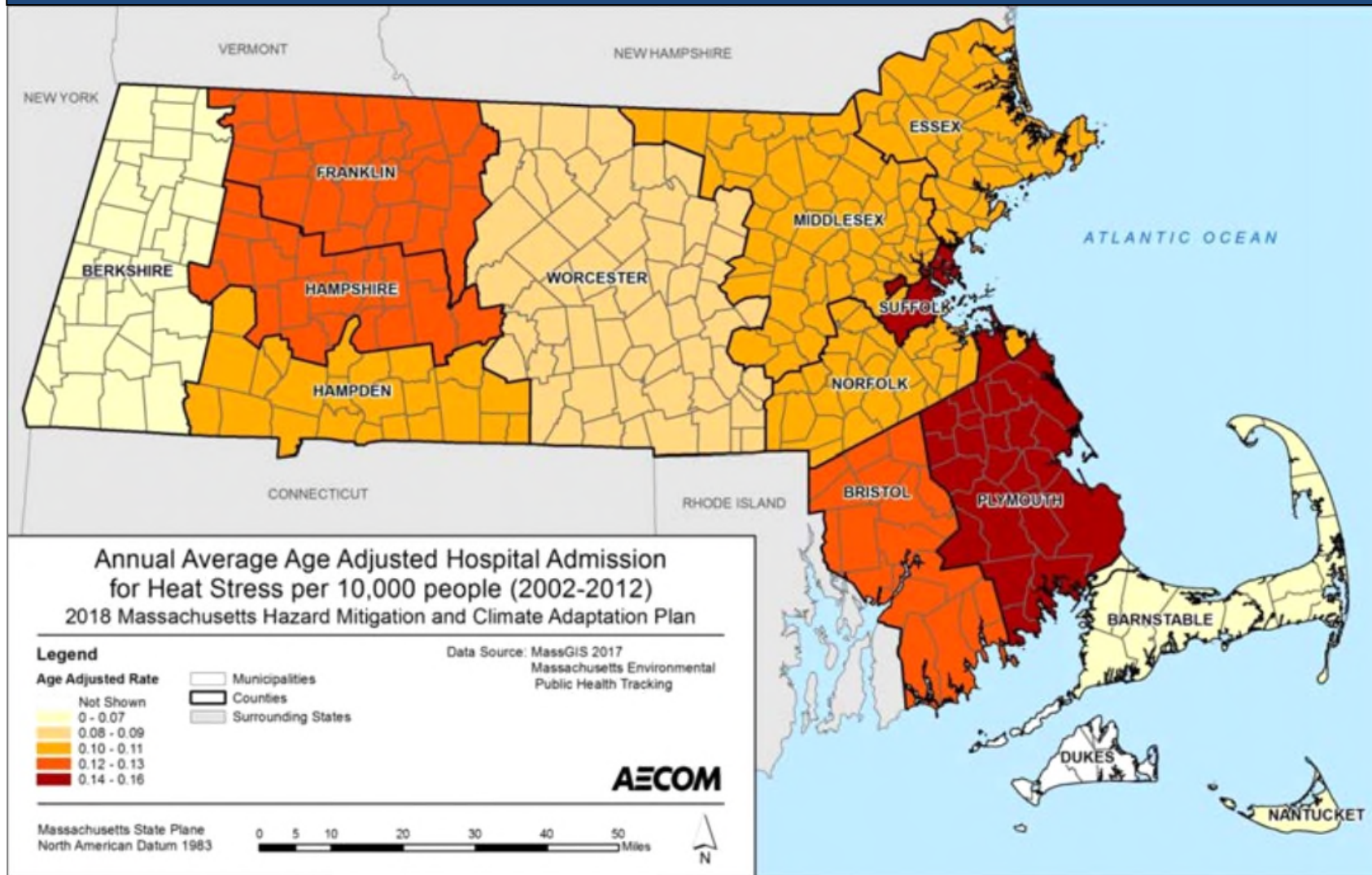
the state currently has asthma. In Massachusetts, poor air quality often accompanies heat events, as increased heat increases the conversion of ozone precursors in fossil fuel combustion emissions to ozone. Particulate pollution may also accompany hot weather, as the weather patterns that bring heat 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.

The rate of hospital admissions for heat stress under existing conditions is shown in Figure 3-29. Between 2002 and 2012, the annual average age-adjusted rate of hospital admission for heat stress was highest in Plymouth and Suffolk Counties. Franklin County ranked among the second highest rate of 0.12-0.13 admissions per 10,000 people. As displayed in Figure 3-30, Franklin County experienced the highest annual average age-adjusted hospital admissions for heart attacks (4.29 to 4.17 per 10,000 people) during this period, along with Plymouth, Bristol, and Berkshire Counties. Hamden County had the highest annual average age emergency department visits due to asthma (see Figure 3-31), while Franklin County's rate was statistically significantly lower.

Some behaviors increase the risks of temperature-related impacts. These behaviors include voluntary actions, such as drinking alcohol or taking part in strenuous outdoor physical activities in extreme weather, but may also include necessary actions, such as taking prescribed medications that impair the body's ability to regulate its temperature or that inhibit perspiration.

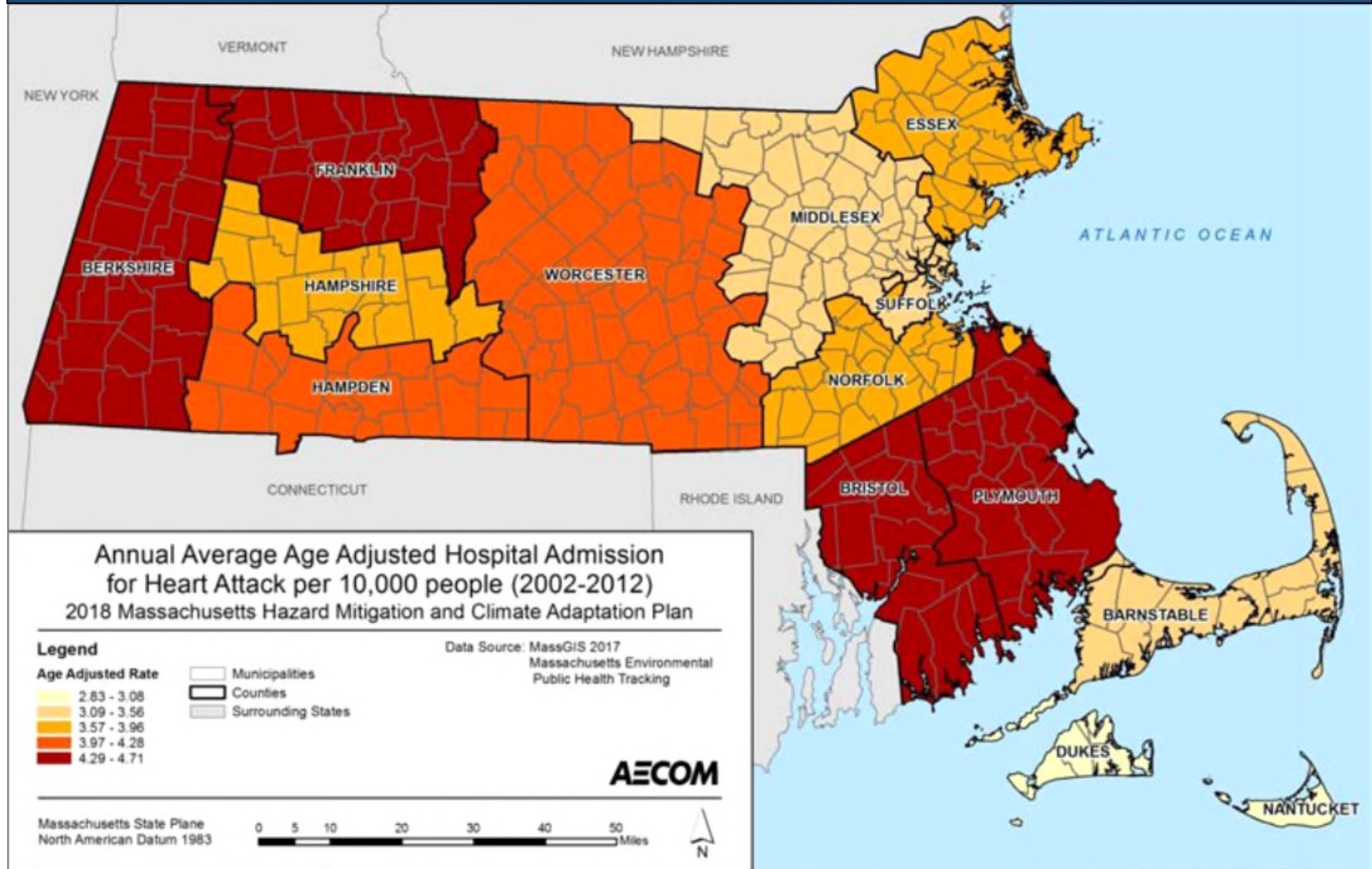
Cold-weather events can also have significant health impacts. The most immediate of these impacts are cold-related injuries, such as frostbite and hypothermia, which can become fatal if exposure to cold temperatures is prolonged. Similar to the impacts of hot weather that have already been described, cold weather can exacerbate pre-existing respiratory and cardiovascular conditions. Additionally, power outages that occur as a result of extreme temperature events can be immediately life-threatening to those dependent on electricity for life support or other medical needs. Isolation of these populations is a significant concern if extreme temperatures preclude their mobility or the functionality of systems they depend on. Power outages during cold weather may also result in inappropriate use of combustion heaters, cooking appliances, and generators in indoor or poorly ventilated areas, leading to increased risk of carbon monoxide poisoning or fires.

Figure 3-29: Rates of Heat Stress-Related Hospitalization by County



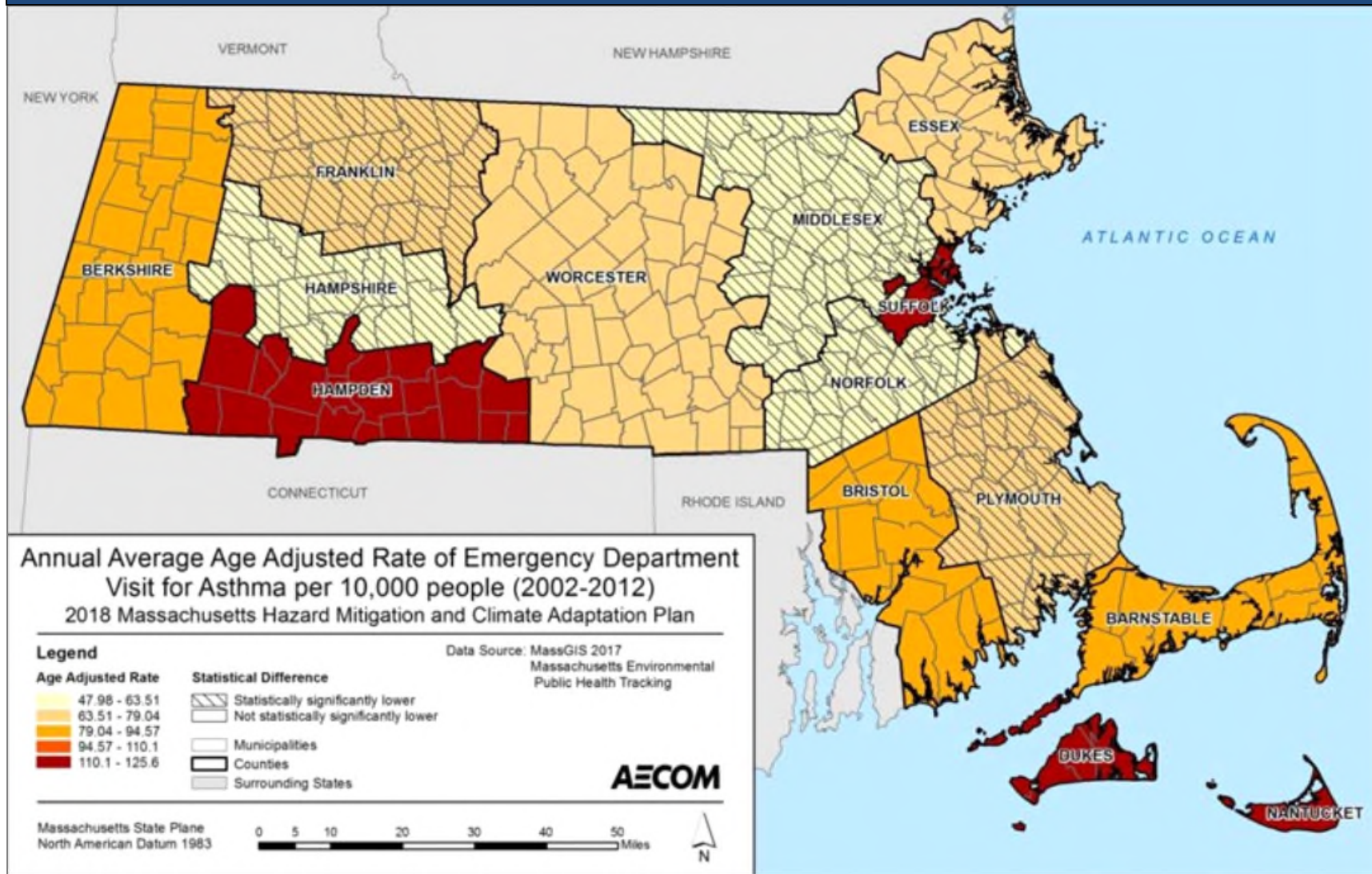
Source: Massachusetts Hazard Mitigation and Climate Adaptation Plan, September 2018.

Figure 3-30: Rates of Hospital Admissions for Heart Attacks by County



Source: Massachusetts Hazard Mitigation and Climate Adaptation Plan, September 2018.

Figure 3-31: Rates of Emergency Department Visits Due to Asthma by County



Source: Massachusetts Hazard Mitigation and Climate Adaptation Plan, September 2018.

Economic Impacts

Extreme temperature events also have impacts on the economy, including loss of business function and damage to and loss of inventory. Business owners may be faced with increased financial burdens due to unexpected building repairs (e.g., repairs for burst pipes), higher than normal utility bills, or business interruptions due to power failure (i.e., loss of electricity and telecommunications). Increased demand for water and electricity may result in shortages and a higher cost for these resources. Industries that rely on water for business (e.g., landscaping businesses) will also face significant impacts. There is a loss of productivity and income when the transportation sector is impacted and people and commodities cannot get to their intended destination. Businesses with employees that work outdoors (such as agricultural and construction companies) may have to reduce employees' exposure to the elements by reducing or shifting their hours to cooler or warmer periods of the day.

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. Higher temperatures that result in greater concentrations of ozone negatively impact plants that are sensitive to ozone. Additionally, as described in the Environment sub-section, changing temperatures can impact the phenology.

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 and pests grows.

Infrastructure

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

Agriculture

Above average, below average, and extreme temperatures are likely to impact crops—such as apples, peaches, and maple syrup—that rely on specific temperature regimes. Unseasonably warm temperatures in early spring that are followed by freezing temperatures can result in crop loss of fruit-bearing trees. Increasing heat stress days (above 90°F) may stress livestock and some crops. More pest pressure from insects, diseases and weeds may harm crops and cause farms to increase pesticide use. 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.⁴⁷

Energy

In addition to increasing demand for heating and cooling, periods of both hot and cold weather can stress energy infrastructure. Electricity consumption during summer may reach three times the average consumption rate of the period between 1960 and 2000; more than 25 percent of this consumption may be attributable to climate change.⁴⁸ In addition to affecting consumption rates, high temperatures can also reduce the thermal efficiency of electricity generation.

Extended-duration extreme cold can lead to energy supply concerns, as the heating sector then demands a higher percentage of the natural gas pipeline capacity. When this occurs, New England transitions electricity generation from natural gas to oil and liquid natural gas. Limited on-site oil and liquid natural gas storage as well as refueling challenges may cause energy supply concerns if the events are colder and longer in duration.

Transportation

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.⁴⁹ 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. Roads are also vulnerable to rapid freeze and thaw cycles, which may cause damage to road surfaces. An increase in freeze and thaw cycles can also damage bridge expansion joints.⁵⁰

⁴⁷ Resilient MA: <http://resilientma.org/sectors/agriculture>. Accessed March 4, 2019.

⁴⁸ Massachusetts Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee (EOEEA). 2011. Massachusetts Climate Change Adaptation Report.

⁴⁹ Massachusetts Department of Transportation (MassDOT). 2017. Assessment of Extreme Temperature Impacts on MassDOT Assets

⁵⁰ Resilient MA: <http://resilientma.org/sectors/transportation>. Accessed March 4, 2019.

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. Rail operations will also be impacted when mandatory speed reductions are issued in areas where tracks have been exposed to high temperatures over many days, resulting in increased transit travel time and operating costs as well as a reduction in track capacity. Finally, extreme temperatures also discourage active modes of transportation, such as bicycling and walking. This will have a secondary impact on sustainable transportation objectives and public health.

Operations are vulnerable to heat waves and associated power outages that affect electrical power supply to rail operations and to supporting ancillary assets for highway operations, such as electronic signing. Increased heat also impacts transportation workers, the viability of vegetation in rights-of-way, and vehicle washing or maintenance schedules.⁵¹ Hot weather increases the likelihood that cars may overheat during hot weather, and also increases the deterioration rate of tires.

Water Infrastructure

Extreme temperatures do not pose as great a threat to water infrastructure as flood-related hazards, but changes in temperature can impact water infrastructure. For example, extreme heat that drives increases in air-conditioning demand can trigger power outages that disrupt water and wastewater treatment.⁵² Hotter temperatures will also likely result in increased outdoor water consumption. Combined with other climate impacts such as an increase in surface water evapotranspiration, changing precipitation patterns, and groundwater recharge rates, increased water demand may challenge the capacity of water supplies and providers. Extreme heat can damage aboveground infrastructure such as tanks, reservoirs, and pump stations. Warmer temperatures can also lead to corrosion, water main breaks, and inflow and infiltration into water supplies. Extreme heat is likely to result in increased drought conditions, and this has significant implications for water infrastructure, as discussed in the Drought Section.

Extreme cold can freeze pipes, causing them to burst. This can then lead to flooding and mold inside buildings when frozen pipes thaw.

⁵¹ Massachusetts Department of Transportation (MassDOT). 2017. Assessment of Extreme Temperature Impacts on MassDOT Assets

⁵² Resilient MA: <http://resilientma.org/sectors/water-resources>. Accessed March 4, 2019.

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. Higher summer temperatures will disrupt wetland hydrology. Paired with a higher incidence and severity of droughts, high temperatures and evapotranspiration rates could lead to habitat loss and wetlands drying out.⁵³ 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.

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. One specific way in which average temperatures influence plant behavior is through changes in phenology, the pattern of seasonal life events in plants and animals. A recent study by the National Park Service found that of 276 parks studied, three-quarters are experiencing earlier spring conditions, as defined by the first greening of trees and first bloom of flowers, and half are experiencing an “extreme” early spring that exceeds 95% of historical conditions.⁵⁴ These changing seasonal cues can lead to ecological mismatches, as plants and animals that rely on each other for ecosystem services become “out of sync.” For example, migratory birds that rely on specific food sources at specific times may reach their destinations before or after the species they feed on arrive or are in season. Additionally, invasive species tend to have more flexible phenologies than their native counterparts; therefore, shifting seasons may increase the competitiveness of present and introduced invasive species.

Wild plants and animals are also migrating away from their current habitats in search of the cooler temperatures to which they are accustomed. This is particularly pertinent for

⁵³ Manomet Center for Conservation Sciences (MCCS) and Massachusetts Division of Fisheries and Wildlife (DFW). 2010. Climate Change and Massachusetts Fish and Wildlife: Volume 3 Habitat Management.

⁵⁴ National Park System (NPS). 2016. Project Brief: Phenology and Climate Change.

<https://www.nps.gov/subjects/climatechange/upload/2016-10-26-NPS-Phen-Project-Brief.pdf>

ecosystems that (like many in the northeastern U.S.) lie on the border between two biome types. For example, an examination of the Green Mountains of Vermont found a 299- to 390-foot upslope shift in the boundary between northern hardwoods and boreal forests between 1964 and 2004.⁵⁵ Such a shift is hugely significant for the species that live in this ecosystem as well as for forestry companies or others who rely on the continued presence of these natural resources. Massachusetts ecosystems that are expected to be particularly vulnerable to warming temperatures include:

- Coldwater streams and fisheries
- Vernal pools
- Spruce-fir forests
- Northern hardwood (Maple-Beech-Birch) forests, which are economically important due to their role in sugar production
- Hemlock forests, particularly those with the hemlock wooly adelgid
- Urban forests, which will experience extra impacts due to the urban heat island effect

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.⁵⁶ As temperature increases, the length of the growing season will also increase.

Vulnerability Summary

Based on the above assessment, Orange has a Medium vulnerability to extreme temperatures. The following problem statements summarize Orange’s areas of greatest concern regarding extreme temperatures.

Extreme Temperature Hazard Problem Statements
<ul style="list-style-type: none"> • Ice jams on the Millers River in Athol are of concern, as they result in localized flood events in Orange. Regular dredging of the river is needed in order to prevent ice jams. • New initiatives are needed to improve household disaster preparedness Town-wide and to better reach vulnerable populations, including seniors and disabled residents with lessened mobility or medical needs, as well as homeless or transient people who may be difficult to reach in the event of an emergency. The Town may need to review and update evacuation planning for vulnerable populations in its CEMP, explore additional sheltering options, and pursue supportive

⁵⁵ U.S. Global Change Research Program (USGCRP). 2014. Hatfield, J. et al., Ch. 6: Agri-culture. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., pp 150-174

⁵⁶ Manomet Center for Conservation Sciences (MCCS) and Massachusetts Division of Fisheries and Wildlife (DFW). 2010. Climate Change and Massachusetts Fish and Wildlife: Volume 3 Habitat Management.



<p>Extreme Temperature Hazard Problem Statements</p>
<p>partnerships for sheltering in the community.</p>
<ul style="list-style-type: none"> • Emergency shelters may not be adequately staffed or supplied with water, food, and first aid supplies. There is a need to inventory the supplies currently available at Orange shelters. • Although the Town has a Reverse 911 Warning System (CodeRED) with a large percentage of residents subscribing to the service, there is a need to continue to increase subscription among residents and businesses. Education and outreach are needed to ensure that all residents are aware of emergency situations and have access to evacuation and sheltering instructions, including options for residents with specialized medical needs, and pet sheltering options. • Many residents live in isolated locations with unreliable cell service, which can decrease access to emergency services. • Extreme heat may worsen risk of wildfires and the availability of local water supplies for firefighting. Firefighters may already lack sufficient water volume, pressure, and/or infrastructure across town to fight wildfires. • Orange’s forests make up approximately 77% of the town and are vulnerable to extended drought, which could also increase the risk to other hazards including wildfire and pests. • Some of Orange’s residents are serviced by private wells that run the risk of going dry during prolonged drought. • Orange does not have a forest stewardship plan that includes climate change considerations, such as drought. • Extreme cold temperatures combined with power outages, even short duration, can result in frozen and burst pipes for properties without back-up power. • Residents may not be familiar with how to deal with or prevent diseases associated with increasing average temperatures (e.g., tick and mosquito borne diseases). • Elderly, disabled and low-income residents are more vulnerable to extreme temperatures and may lack air conditioning or adequate heating systems in their homes. • Extreme temperatures create a risk of “brown-outs” in the power grid, where electricity supply may dip due to excess demand on the system and can affect vulnerable populations and municipal operations dependent on a consistent and uninterrupted power supply. • Changing climate has resulted in an annual decrease in days below freezing, a trend that will progress over the next century. Fewer days below freezing and deep frosts occurring later in the season are some of the contributing factors for larger tick and mosquito populations and longer seasons for both. This increases risk to Orange residents from insect borne diseases.

3.13 INVASIVE SPECIES

Potential Impacts of Climate Change

A warming climate may place stress on colder-weather species while allowing non-native species accustomed to warmer climates to spread northward. This northward trend is already well documented, and is expected to accelerate in the future. Another way in which climate change may increase the frequency of natural species threat is through the possibility of climate refugees. As populations move to escape increasingly inhospitable climates, they are likely to bring along products, food, and livestock that could introduce novel (and potentially invasive) species to the areas in which they settle.

Extreme winter temperatures are also critical limiting factors for many forest pests, and warming is expected to increase their survival and lead to expansions and outbreaks. For example, in Massachusetts, it's likely that winter temperatures have been limiting the impact of hemlock wooly adelgid (*Adelges tsugae*), as many infested forest stands are surviving while in more southerly ranges there is near complete mortality from this pest. But the adelgid has already expanded its range with warming winter temperatures and is likely to have increased survival and higher reproductive rates in the northern portion of its range as temperatures warm, likely leading to more significant impacts on forests.⁵⁷

Figure 3-32: Impacts of Climate Change on Invasive Species		
Potential Effects of Climate Change		
	RISING TEMPERATURES → WARMING CLIMATE	A warming climate may place stress on colder-weather species, while allowing non-native species accustomed to warmer climates to spread northward.
	RISING TEMPERATURES AND CHANGES IN PRECIPITATION → ECOSYSTEM STRESS	Changes in precipitation and temperature combine to create new stresses for Massachusetts' unique ecosystems. For example, intense rainfall in urbanized areas can cause pollutants on roads and parking lots to get washed into nearby rivers and lakes, reducing habitat quality. As rainfall and snowfall patterns change, certain habitats and species that have specific physiological requirements may be affected. The stresses experienced by native ecosystems as a result of these changes may increase the chances of a successful invasion of non-native species.

Source: Massachusetts State Hazard Mitigation and Climate Adaptation Plan. September 2018

Hazard Description

"Invasives" are species recently introduced to new ecosystems that cause or are likely to cause significant harm to the environment, economy, or human health. Invasives compete with native plants and wildlife for resources, disrupt beneficial relationships, spread disease, cause direct

⁵⁷ MassWildlife Climate Action Tool: <http://climateactiontool.org/content/invasive-plants-and-animals>. Accessed March 4, 2019.

mortality, and can significantly alter ecosystem function. Some of the more common invasives in Massachusetts may already be familiar - problematic invasive plants include purple loosestrife (*Lythrum salicaria*), Japanese barberry (*Berberis thunbergii*), glossy buckthorn (*Frangula alnus*), multiflora rose (*Rosa multiflora*), Japanese knotweed (*Fallopia japonica*), garlic mustard (*Alliaria petiolata*) and black locust (*Robinia pseudoacacia*). Invasive animals include forest pests such as the hemlock woolly adelgid (*Adelgis tsugae*), Asian longhorn beetle (*Anoplophora glabripennis*), and the emerald ash borer (*Agrilus planipennis*). The zebra mussel (*Dreissena polymorpha*) is a particularly detrimental aquatic invasive species that has recently been detected in Western Massachusetts.⁵⁸

The Massachusetts Invasive Plant Advisory Group (MIPAG), a collaborative representing organizations and professionals concerned with the conservation of the Massachusetts landscape, is charged by the Massachusetts Executive Office of Energy and Environmental Affairs to provide recommendations to the Commonwealth to manage invasive species. 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." 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. MIPAG recognized 69 plant species as "Invasive," "Likely Invasive," or "Potentially Invasive."

Massachusetts has a variety of laws and regulations in place that attempt to mitigate the impacts of these species. The Massachusetts Department of Agricultural Resources (MDAR) maintains a list of prohibited plants for the state, which includes federally noxious weeds as well as invasive plants recommended by MIPAG and approved for listing by MDAR. Species on the MDAR list are regulated with prohibitions on importation, propagation, purchase, and sale in the Commonwealth. Additionally, the Massachusetts Wetlands Protection Act (310 CMR 10.00) includes language requiring all activities covered by the Act to account for, and take steps to prevent, the introduction or propagation of invasive species.

In 2000, Massachusetts passed an Aquatic Invasive Species Management Plan, making the Commonwealth eligible for federal funds to support and implement the plan through the federal Aquatic Nuisance Prevention and Control Act. MassDEP is part of the Northeast Aquatic

⁵⁸ MassWildlife Climate Action Tool: <http://climateactiontool.org/content/invasive-plants-and-animals>. Accessed March 4, 2019.

Nuisance Species Panel, which was established under the federal Aquatic Nuisance Species Task Force. This panel allows managers and researchers to exchange information and coordinate efforts on the management of aquatic invasive species. The Commonwealth also has several resources pertaining to terrestrial invasive species, such as the Massachusetts Introduced Pest Outreach Project, although a strategic management plan has not yet been prepared for these species.

Code of Massachusetts Regulation (CMR) 330 CMR 6.0(d) requires any seed mix containing restricted noxious weeds to specify the name and number per pound on the seed label. Regulation 339 CMR 9.0 restricts the transport of currant or gooseberry species in an attempt to prevent the spread of white pine blister rust. There are also a number of state laws pertaining to invasive species. Chapters 128, 130, and 132 of Part I of the General Laws of the state include language addressing water chestnuts, green crabs, the Asian longhorn beetle, and a number of other species. These laws also include language allowing orchards and gardens to be surveyed for invasive species and for quarantines to be put into effect at any time.

Identification and monitoring is an important element in mitigating impacts from invasive species. The Outsmart Invasive Species project is a collaboration between the University of Massachusetts Amherst, the Massachusetts Department of Conservation and Recreation (MA DCR) and the Center for Invasive Species and Ecosystem Health at the University of Georgia. The goal of the project is to strengthen ongoing invasive-species monitoring efforts in Massachusetts by enlisting help from citizens. The web- and smartphone-based approach enables volunteers to identify and collect data on invasive species in their own time, with little or no hands-on training. By taking advantage of the increasing number of people equipped with iPhone or digital camera/web technology, this approach will expand the scope of invasive-species monitoring, in an effort to help control outbreaks of new or emergent invasive species that threaten our environment.⁵⁹

Location

The damage rendered by invasive species is significant. The massive scope of this hazard means that the entire Town of Orange may experience 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 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).

⁵⁹ <https://masswoods.org/outsmart>. Accessed March 5, 2019.

One of the immediate threats to Orange is the Hemlock wooly adelgid, a small insect that attacks and kills Hemlocks, which has been sighted at several locations in nearby Wendell. The pest may spread unimpeded, leading to widespread hemlock mortality.

Extent

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. Some (such as the gypsy moth) are nearly controlled, whereas others, such as the zebra mussel, are currently adversely impacting ecosystems throughout the Commonwealth. Invasive species can be measured through monitoring and recording observances.

Previous Occurrences

The terrestrial and freshwater species listed on the MIPAG website as “Invasive” (last updated April 2016) are identified in Table 3-41. The table also includes details on the nature of the ecological and economic challenges presented by each species as well as information on where the species has been detected in Massachusetts. Twenty-two of the invasive species on the list have been observed in Orange since 2010.

Table 3-41: Invasive Plants Occurring in Western Massachusetts		
Species (Common Name)	Notes on Occurrence and Impact	Observed in Orange
<i>Acer platanoides</i> L. (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; out-competes native vegetation, including sugar maple; dispersed by water, wind and vehicles.	Y
<i>Aegopodium podagraria</i> L. (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 flood plains.	N
<i>Ailanthus altissima</i> (P. Miller) Swingle (Tree of heaven)	This tree occurs in all regions of the state in upland, wetland, & coastal habitats. Grows in full sun to full shade. Spreads aggressively from root suckers, especially in disturbed areas.	Y
<i>Alliaria petiolata</i> (Bieb.) Cavara & Grande (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.	Y
<i>Berberis thunbergii</i> DC. (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. Escaping from cultivation; spread by birds; forms dense stands.	Y
<i>Cabomba caroliniana</i> A.Gray (Carolina fanwort; fanwort)	A perennial herb occurring in all regions of the state in aquatic habitats. Common in the aquarium trade; chokes waterways.	Y
<i>Celastrus orbiculatus</i> Thunb. (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. Escaping from cultivation; berries spread by birds and humans; overwhelms and kills vegetation.	Y
<i>Cynanchum louiseae</i> Kartesz & Gandhi (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, out-competing native species: deadly to Monarch butterflies.	Y
<i>Elaeagnus umbellata</i> Thunb. (Autumn olive)	A shrub occurring in uplands in all regions of the state. Grows in full sun. Escaping from cultivation; berries spread by birds; aggressive in open areas; has the ability to change soil.	Y

Table 3-41: Invasive Plants Occurring in Western Massachusetts

Species (Common Name)	Notes on Occurrence and Impact	Observed in Orange
<i>Euonymus alatus</i> (Thunb.) Sieb. (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. Escaping from cultivation and can form dense thickets and dominate the understory; seeds are dispersed by birds.	Y
<i>Frangula alnus</i> P. Mill. (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.	Y
<i>Hesperis matronalis</i> L. (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 flood plains.	Y
<i>Iris pseudacorus</i> L. (Yellow iris)	A perennial herb occurring in all regions of the state in wetland habitats, primarily in flood plains. Grows in full sun to partial shade. Out-competes native plant communities.	Y
<i>Lonicera japonica</i> Thunb. (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 bird dispersed; more common in southeastern Massachusetts.	N
<i>Lonicera morrowii</i> A.Gray (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 nonnative honeysuckles commonly planted and escaping from cultivation via bird dispersal.	Y
<i>Lonicera x bella</i> Zabel [<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 nonnative honeysuckles commonly planted and escaping from cultivation via bird dispersal.	N
<i>Lysimachia nummularia</i> L. (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 flood plains, forests and wetlands; forms dense mats.	Y
<i>Lythrum salicaria</i> L. (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	Y

Table 3-41: Invasive Plants Occurring in Western Massachusetts

Species (Common Name)	Notes on Occurrence and Impact	Observed in Orange
	cultivation; overtakes wetlands; high seed production and longevity.	
<i>Myriophyllum heterophyllum</i> Michx. (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.	Y
<i>Myriophyllum spicatum</i> L. (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.	N
<i>Phalaris arundinacea</i> L. (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.	Y
<i>Phragmites australis</i> (Cav.) Trin. ex Steud. subsp. australis (Common reed)	A perennial grass (USDA lists as subshrub, shrub) found in all regions of the state. Grows in upland and wetland habitats in full sun to full shade. Overwhelms wetlands forming huge, dense stands; flourishes in disturbed areas; native and introduced strains.	Y
<i>Fallopia japonica</i> var. <i>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.	Y
<i>Persicaria perfoliata</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 has been found in RI and CT. Habitats include streamside, fields, and road edges in full sun to partial shade. Highly aggressive; bird and human dispersed.	N
<i>Potamogeton crispus</i> L. (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.	N
<i>Ficaria verna</i> ssp. <i>bulbilifer</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	N

Table 3-41: Invasive Plants Occurring in Western Massachusetts

Species (Common Name)	Notes on Occurrence and Impact	Observed in Orange
	woodlands; an ephemeral that outcompetes native spring wildflowers.	
<i>Rhamnus cathartica</i> L. (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.	Y
<i>Robinia pseudoacacia</i> L. (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 Massachusetts. It has been planted throughout the state since the 1700's and is now widely naturalized. It behaves as an invasive species in areas with sandy soils.	Y
<i>Rosa multiflora</i> Thunb. (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.	Y
<i>Trapa natans</i> L. (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.	N

Source: Massachusetts Invasive Plant Advisory Group, <https://www.massnrc.org/mipag/invasive.htm>, and Franklin County Flora Group, 2019.

Although there are less clear-cut criteria for invasive fauna, there are a number of animals that have disrupted natural systems and inflicted economic damage on the Commonwealth, and may impact Orange (Table 3-42). One invasive species, the Zebra mussel, was first documented in Massachusetts in Laurel Lake in Lee (Berkshire County, Housatonic River watershed) in 2009. Invasive fungi are also included in this table. Because of the rapidly evolving nature of the invasive species hazard, this list is not considered exhaustive.

Table 3-42: Invasive Animal and Fungi Species in Massachusetts	
Species (Common Name)	Notes on Occurrence and Impact
<i>Terrestrial Species</i>	
Lymantria dispar dispar (Gypsy moth (insect))	This species was imported to Massachusetts for silk production, but escaped captivity in the 1860s. It is now found throughout the Commonwealth and has spread to parts of the Midwest. This species is considered a serious defoliator of oaks and other forest and urban trees; however, biological controls have been fairly successful against it.
Ophiostoma ulmi, Ophiostoma himal-ulmi, Ophiostoma novo-ulmi (Dutch elm disease (fungus))	In the 1930s, this disease arrived in Cleveland, Ohio, on infected elm logs imported from Europe. A more virulent strain arrived in the 1940s. The American elm originally ranged in all states east of Rockies, and elms were once the nation's most popular urban street tree. However, the trees have now largely disappeared from both urban and forested landscapes. It is estimated that "Dutch" elm disease has killed more than 100 million trees.
Adelges tsugae (Hemlock woolly adelgid (insect))	This species was introduced accidentally around 1924 and is now found from Maine to Georgia, including all of Massachusetts. It has caused up to 90% mortality in eastern hemlock species, which are important for shading trout streams and provide habitat for about 90 species of birds and mammals. It has been documented in about one-third of Massachusetts cities and towns and threatens the state's extensive Eastern Hemlock groves.
Cryphonectria parasitica (Chestnut blight (fungus))	This fungus was first detected in New York City in 1904. By 1926, the disease had devastated chestnuts from Maine to Alabama. Chestnuts once made up one-fourth to one-half of eastern U.S. forests, and the tree was prized for its durable wood and as a food for humans, livestock, and wildlife. Today, only stump sprouts from killed trees remain.
Anoplophora glabripennis (Asian long-horned beetle)	This species was discovered in Worcester in 2008. The beetle rapidly infested trees in the area, resulting in the removal of nearly 30,000 infected or high-risk trees in just 3 years.

Table 3-42: Invasive Animal and Fungi Species in Massachusetts	
Species (Common Name)	Notes on Occurrence and Impact
Cronartium ribicola (White pine blister rust (fungus))	This fungus is an aggressive and non-native pathogen that was introduced into eastern North America in 1909. Both the pine and plants in the Ribes genus (gooseberries and currants) must be present in order for the disease to complete its life cycle. The rust threatens any pines within a quarter-mile radius from infected Ribes.
<i>Aquatic Species</i>	
Dreissena polymorpha (Zebra mussel)	The first documented occurrence of zebra mussels in a Massachusetts water body occurred in Laurel Lake in July 2009. Zebra mussels can significantly alter the ecology of a water body and attach themselves to boats hulls and propellers, dock pilings, water intake pipes and aquatic animals. They are voracious eaters that can filter up to a liter of water a day per individual. This consumption can deprive young fish of crucial nutrients.

Source: Chase et al., 1997; Pederson et al., 2005, CZM, 2013, 2014; Defenders of Wildlife; Gulf of Maine; EOEEA, 2013a, 2013b; as presented in the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan.

Probability of Future Events

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. However, 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.

More generally, a warming climate may place stress on colder-weather species while allowing non-native species accustomed to warmer climates to spread northward. The impacts of invasive species and climate change is discussed in more detail below.

Impact

The impacts of invasive species may interact with those of climate change, magnifying the negative impacts of both threats. Furthermore, due to the very traits that make them successful at establishing in new environments, invasives may be favored by climate change. These traits include tolerance to a broad range of environmental conditions, ability to disperse or travel long distances, ability to compete efficiently for resources, greater ability to respond to changes in the environment with changes in physical characteristics (phenotypic plasticity), high reproductive rates, and shorter times to maturity.

To become an invasive species, the species must first be transported to a new region, colonize

and become established, and then spread across the new landscape. Climate change may impact each stage of this process. Globally, climate change may increase the introduction of invasive species by changing transport patterns (if new shipping routes open up), or by increasing the survival of invasives during transport. New ornamental species may be introduced to Massachusetts to take advantage of an expanded growing season as temperatures warm. Aquatic invasives may survive in ships' ballast waters with warmer temperatures. Extreme weather events or altered circulation patterns due to climate change could also allow the dispersal of invasive species to new regions via transportation of seeds, larvae and small animals.

Species may shift their ranges north as the climate warms and be successful in regions they previously had not colonized. Invasives may also be able to spread more rapidly in response to climate change, given their high dispersal rates and fast generation times. These faster moving species may be at a competitive advantage if they can move into new areas before their native competitors.

Here in the Northeast, warming conditions may be particularly concerning for some invasives because species ranges in temperate regions are often limited by extreme cold temperatures or snowfall. There is concern that aquatic species, such as hydrilla (*Hydrilla verticillata*) and water hyacinth (*Eichhornia crassipes*), may be able to survive and overwinter in Massachusetts with increased temperatures and reduced snowfall. Nutria (*Myocastor coypus*), large, non-native, semi-aquatic rodents that are currently established in Maryland and Delaware, are likely to move north with warming temperatures - perhaps as far as Massachusetts.

Extreme winter temperatures are also critical limiting factors for many forest pests, and warming is expected to increase their survival and lead to expansions and outbreaks. For example, in Massachusetts, it's likely that winter temperatures have been limiting the impact of hemlock wooly adelgid (*Adelges tsugae*), as many infested forest stands are surviving while in more southerly ranges there is near complete mortality from this pest. But the adelgid has already expanded its range with warming winter temperatures and is likely to have increased survival and higher reproductive rates in the northern portion of its range as temperatures warm, likely leading to more significant impacts on forests.

Invasive species are often able to thrive or take advantage of areas of high or fluctuating resource availability such as those found in disturbed environments. For example, for invasive plants, insect outbreaks or storms often free up space in the forest allowing light to penetrate and nutrients and moisture balances to change, allowing invasive plants to move in. Climate change is likely to create these types of opportunities through increased disturbances such as

storms and floods, coastal erosion and sea level rise.

Invasives may also be better able to respond to changing environmental conditions that free up resources or create opportunities. For example, greater plasticity in response to their environment may allow some invasive plants to respond faster to increases in spring temperature than native plants. These invasives are able to leaf-out earlier in warmer years, taking up available space, nutrients, and sunlight, and achieving a competitive advantage against native species. Increased carbon dioxide in the atmosphere may also benefit some weedy plant species, allowing them to compete for other resources (like water) more effectively than their native counterparts.

Species roles may change as the climate changes, further complicating the management and policy response. As species ranges shift and existing inter-species relationships are broken, there is the potential that some species, including native species, may become pests because the interspecies interactions (e.g., predation, herbivory) that used to keep their population numbers in check are no longer functional.⁶⁰

Once established, invasive species often escape notice for years or decades. Introduced species that initially escaped many decades ago are only now being recognized as invasives. Because these species can occur anywhere (on public or private property), new invasive species often escape notice until they are widespread and eradication is impractical. As a result, early and coordinated action between public and private landholders is critical to preventing widespread damage from an invasive species.

Vulnerability

Because plant and animal life is so abundant in Orange, the entire town is considered to be exposed to the invasive species hazard. Areas with high amounts of plant or animal life may be at higher risk of exposure to invasive species than less vegetated areas; however, invasive species can disrupt ecosystems of all kinds.

Society

The majority of invasive species do not have direct impacts on human well-being; however, as described in the following subsections, there are some health impacts associated with invasive species.

⁶⁰ This section excerpted from the MassWildlife Climate Action Tool:
<http://climateactiontool.org/content/invasive-plants-and-animals>. Accessed March 5, 2019.

Vulnerable Populations

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.

Health Impacts

Of particular concern to human health are species like the Asian tiger mosquito (“ATM”) (*Aedes albopictus*). This invasive mosquito, originally from southeast and subtropical Asia, arrived in Houston in 1985 via a container ship and quickly became established in warm-climate, Southern states. Since then, its range has recently expanded to Massachusetts, mainly due to an increase in minimum winter temperatures which allow its eggs to successfully survive until Spring. Capable of spreading diseases endemic to the Commonwealth, such as West Nile Virus and Eastern Equine Encephalitis (EEE), the ATM is also a known competent vector for tropical flaviviruses, including Zika virus, dengue, yellow fever, and chikungunya. Informal surveillance for the ATM by a nearby city found evidence of its presence and in 2019 it was detected in Brattleboro, VT - even further north than Shelburne. This aggressive mosquito is likely range-limited by cold winter temperatures, suitable landscape conditions (it prefers urban areas and areas with standing water), and variation in moisture. As winter temperatures increase, the species is likely to become more prevalent in Massachusetts and throughout the Northeast, increasing the risk of serious illness for residents in summer months.

Additional invasive species have negative impacts on human health. The Tree of Heaven (*Ailanthus altissima*) produces powerful allelochemicals that prevent the reproduction of other species and can cause allergic reactions in humans. Similarly, due to its voracious consumption, the zebra mussel accumulates aquatic toxins, such as polychlorinated biphenyls or polycyclic aromatic hydrocarbons, in their tissues at a rapid rate. When other organisms consume these mussels, the toxins can accumulate, resulting in potential human health impacts if humans consume these animals.

Loss of urban tree canopy from invasive species and pests can lead to higher summertime temperatures and greater vulnerability to extreme temperatures. Health impacts from extreme heat exposure is discussed in the Extreme Temperature section.

Economic Impacts

Economic impacts include the cost to control invasive species on public and private land.

Individuals who are particularly vulnerable to the economic impacts of this hazard include all groups who depend on existing ecosystems in Orange for their economic success. This includes all individuals working in forestry and agriculture-related fields, as well as those whose livelihoods depend on outdoor recreation activities such as hunting, hiking, or aquatic sports. Businesses catering to visitors who come to a town for outdoor recreation opportunities can also suffer from loss of business. Additionally, homeowners whose properties are adjacent to vegetated areas or waterbodies experiencing decline from an invasive species outbreak could experience decreases in property value.

Infrastructure

The entire town of Orange is 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.

Agriculture

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.

Public Health

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.

Transportation

Water transportation may be subject to increased inspections, cleanings, and costs that result from the threat and spread of invasive species. Species such as zebra mussels can damage aquatic infrastructure and vessels.

Water Infrastructure

Water storage facilities may be impacted by zebra mussels. Invasive species may lead to reduced water quality, which has implications for the drinking water supplies and the cost of

treatment.

Environment

Orange is 77% forested, and is therefore vulnerable to invasive species impacts to forests. Invasive plants can out-compete native vegetation through rapid growth and prolific seed production. Increased amounts of invasive plants can reduce plant diversity by dominating forests. When invasive plants dominate a forest, they can inhibit the regeneration of native trees and plants. This reduced regeneration further reduces the forest's ability to regenerate in a timely and sufficient manner following a disturbance event. In addition, invasive plants have been shown to provide less valuable wildlife habitat and food sources.

As discussed previously, the movement of a number of invasive insects and diseases has increased with global trade. Many of these insects and diseases have been found in New England, including the hemlock woolly adelgid, the Asian long-horned beetle, and beech bark disease. These organisms have no natural predators or controls and are significantly affecting our forests by changing species composition as trees susceptible to these agents are selectively killed.

Invasive species interact with other forest stressors, such as climate change, increasing their negative impact. Examples include:

- A combination of an earlier growing season, more frequent gaps in the forest canopy from wind and ice storms, and carbon dioxide fertilization will likely favor invasive plants over our native trees and forest vegetation.
- Preferential browse of native plants by larger deer populations may favor invasive species and inhibit the ability of a forest to regenerate after wind and ice storms.
- Warming temperatures favor some invasive plants, insects, and diseases, whose populations have historically been kept in check by the cold climate.
- Periods of drought weaken trees and can make them more susceptible to insects and diseases.⁶¹

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

⁶¹ Catanzaro, Paul, Anthony D'Amato, and Emily Silver Huff. *Increasing Forest Resiliency for an Uncertain Future*. University of Massachusetts Amherst, University of Vermont, USDA Forest Service. 2016

- Degradation of wildlife habitat
- Increased threats to public health and safety
- Diminished property values
- Local and complete extinction of rare and endangered species

Vulnerability Summary

Based on the above assessment, Orange has a “High” vulnerability to Invasive species. The following problem statements summarize Greenfield’s areas of greatest concern regarding invasive species.

Invasive Species Hazard Problem Statements
<ul style="list-style-type: none"> • Orange’s forests make up approximately 77% of the town and are vulnerable to extended drought, which could also increase the risk to other hazards including wildfire and pests.
<ul style="list-style-type: none"> • Residents may not be familiar with how to deal with or prevent diseases associated with increasing average temperatures (e.g., tick and mosquito borne diseases).
<ul style="list-style-type: none"> • Agriculture and forestry in Orange rely on biodiverse ecosystems and are experiencing negative impacts due to invasive species. The scope of successfully controlling invasives long-term is often beyond the reach of what farmers and foresters can manage on their own.
<ul style="list-style-type: none"> • Education and outreach is needed to increase local awareness around invasive species and equip residents with appropriate control measure.

3.14 OTHER HAZARDS

In addition to the hazards identified above, the Committee reviewed the full list of hazards listed in the Massachusetts Hazard Mitigation and Climate Adaptation Plan. Due to the location and context of the Town of Orange, coastal erosion, coastal flooding, and tsunamis were determined not to be a threat. Manmade hazards are not addressed in the State plan, but were addressed in the 2014 Orange Hazard Mitigation Plan, and are considered a risk to the Town.

This plan does not address all manmade hazards that could affect Orange. A complete hazards vulnerability analysis was not within the scope of this update. For the purposes of the 2020 plan, the Committee discussed and updated the information from the 2014 Plan, where available, and discussed non-natural hazards that are of an accidental nature, including industrial transportation accidents and industrial accidents in a fixed facility. New to the 2020 plan is are evaluations of vector-borne diseases and cyber-security, which have become threats of greater concern in recent years.

3.14.1 VECTOR-BORNE DISEASES⁶²

Hazard Profile

The Town of Orange chose to include a discussion of the hazards posed by vector-borne disease in their community as part of this Plan update. Vector-borne disease is defined by the Centers for Disease Control (CDC) as illnesses in humans that are caused by contact (being bitten by) a vector such as mosquito, tick, or flea. Examples of mosquito-borne diseases include Chikungunya, Eastern Equine Encephalitis (EEE), Zika and West Nile Virus. Examples of tick-borne disease include Lyme disease, Anaplasmosis/Ehrlichiosis, Babesiosis and Powassan.

In the US in 2016, a total of 96,075 cases of vector-borne diseases were reported, 1,827 of which were reported in Massachusetts. The CDC indicates that cases of vector-borne diseases are substantially underreported. Tick-borne illnesses more than doubled between 2004 and 2016 and accounted for 77% of all vector-borne disease reports in the United States. Lyme disease accounted for 82% of all tick-borne cases, but cases of Spotted fever rickettsioses, Babesiosis and Anaplasmosis/Ehrlichiosis also increased. Between 2004 and 2016, nine vector-borne human diseases were reported for the first time from the United States and its

⁶² This section relies heavily on a template prepared by the Berkshire Regional Planning Commission (BRPC) for towns in their region that are working to update local hazard mitigation plans. Orange requested that this section be added to their 2020 Hazard Mitigation Plan. FRCOG updated available statistics for Massachusetts using information from MA DPH's website and for Franklin County (FRCOG Public Health Nurse and MAVEN).

territories. According to the CDC, vector-borne diseases have been difficult to prevent and control, and a Food and Drug Administration approved vaccine is only available for yellow fever virus. Insecticide resistance is widespread and is increasing.

The impacts of vector-borne diseases can be significant in a community and can affect residents' quality of life and ability to work. Other impacts of these diseases can include an increase in life-long morbidity and an increase in mortality.

Probability of Occurrence

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.

Franklin County provides many and varied outdoor recreation opportunities for both residents and visitors, including hiking, swimming, mountain biking, and camping. Increased exposure to the outdoors, particularly to areas with heavy tree and forest cover, and areas with tall grass or standing water, significantly increase a person's exposure to vector-borne illnesses. Increases in average year-round temperature during the past few decades has also led to the overwintering of ticks in Franklin County and across the Commonwealth. A lengthening warm season has also increased tick and mosquito populations significantly.

Location

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

Extent⁶³

Tick-borne Illness

Massachusetts has seen cases of once non-existent or very rare tick-borne illnesses rise,

⁶³ <https://www.mass.gov/lists/tick-borne-disease-surveillance-summaries-and-data#monthly-tick-report-page-> accessed March 19, 2020.

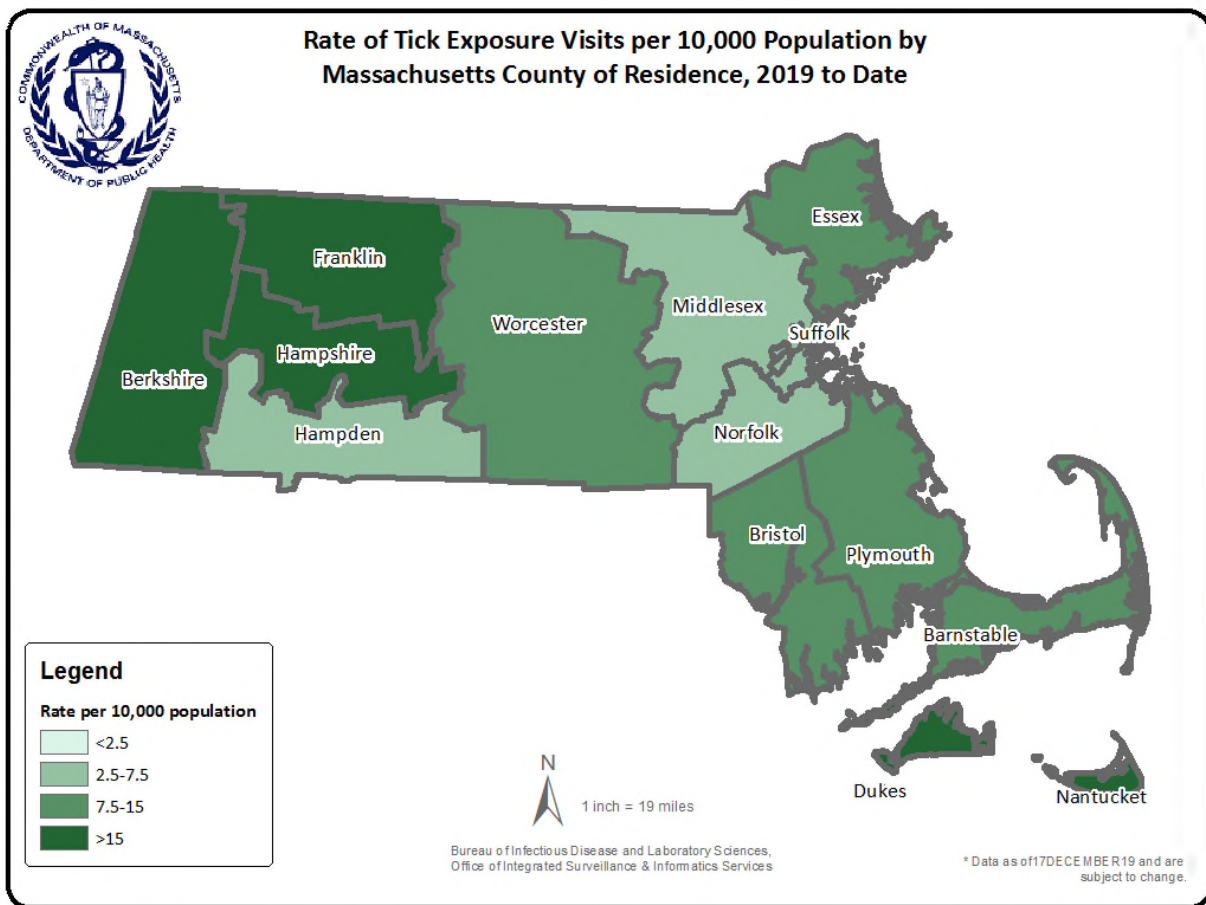


including Anaplasmosis, Babesiosis, Lyme, Powassan, Spotted fever rickettsiosis and Tularemia. Tick activity and tick-borne diseases occur year-round in Massachusetts. Although tick activity is weather dependent, there are two peaks during the year; the first begins in March/April and lasts through August, and the second occurs in October-November. The majority of cases of tick-borne disease occur in June through August.

The map on the following page shows the rate, per 10,000 total population, of ED visits by patients who had a visit related to a tick exposure, by Massachusetts county of residence, 2019 to date. Although there are differences in the rate of patient visits, this shows that people are exposed to ticks throughout all of Massachusetts and should

take recommended steps to reduce the chance of being bitten.⁶⁴

⁶⁴ <https://www.mass.gov/info-details/monthly-tick-report-november-2019> accessed March 19, 2020.



The following information was downloaded from the website of the Massachusetts Department of Public Health.⁶⁵

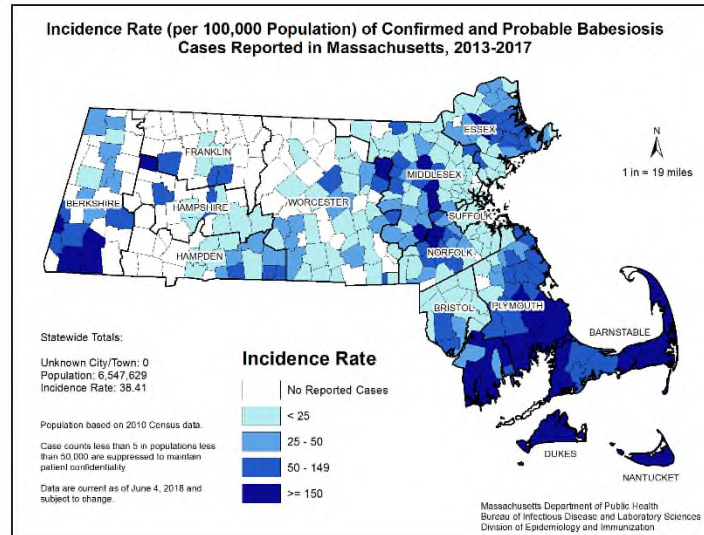
Babesiosis:

- ✱ 590 confirmed and probable cases of Babesiosis were reported in Massachusetts in 2017, a 13% increase from 2016. Overall, 1,677 suspect cases of Babesiosis were investigated.
- ✱ **2 confirmed cases in Franklin County.**
- ✱ Statewide, Babesiosis incidence increased from 7.9 to 9.0 cases per 100,000 residents. The incidence in Berkshire, Dukes, Hampden, Hampshire, Norfolk, Plymouth, Suffolk,

⁶⁵ <https://www.mass.gov/lists/tick-borne-disease-surveillance-summaries-and-data#lyme-disease-surveillance-data> accessed March 19, 2020.

and Worcester counties increased slightly. Counties with the highest incidence continued to be Barnstable, Dukes, and Nantucket.

- ✱ The majority of cases occurred in June, July and August, with only 35% of cases reporting awareness of a recent tick bite.
- ✱ People aged 60 years and older continue to be at greatest risk for clinical disease (59% of all patients identified with Babesiosis were 60 years or older) and 66% of all cases were male.
- ✱ 1,209 confirmed and probable cases of HGA were reported in Massachusetts in 2017, a 38% increase over 2016. Overall 2,473 suspect cases of HGA were investigated.



Human Granulocytic Anaplasmosis (HGA)

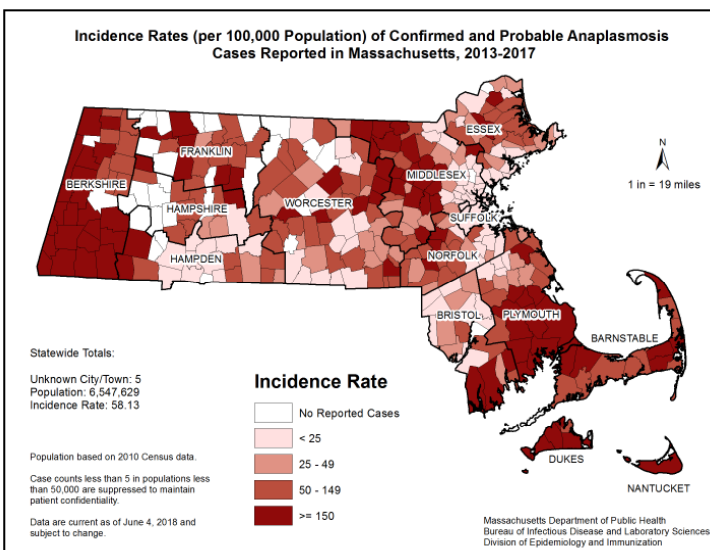
- ✱ Statewide, HGA incidence increased from 13.3 to 18.4 cases per 100,000 residents. The counties with the highest incidence are Barnstable, Berkshire, Dukes, **Franklin**, Nantucket and Plymouth. Berkshire County had the greatest change in incidence, from 66.3 to 133.4 cases per 100,000 residents.
- ✱ **27 confirmed cases in Franklin County.**
- ✱ The majority of cases occurred in May, June, and July, with only 45% of cases reporting awareness of a recent tick bite.
- ✱ People aged 60 years and over continue to be at greatest risk for clinical disease (56% of patients identified with HGA were 60 or over) and 64% of all cases were male.
- ✱ Nearly one out of three patients with HGA (29%) was hospitalized. The symptoms most commonly reported included fever (93%), malaise (72%), and muscle aches and pain (63%). There were three fatalities.

Lyme disease:

- ✱ 3,830 confirmed Lyme disease cases, and 1,770 probable cases, were reported in Massachusetts in 2014, which is a decrease of 1% from the number of confirmed and probable cases reported in 2013
- ✱ **50 confirmed cases in Franklin County in 2014.**
- ✱ The highest incidence rates were among children aged 5-9 years and adults aged 65-74 years.
- ✱ The majority of cases had onsets in June, July, and August.
- ✱ 66% of confirmed cases had a reported erythema migrans (“bulls-eye”) rash.

The Franklin Regional Council of Governments’ Cooperative Public Health Services (CPHS) Public Health Nurse supplied the following information for reported cases of vector-borne illnesses in 2019:^{66 67}

- ✱ Lyme 92 suspect in 2019



- In 2018, 76 suspect Lyme
- In 2017, 86 suspect Lyme

- ✱ Babesiosis 1 (5 were reported but 4 were revoked-determined not to be Babesiosis)

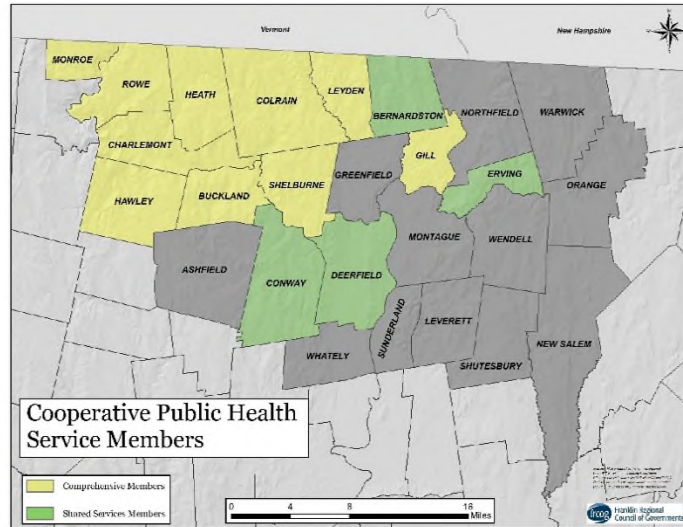
- ✱ HGA Human Granulocytic Anaplasmosis (37 total reported, 11 confirmed, 14 suspect, 1 probable and 10 revoked)

- ✱ Erlichiosis 1 (6 reported: 1 probable, 5 revoked)

⁶⁶ Note: It is never clear if these trends actually represent an increase in infection/illness as small sample, underreporting is assumed, reporting of cases determined by clinical judgement. Virtually all of the reports that reach MAVEN are due to a laboratory result.

⁶⁷ Orange is not a member of the CPHS. The data from other Towns in Franklin County are meant to demonstrate case rates in a nearby area.

- ✱ No other tick-borne illnesses reported in 2019.



Mosquito-borne Illnesses⁶⁸

West Nile Virus (WNV) and Eastern Equine Encephalitis (EEE or “Triple E”) are viruses that occur in Massachusetts and can cause illness ranging from a mild fever to more serious disease like encephalitis or meningitis. There are other diseases spread by mosquitoes that people may be exposed to when traveling in other regions of the world. These include Zika virus, Dengue fever, and Chikungunya.

Eastern equine encephalitis (EEE) is a rare but serious disease caused by a virus that can affect people of all ages. EEE is generally spread to humans through the bite of a mosquito infected with the virus. EEE can cause severe illness and possibly lead to death in any age group; however, people under age 15 are at particular risk.⁶⁹

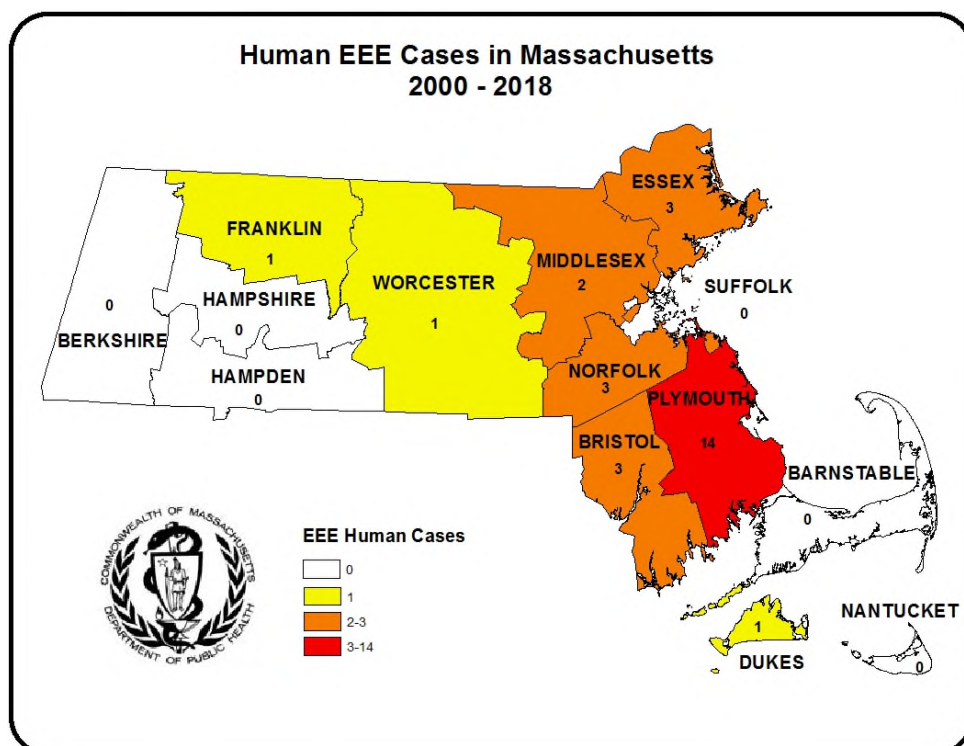
EEE has a 30-50% mortality and lifelong neurological disability among many survivors. The first symptoms of EEE are fever (often 103° to 106°F), stiff neck, headache, and lack of energy. These symptoms show up three to ten days after a bite from an infected mosquito. Inflammation and swelling of the brain, called encephalitis, is the most dangerous and frequent serious complication. The disease rapidly worsens and some patients may go into a coma within a

⁶⁸ <https://www.mass.gov/mosquito-borne-diseases> accessed March 20, 2020.

⁶⁹ <https://www.mass.gov/guides/eee-in-massachusetts> accessed March 20, 2020

week. There is no treatment for EEE. In Massachusetts, approximately half of the people identified with EEE have died from the infection. People who survive this disease will often be permanently disabled due to neurologic damage. Few people recover completely.

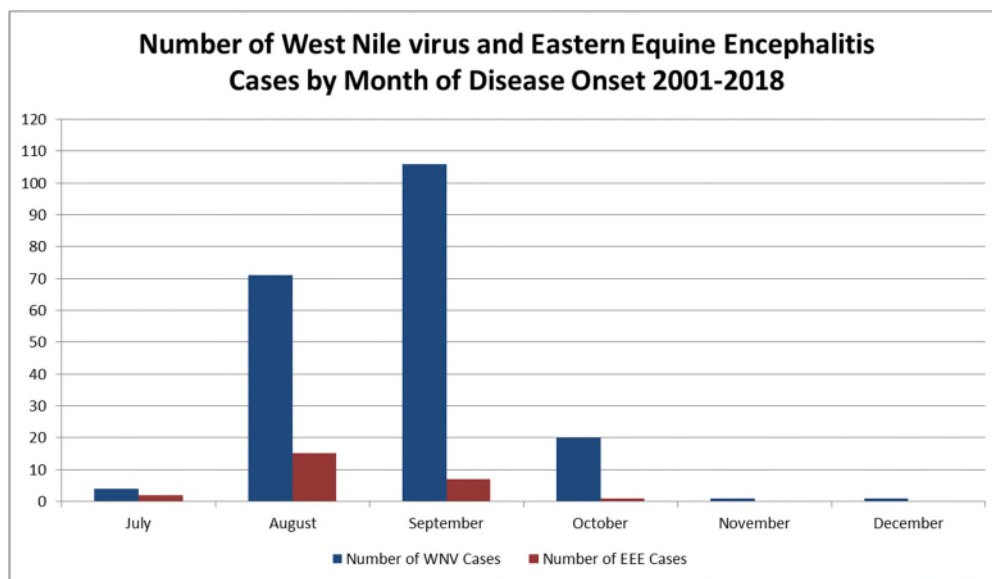
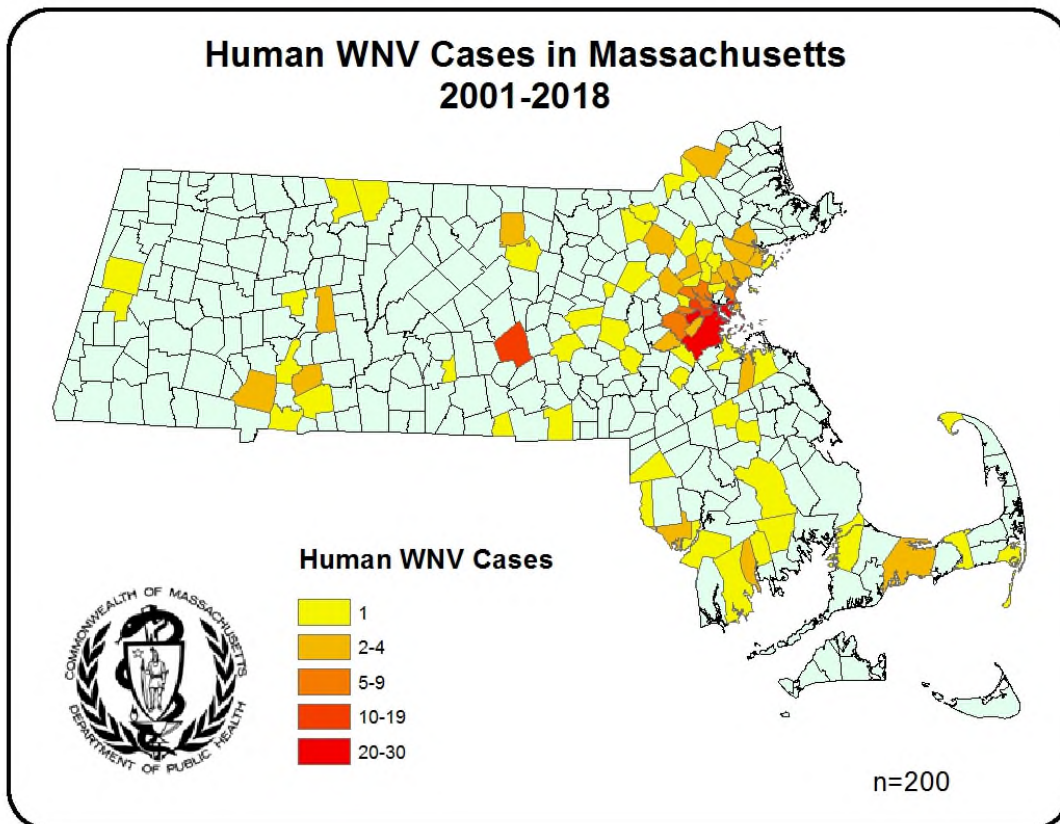
Historically, clusters of human cases have occurred over a period of two to three years, with a variable number of years between clusters. In the years between these case clusters or outbreaks, isolated cases can and do occur. Outbreaks of human EEE disease in Massachusetts occurred in 1938-39, 1955-56, 1972-74, 1982-84, 1990-92, and, 2004-06. Two cases of EEE occurred in each of 2010 and 2011; one case each of these years occurred in visitors to



Massachusetts. Seven human cases of EEE occurred in 2012, a single case in 2013 and no cases from 2014 - 2018.

The narrative above and the following figures are from the MA Department of Public Health's 2019 Arbovirus Surveillance and Response Plan.⁷⁰

⁷⁰ <https://www.mass.gov/lists/arbovirus-surveillance-plan-and-historical-data> accessed March 20, 2020. Narrative copied from p. 1 of the report. Figures from pp. 24-26.



West Nile virus (WNV) first appeared in the United States in 1999. Since the initial outbreak in New York City, the virus has spread across the US from east to west. Following the identification of WNV in birds and mosquitoes in Massachusetts during the summer of 2000, MDPH arranged

meetings between local, state, and federal officials, academicians, environmentalists and the public to develop recommendations to adapt the arbovirus surveillance and response plan to include activities appropriate for WNV. Four workgroups addressed the issues of surveillance, risk reduction interventions, pesticide toxicity, and communication.

WNV infection may be asymptomatic in some people, but it leads to morbidity and mortality in others. WNV causes sporadic disease of humans, and occasionally significant outbreaks. Nationally, 2,554 human cases of WNV neuroinvasive disease (meningitis and encephalitis) and WNV fever were reported to the CDC in 2018. The majority of people who are infected with WNV (approximately 80%) will have no symptoms. A smaller proportion of people who become infected (~ 20%) will have symptoms such as fever, headache, body aches, nausea, vomiting, and sometimes swollen lymph glands. They may also develop a skin rash on the chest, stomach, and back. Less than 1% of people infected with WNV will develop severe illness, such as encephalitis or meningitis. The symptoms of severe illness can include high fever, headache, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, vision loss, numbness, and paralysis. Persons older than 50 years of age have a higher risk of developing severe illness. In Massachusetts, there were at least 12 fatal WNV human cases identified between 2002 and 2018. All but three of these fatalities were in individuals 80 years of age or older; all of them were in individuals over 60.⁷¹

The number of EEE and WNV cases in Massachusetts in 2019 is shown below.⁷²

2019 Arbovirus results summary			
	Mosquito samples positive	Animals positive	Humans positive
WNV	87	0	3
EEE	428	9	12
LAST UPDATED: November 14, 2019			

Vulnerability Assessment

Society

Vector-borne illness has a significant impact on humans and on a community. These illnesses

⁷¹ <https://www.mass.gov/lists/arbovirus-surveillance-plan-and-historical-data> accessed March 20, 2020. pp.3-4.

⁷² <https://www.mass.gov/info-details/massachusetts-arbovirus-update> accessed March 20, 2020.

can significantly impact the health, long-term morbidity and mortality, and quality of life of Town residents and can reduce a person's ability to work or contribute to the community in other ways. In addition, pesticides and herbicides used to control vector populations can also negatively impact human health.

Infrastructure

Vector-borne illnesses pose little threat to infrastructure and the built environment. Overtime, changes in development patterns may occur as people respond to the increase in disease carrying insects.

Natural Environment

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

Economy

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

Future Conditions

Continued changes to the climate, extreme precipitation events, issues with the control of stormwater, changes to animal and vector populations, and increases in insecticide resistance will lead to an ongoing and growing threat to individuals, governments and businesses. Local governments will need to invest in methods to reduce or prevent exposure to vector-borne diseases and should strongly consider methods that do not include the increased use of insecticides and herbicides. This may include methods such as promoting populations of bats,

opossums and other animals that consume vectors of concern, increasing opportunities for residents to get ticks tested, reducing the cost and burden of tick testing and increasing the level of education and outreach to the public and health care practitioners about current and new vector-borne illnesses so treatment can be expedited. Towns should implement educational programs for residents and visitors for bite-prevention and detection.

Vector-borne Disease Problem Statements
<ul style="list-style-type: none"> • Climate change will increase the number of disease carrying vectors (ticks and mosquitoes) and increase demands on our public health system for symptom management and care for infected people. • More and consistent outreach and education is needed to increase prevention and diagnosis of vector-borne diseases. The Massachusetts DPH website contains many good education and outreach materials as does the Franklin Regional Council of Governments' Cooperative Public Health Service program. • Participating in mosquito control districts will reduce hazards and protect public health. Deerfield is a member of the newly formed Pioneer Valley Mosquito Control District. • Vector-borne disease can have a significant negative impact on public health and the local and regional outdoor recreation economy. • Vector management strategies should strive to be protective of public health and, when feasible, use effective alternatives that are cost-effective and have minimum impacts on the natural environment.

3.14.2 MANMADE HAZARDS

Hazard Description

Most non-natural or manmade hazards fall into two general categories: intentional acts and accidental events, although these categories can overlap. Some of the hazards included in these two categories, as defined by MEMA, consist of intentional acts such as explosive devices, biological and radiological agents, arson and cyberterrorism and accidental events such as nuclear hazards, invasive species, infrastructure failure, industrial and transportation accidents. Accidental events can arise from human activities such as the manufacture, transportation, storage, and use of hazardous materials.

Hazardous materials in various forms can cause death, serious injury, long-lasting health effects, and damage to buildings, homes, and other property. Many products are shipped daily on the nation's highways, railroads, waterways, and pipelines. Chemical manufacturers are one source of hazardous materials, but there are many others, including service stations, hospitals,

and hazardous materials waste sites. Hazardous materials come in the form of explosives, flammable and combustible substances, poisons, and radioactive materials. These substances are most often released as a result of transportation accidents or because of chemical accidents in plants.

Location and Extent

A release may occur at a fixed facility or in transit. Communities with a large industrial base, may be more inclined to experience a hazardous materials release due to the number of facilities using such materials in their manufacturing process. Communities with several major roadways may be at a greater risk due to the number and frequency of trucks transporting hazardous materials passing through, with similar risks associated with the location of railways in a town.

Industrial Accidents - Transportation

Franklin County transportation systems include road, rail, and air. Accessible and efficient freight transportation plays a vital function in the economy of the region. Most freight and goods being transported to and from Franklin County are by truck; however, a significant amount of freight that moves through the county is being hauled over the three main rail lines. Given that any freight shipped via air needs first to be trucked to an airport outside the region, air transportation is not being evaluated in this plan.

According to the Franklin County Hazardous Material Emergency Plan,⁷³ 12 or more trucks per hour travel through the region containing hazardous materials (Table 3-41). While most of these vehicles are on Interstate 91, approximately 2 trucks per hour travel on Route 2, which is a main road in Orange, and 1 truck per hour on Route 63. Ten to twenty-four (10-24) trains per day travel on the Pan Am Systems Main Freight line (east-west) and 2 trains per day travel on the New England Central line (north-south). On each of these trains, an average of 4 to 5 cars carries hazardous waste. Rail accidents can be caused by flooding that washes out track beds, like what happened in Wendell in 2018; faulty or sabotaged track; collision with another train, vehicle or other object on the track; mechanical failure of the train; or driver error. Depending on the freight, an accident could cause residents to evacuate the area.

The hazardous materials listed above, tank or van trucks traveling on Routes 2 and 63 could also be carrying the following:

- Pesticides

⁷³ Franklin County Regional Emergency Planning Committee, Franklin County Hazardous Material Emergency Plan and Maps, 2015.

- Agricultural fertilizers
- Liquid Asphalt
- Sludge
- Methane

In October 2019, a cargo truck carrying compressed methane gas rolled off of Route 2. The impact of the crash killed the driver and caused the contents of the truck to leak, triggering a Tier 2 response. Residents in the surrounding area were evacuated and a portion of Route 2 was closed.⁷⁴ Participants during the MVP workshop discussed this event and expressed concern that similar events will continue to occur, especially as hazardous materials are more frequently transported on Route 2.



Emergency responders survey the truck that rolled off of Route 2 in Orange. Photo courtesy of the Massachusetts State Police.

The hazardous chemicals carried by rail through the county in 2013 were:

- | | |
|-----------------------|-------------------------------|
| • Petroleum crude | • Phenol molten |
| • Liquefied petroleum | • Hydrochloric acid |
| • Petroleum gases | • Acetone |
| • Sodium chlorate | • Methanol |
| • Sodium hydroxide | • Air bag inflation chemicals |
| • Carbon dioxide | • Methyl methacrylate |

⁷⁴ <https://whdh.com/news/route-2-closed-in-orange-after-deadly-crash-involving-methane-tanker-truck/>

- Alkylphenols
- Batteries, wet
- Adhesives
- Caustic alkali
- Helium, compressed
- Fire extinguisher chemicals
- Sulfuric acid
- Paint
- Gasoline
- Toluene
- Hydrogen peroxide

The trains themselves pose a potential hazard since 3 or 4 engines are used per train and each engine has a 2,000 gallon fuel tank. The hazardous materials regularly carried on these trains passing through Orange include:

- Gasoline
- Fuel oil
- Kerosene
- Liquefied petroleum gas (LPG)
- Propane
- Sodium aluminate
- Sulfuric acid
- NOS liquids 3082

Table 3-43: Estimated Level of Hazardous Material Transport on Area Train Lines			
Train Line	Trains per Day (General Merchandise)	Average Number of Cars per Train	Average Number of Cars per Train with Hazardous Materials
Main Freight Line, Pan Am Systems*	10 to 24	50	4
Connecticut River Line, Pan Am Systems	2 to 3	30	2
East Deerfield Rail Yard, Pan Am Systems	10 to 15 trains passing through yard	n/a	2 to 5
New England Central	2	60	5

* Passes through Orange

The major trucking corridors in Franklin County are Interstate 91, running north/south, and Route 2, running east/west. These two highways also represent the busiest travel corridors in the region for non-commercial traffic. Safe and efficient transportation routes for trucks to and through the region are important to the region's economy to and to the safety of its citizens.

The safer the transportation routes are, the less likely a transportation accident will occur.

Route 2 East Safety Improvements

The Route 2 Task Force, formed in 1994, worked with MassDOT and a transportation consultant to identify safety improvements that could be constructed within the existing right-of-way on Route 2 between Greenfield and Phillipston. Improvements were identified for Athol/Phillipston, Orange, Erving Paper Mill Corner, Erving Center, Farley, Erving side and Gill/Greenfield. Since 1996, approximately \$168 million of safety improvements have been successfully implemented.

Industrial Accidents - Fixed Facilities

An accidental hazardous material release can occur wherever hazardous materials are manufactured, stored, transported, or used. Such releases can affect nearby populations and contaminate critical or sensitive environmental areas. Those facilities using, manufacturing, or storing toxic chemicals are required to report their locations and the quantities of the chemicals stored on-site to state and local governments. FRCOG's Emergency Preparedness Program generated a list of the Tier II Facilities in Orange and they are presented in Table 3-45. Facilities covered by the reporting requirements of the Federal Emergency Planning and Community Right-to-Know Act (EPCRA) must submit annual Tier II reports to their Emergency Planning Committee (EPC), and Local Fire Department, and the State Emergency Response Commission (SERC).

Table 3-44: Tier II Facilities in Orange	
Facility	Street Address
ECHO Industries, Inc.	61 R W Moore Avenue
Orange Water Department Well #2	465 West River Street
Orange Water Department Well #3	251 Daniel Shay Highway
PHA Industries	153 Quabbin Road
Suburban Heating Oil Partners – Orange Plant	6 Rogers Avenue
Verizon Orange Co (VZ – MA874506)	76 South Main Street
Walmart #2329	555 East Main Street

Source: FRCOG Emergency Preparedness Program, List prepared September 2019

Also worth consideration is that many farmers store agricultural chemicals on their properties. Given that much farmland is located in or near floodplains and their adjacent water bodies, the potential for an accidental hazardous materials spill to impact water quality is present. This

plan does not include an in-depth evaluation of hazardous materials as they relate to farming. In many cases, farmers do use and store pesticides, herbicides and fertilizers on their property. And in most cases, farmers are utilizing best management practices in the use and storage of agricultural chemicals and have undergone any required training and licensing if they are applying these chemicals to the land. Despite training and best management practices, an accidental release of hazardous materials can occur and potentially threaten human health and the environment. One approach that the Town could take to help prepare for a hazardous materials spill on a farm, possibly through coordination with the Agricultural Commission, would be to become familiar with the types and quantities of chemicals stored on-site at the larger farms within the Town.

Another potential source of contamination from hazardous materials stored and use on-site could be the many local public and private schools that maintain sports fields, often with the use of pesticides and herbicides. These sites and the chemicals that are stored there should be documented as well. These actions would assist first responders in being adequately prepared to protect human health and prevent contamination of the environment in the event of a major spill or other accidental release of hazardous materials.

Cyber Threats

A failure of networked computer systems could result in the interruption or disruption of Town services (including public safety and other critical services), the disruption or interruption of the functioning of Town departments, and the potential for loss or theft of important data (including financial information of the Town and residents).

There are many possible causes of a network failure, but most either happen because of damage to the physical network/computer system infrastructure or damage to the network in cyberspace. Physical damages are incidents that damage physical telecommunications infrastructure or server/computer hardware. Examples are a water main break above a server room, fire/lighting strike that destroys equipment, construction accident damaging buried fiber line, or power outage and other issues effecting the Internet Service Provider (ISP) that interrupts access to the internet to the Town.

Damage to the cyber infrastructure can be malicious attacks or critical software errors that affect computer systems, from individual computers to the entire network. These virtual hazards can cause lack of access to the network, permanent data loss, permanent damage to computer hardware, and impact the ability to access programs or systems on the network. When incidents are malicious attacks, they can impact:

- Confidentiality: protecting a user's private information.
- Integrity: ensuring that data is protected and cannot be altered by unauthorized parties.
- Availability: keeping services running and giving administration access to key networks and controls.
- Damage: irreversible damage to the computer or network operating system or "bricking" and physical, real world damages, caused by tampering with networked safety systems.
- Confidence: confidence of stakeholders in the organization who was victim of the attack.

Motives for cyber-attacks can vary tremendously, ranging from the pursuit of financial gain—the primary motivation for what is commonly referred to as “cyber-crimes” is for profit, retribution, or vandalism. Other motivations include political or social aims. Hacktivism is the act of hacking, or breaking into a computer system, for a political or social purpose. Cyber espionage is the act of obtaining secrets without permission of the holder of the information, using methods on the Internet, networks, or individual computers.⁷⁵ These threats are not only external; many acts of cyber-crime happened from current or former employees who were given network access legitimately.

For Orange, the most likely cyber-threat affecting the Town and Town departments comes from malware and social engineering. These crimes prey on the vulnerable and unprepared and every individual and organization that connects a device to the internet is a potential mark.

Social Engineering:

Social engineering involves obtaining confidential information from individuals through deceptive means by mail, email, over the phone, and increasingly through text messages.⁷⁶ These techniques are referred to as ‘Phishing’.

Malware

Malware, or malicious software, is any program or file that is harmful to a computer user. Types of malware can include computer viruses, worms, Trojan horses, and spyware. These malicious programs can perform a variety of different functions such as stealing, encrypting or deleting sensitive data, altering or hijacking core computing functions and monitoring users' computer activity without their permission. The most common way for malware to infect a Town's network is through an employee opening an infected email attachment.

⁷⁵ NYC Hazard Mitigation, Cyber Threats, <https://nychazardmitigation.com/hazard-specific/cyber-threats/what-is-the-hazard/>

⁷⁶ Cybersecurity Precautions, MA Executive Office of Technology Services & Security, 2017

Previous Occurrences

Over the past few years a type of malware called ransomware has been targeted at local governments. Cyber-criminals will use social-engineering to infect a network, take control and block user access to that network, then request a ransom from the organization. Once the ransomware is on the network, it can be extremely expensive and time consuming to restore that network without paying the ransom. When the cost of the ransom is less than the cost of resorting the system, is when the cyber-criminals succeed.

In July 2019, school districts all across the United States were targeted by ransomware. Since 2013, there have been some 170 attacks against state and local governments and there is no sign that this trend is slowing. Unlike other hazards, cyber-threats are global. Cyber-criminals don't care where you are or how small your town is. Many cyber-crimes are not just lone criminals, they are more often than not committed by sophisticated criminal organizations and foreign governments who work around the clock looking to exploit small towns and big businesses alike.

The best way to prevent a cyber-attack is to follow best practices in cyber-security. Following these best practices will greatly mitigate the likelihood a cyber-attack is successful. MA Executive Office of Technology Services and Security (EOTSS)⁷⁷ is the chief MA State program that can assist local governments with cyber-security. There are educational opportunities available throughout the region that aim to assist municipalities learn and implement these best practices.

Manmade Hazard Problem Statements
<ul style="list-style-type: none">• The parking lot pavement at the Orange Airport (a designated Point of Distribution by MEMA and FEMA) is in poor condition. The deteriorating pavement makes it difficult to plow the lot without digging up pavement and creating holes. As an emergency POD site, the parking lot needs to be plowed and maintained so that it is in a serviceable condition at all times.• Orange is vulnerable to a spill of hazardous materials and/or hazardous waste at one of several facilities in town that use and store hazardous materials.• Hazardous materials, such as ethanol and compressed natural gas are frequently transported through Orange on Route 2.• Cyber-attacks on local government is a growing threat. Keeping up with current best practices in cyber security can be challenging for communities.

⁷⁷ <https://www.mass.gov/cybersecurity>

- Several farms in Orange store hazardous materials on site. Emergency responders and Town Officials may not have up to date information about the different types of materials stored throughout Town and where they are located.

4 MITIGATION CAPABILITIES & STRATEGIES

4.1 NATURE-BASED SOLUTIONS FOR HAZARD MITIGATION & CLIMATE RESILIENCY

Nature-Based Solutions are actions that work with and enhance nature to help people adapt to socio-environmental challenges. They may include the conservation and restoration of natural systems, such as wetlands, forests, floodplains and rivers, to improve resiliency. NBS can be used across a watershed, a town, or on a particular site. NBS use natural systems, mimic natural processes, or work in tandem with engineering to address natural hazards like flooding, erosion and drought.

The 2018 Massachusetts Hazard Mitigation and Climate Adaptation Plan and the MVP program both place great emphasis on NBS, and multiple state and federal agencies fund projects that utilize NBS. For this plan, Low Impact Development (LID) and Green Infrastructure (GI) are included under the blanket term of NBS. Following are examples of how NBS can mitigate natural hazards and climate stressors, and protect natural resources and residents:

- Restoring and reconnecting streams to floodplains stores flood water, slows it down and reduces infrastructure damage downstream
- Designing culverts and bridges to accommodate fish and wildlife passage also makes those structures more resilient to flooding, allowing for larger volumes of water and debris to safely pass through
- Managing stormwater with small-scale infiltration techniques like rain gardens and vegetated swales recharges drinking water supplies, reduces stormwater runoff, and reduces mosquito habitat and incidents of vector-borne illness by eliminating standing pools of water following heavy rain events
- Planting trees in developed areas absorbs carbon dioxide, slows and infiltrates stormwater, and provides shade, reducing summertime heat, lowering energy costs for village residents and improving air quality by reducing smog and particulate matter
- Vegetated riparian buffers absorb and filter pollutants before they reach water sources, and reduce erosion and water velocity during high flow events

This update of the Orange Hazard Mitigation Plan incorporates Nature-Based Solutions into mitigation strategies where feasible.

4.2 EXISTING AUTHORITIES POLICIES, PROGRAMS, & RESOURCES

One of the steps of this Hazard Mitigation Plan update process is to evaluate all of the Town's existing policies and practices related to natural hazards and identify potential gaps in protection.

Orange has most of the no cost or low cost hazard mitigation capabilities in place. Land use zoning, subdivision regulations and an array of specific policies and regulations that include hazard mitigation best practices, such as limitations on development in floodplains, stormwater management, tree maintenance, etc. Orange has appropriate staff dedicated to hazard mitigation-related work for a community its size, including a Town Administrator, Emergency Management Director, a professionally run Highway Department, and a Tree Warden. Orange is a member of the Franklin County Inspection Service, which provides Building, Plumbing, and Electrical permitting and inspections in town. In addition to Town staff, Orange has an experienced Planning Board which reviews all proposed developments and assures that buildings are built to the current zoning requirements.

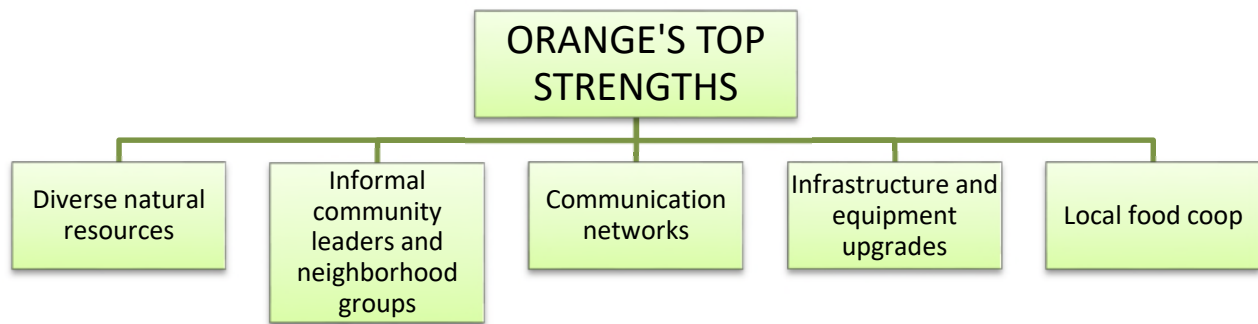
Orange has some recommended plans in place, including a Master Plan and a recently updated Open Space and Recreation Plan. The Master Plan needs to be updated and should be supplemented by a Capitol Improvements Plan. The Town also has very committed and dedicated volunteers who serve on Boards and Committees and in Volunteer positions. The Town collaborates closely with surrounding communities and is party to Mutual Aid agreements through MEMA. Orange is also a member community of the Franklin Regional Council of Governments, and participates in the Franklin County Regional Emergency Planning Committee (REPC).

Orange's Top Strengths and Assets

All Hazards

Participants at the 2019 MVP Community Resilience Building workshop expressed pride that people who have lived in Orange for a long time are accustomed to weathering storms, "sheltering in place," and helping out neighbors. Many families in town know each other and know the first responders and Town staff who help run the Town. Participants cited several strengths and assets that help keep their community resilient in the face of climate change and other challenges. They include:

Figure 4-1: Oranges' Top Strengths From MVP



Diverse Natural Resources: Workshop participants noted that there are many protected open spaces throughout the town. The ownership of the land parcels is mixed: spaces are either publicly or privately owned, and some are owned by non-profits. Depending on the type of ownership and the number of restrictions placed on the open spaces, there may be room for the Town to move forward with climate resiliency projects that could help to mitigate the effects of future severe weather events.

Societal strengths and assets: These include Orange's informal community leaders, neighborhood groups and communication networks. Participants said that there are a number of well-connected informal leaders in the community who could serve to help vulnerable populations in the event of an emergency. For example, a local interfaith group would like to work with Town Officials to gain designation as an official shelter in order to alleviate some of the strains on the town to staff and supply shelters. Additionally, residents in the North Orange and Tully neighborhoods are working to develop a small neighborhood network with individual leaders. The proposed network would serve as an information resource during emergencies; leaders would help residents in need of assistance evacuate their homes, organize temporary cooling or warming shelters in homes with power or woodstoves, and direct residents to official shelters made available by the Town of Orange.

Although there are some concerns about isolated residents who may be not be reachable during storms, emergency responders reported that close to 4,000 residents are registered for Code Red. This service is functional even when there is a power outage, and responders believe the large number of contacts mean they are able to reach the majority of households in Orange.

Infrastructure and assets: Workshop participants expressed that failing DPW equipment had recently been replaced, which has improved the Town's ability to respond to natural hazards. Town officials noted that there was still a fair amount of equipment that needs to be upgraded,

but the newest improvements were a good start. Utility poles throughout the town were also recently raised and many tree hazards were eliminated so they could better withstand severe weather events.

The Orange Municipal Airport on East River Street was also noted as a strength by participants, as it could serve as a large staging area in the event of an emergency. The airfield is located in a relatively central location, which allows the area to be easily accessible.

Local food coop: The Quabbin Harvest Food Coop was identified as an asset to Orange. The coop is closely connected to local and regional farmers, which allows residents to purchase fresh local food. Participants discussed that they are working to get more residents signed up for HIP and SNAP benefits, which would help to provide greater food resiliency. Quabbin Harvest also has a backup generator and is located in downtown Orange where power typically comes back quickly after an outage.

Overview of Mitigation Strategies by Hazard

An overview of the general concepts underlying mitigation strategies for each of the hazards identified in this plan is as follows:

Flooding

The key factors in flooding are the water capacity of water bodies and waterways, the regulation of waterways by flood control structures, and the preservation of flood storage areas (like floodplains) and wetlands. As more land is developed, more flood storage is demanded of the town's water bodies and waterways. FEMA has identified no flood control structures within the Town of Orange. Floods on the Connecticut River and portions of its major tributaries that are prone to backwater effects are controlled by nine flood control reservoirs located upstream in Massachusetts, New Hampshire, and Vermont.

The Town of Orange has adopted several land use regulations that serve to limit or regulate development in floodplains, to manage stormwater runoff, and to protect groundwater and wetland resources, the latter of which often provide important flood storage capacity. These regulations are summarized in Table 4-1.

Infrastructure like dams and culverts are also in place to manage the flow of water. However, some of this infrastructure is aging and in need of replacement, or is undersized and incapable of handling heavier flows our region is experiencing due to climate change. The Town has requested assistance from FRCOG to evaluate culverts at road-stream crossings to prioritize

upgrades.

Severe Snowstorms / Ice Storms

Winter storms can be especially challenging for emergency management personnel even though the duration and amount of expected amount of snowfall usually is forecasted. The Massachusetts Emergency Management Agency (MEMA) serves as the primary coordinating entity in the statewide management of all types of winter storms and monitors the National Weather Service (NWS) alerting systems during periods when winter storms are expected.

To the extent that some of the damages from a winter storm can be caused by flooding, flood protection mitigation measures also assist with severe snowstorms and ice storms. The Town has adopted the State Building Code, which ensures minimum snow load requirements for roofs on new buildings. There are no restrictions on development that are directly related to severe winter storms, however, there are some Subdivision Rules and Regulations that could pertain to severe winter storms, summarized in Table 4-1.

Severe snowstorms or ice storms can often result in a small or widespread loss of electrical service. Severe snowstorms or ice storms can often result in a small or widespread loss of electrical service. The Orange Water Department's primary public water supply wells are equipped with a propane-fired engine (Well #3) and a propane-fired generator (Wells #2/2A) as standby power sources. The engine at Well #3 will allow the well to pump at approximately half-capacity during an outage, but is anticipated to be replaced with a generator in the coming years to improve capacity and allow power to flow to other pump house equipment. The Town's Water Superintendent is actively applying for grants that will support the purchase of a generator.

The Orange Wastewater Treatment Facility has a backup generator with the capacity to pump wastewater into the treatment plant and to run the influent pumps, chlorination equipment (for disinfection), lighting, some of the electrical outlets, HVAC systems and air handling (ventilation) systems in the event of primary power failure. However, the generator would not be able to run all components of the treatment plant. Therefore, in an extended power outage, the Orange Wastewater Treatment Facility would likely exceed their National Pollution Discharge Elimination System (NPDES) permit by discharging untreated wastewater to the Millers River. The Wastewater Treatment Facility is currently underway with being upgraded, which will include the acquisition of a generator that can run the entire facility in the event of a power outage.

Hurricanes and Tropical Storms

Hurricanes provide the most lead warning time of all identified hazards, because of the relative ease in predicting the storm's track and potential landfall. MEMA assumes "standby status" when a hurricane's location is 35 degrees North Latitude (Cape Hatteras) and "alert status" when the storm reaches 40 degrees North Latitude (Long Island). Even with significant warning, hurricanes cause significant damage – both due to flooding and severe wind.

The flooding associated with hurricanes can be a major source of damage to buildings, infrastructure and a potential threat to human lives. Flood protection measures can thus also be considered hurricane mitigation measures. The high winds that often accompany hurricanes can also damage buildings and infrastructure, similar to tornadoes and other strong wind events. For new or recently built structures, the primary protection against wind-related damage is construction according to the State Building Code, which addresses designing buildings to withstand high winds. The Town of Orange is a member of the Franklin County Cooperative Building Inspection Program, which provides building inspection services.

Severe Thunderstorms / Winds / Microbursts and Tornadoes

Most damage from tornadoes and severe thunderstorms come from high winds that can fell trees and electrical wires, generate hurtling debris and, possibly, hail. According to the Institute for Business and Home Safety, the wind speeds in most tornadoes are at or below design speeds that are used in current building codes, making strict adherence to building codes a primary mitigation strategy. In addition, current land development regulations, such as restrictions on the height and setbacks of telecommunications towers, can also help prevent wind damages.

Wildfires / Brushfires

Seventy-seven percent of Orange is forested; a large portion of the Town is therefore at risk of fire. Wildfire and brushfire mitigation strategies involve educating people about how to prevent fires from starting, controlling burns within the town, as well as managing forests for fire prevention.

The Orange Fire Department has an ongoing educational program in the schools to teach fire safety. Students also visit the fire station for educational programming. Pamphlets and videos are available to residents and officials are available to assist with family evacuation planning. The Orange Fire Chief personally oversees the dispensation of burn permits for the Town. Each permit is issued on a case-by-case situation according to several factors including where the property is located and any past problems with burning on that property. The Fire Chief monitors permitted properties on a daily basis. Specific burn permit guidelines are established by the state, such as the burning season and the time when a burn may begin on a given day.

The issued burn permits are valid for one year, and the permit holder must contact the Fire Department on the day they wish to burn.

There are currently no restrictions on development based on the need to mitigate wildfires. However, the Orange Fire Department reviews subdivision plans to ensure that their trucks will have adequate access and that the water supply is adequate for firefighting purposes. Cul-de-sac streets are required to have a turnaround sufficient to accommodate the Town's largest fire truck.

Earthquakes

Although there are five mapped seismological faults in Massachusetts, there is no discernible pattern of previous earthquakes along these faults nor is there a reliable way to predict future earthquakes along these faults or in any other areas of the state. Consequently, earthquakes are arguably the most difficult natural hazard for which to plan. Most buildings and structures in the state were constructed without specific earthquake resistant design features. In addition, earthquakes precipitate several potential devastating secondary effects such as building collapse, utility pipeline rupture, water contamination, and extended power outages. Therefore, many of the mitigation efforts for other natural hazards identified in this plan may be applicable during the Town's recovery from an earthquake.

Dam Failure

Dam failure is a highly infrequent occurrence, but a severe incident could prove catastrophic. In addition, dam failure most often coincides with flooding, so its impacts can be multiplied, as the additional water has nowhere to flow. The only mitigation measures currently in place are the state regulations governing the construction, inspection, and maintenance of dams. This is managed through the Office of Dam Safety at the Department of Conservation and Recreation. Owners of dams are responsible for hiring a qualified engineer to inspect their dams and report the results to the DCR. Owners of High Hazard Potential dams and certain Significant Hazard Potential dams are also required to prepare, maintain, and update Emergency Action Plans. Potential problems may arise if the ownership of a dam is unknown or contested. Additionally, the cost of hiring an engineer to inspect a dam or to prepare an Emergency Action Plan may be prohibitive for some owners.

Drought

The Northeast is generally considered to be a moist region with ample rain and snow, but droughts are not uncommon. Widespread drought has occurred across the region as recently as 2016, and before that in the early 2000s, 1980s, and mid-1960s. More frequent and severe droughts are expected as climate change continues to increase temperatures, raise evaporation

rates, and dry out soils - even in spite of more precipitation and heavier rainfall events.⁷⁸ The primary mitigation strategy currently in place is regulating uses within the aquifer recharge area of the public water supply well. Orange's Water Resource Overlay District requires any development that renders impervious more than 15% or 2,500 square feet of any lot, whichever is greater, to obtain a Special Permit. Orange could also consider promoting or requiring drought and heat-tolerant grass, plants and trees in new development, to limit the amount of irrigation needed.

The Orange Public Water Supply has identified three surface water resources that can be used as a backup supply during a prolonged drought.

Forest landowners in town can be encouraged to conserve and manage their forests for climate resiliency. Strategies for promoting a resilient forest include increasing the diversity of tree species and age of trees in a forest, and promoting trees not currently threatened by pests or diseases that will thrive in a warming climate.⁷⁹

Extreme Temperatures

A primary mitigation measure for extreme temperatures is establishing and publicizing warming or cooling centers in anticipation of extreme temperature events. Getting the word out to vulnerable populations, especially the homeless and elderly, and providing transportation is particularly important but can be challenging. The Town's Council on Aging has their own van to transport the elderly in the event of a hazard or emergency. Orange does not yet have a practice of setting up warming or cooling centers.

Planting and maintaining shade trees in villages and developed areas of towns can help mitigate extreme heat in these areas. Roofs and paving absorb and hold heat from the sun, making developed areas hotter during the summer than surrounding forested areas. Trees that shade these surfaces can significantly lower the temperature in a neighborhood, making it easier to be outside and reducing cooling costs for homeowners. Orange currently requires trees be planted along new subdivision streets.

Invasive Species

The spread of invasive species is a serious concern as species ranges shift with a changing climate. People can also be a carrier of invasive plant species. Installing boot brushes at hiking entrances can help slow the spread of invasive species by removing seeds being carried in soil

⁷⁸ MassWildlife Climate Action Tool: <https://climateactiontool.org/content/drought>. Accessed March 8, 2019.

⁷⁹ Catanzaro, Paul, Anthony D'Amato, and Emily Silver Huff. *Increasing Forest Resiliency for an Uncertain Future*. University of Massachusetts Amherst, University of Vermont, USDA Forest Service. 2016

on hiking boots. Landowners can learn the top unwanted plants and look for them when out on their land, and can be encouraged to work with neighbors to control invasive exotic plants.

Before implementing any forest management, landowners should be sure to inventory for invasive exotic species. They will need to be controlled before harvesting trees and allowing sunlight into the forest, which will trigger their growth and spread. Also, the timber harvester should be required to powerwash their machines before entering the woods. Financial assistance may be available to landowners through the USDA NRCS Environmental Quality Incentives Program (EQIP) to address invasive species.⁸⁰

In addition, Orange can require only native, non-invasive species be used in new development and redevelopment.

All Hazards

Orange's designated shelters are the Ralph C. Mahar Regional School, the Fisher Hill Elementary School, and the Armory. The Fisher Hill School is equipped with a backup generator. In order to decrease staffing demands on emergency personnel, the Town is interested in training more volunteers to staff shelters. Other key issues that should be evaluated include: legal and fiscal constraints, transportation to shelters, and coordinated sheltering on both sides of the Millers River. A regional sheltering plan that identifies regional shelter sites was completed for Franklin County with funds from the Western Region Homeland Security Advisory Council (WRHSAC). The Franklin County REPC is now working on operationalizing the plan by creating Shelter Management Teams and cost sharing agreements between towns. Orange officials can participate in this process to ensure its residents have clear guidance on where to shelter during an emergency.

Primary and secondary evacuation routes are shown on the Critical Infrastructure map for Orange. Route 2 is a heavily traveled highway and a key component of the Town's evacuation plans; accidents on this road can cut off the Town from nearby hospitals and other communities.

A regional disaster debris management plan was created for Franklin County in 2015. The Franklin County REPC is currently working to verify the sites identified in the plan and complete agreements between towns for use of the regional sites. Towns may need to identify a site in their own town if regional agreements cannot be made.

⁸⁰ MassWildlife Climate Action Tool: <https://climateactiontool.org/content/maintain-or-restore-soil-quality-limit-recreational-impacts>. Accessed March 8, 2019.

Existing Mitigation Capabilities

The Town of Orange had numerous policies, plans, practices, programs and regulations in place, prior to the creation of this plan, that were serving to mitigate the impact of natural hazards in the Town of Orange. These various initiatives are summarized, described and assessed on the following pages and have been evaluated in the “Effectiveness” column.

Table 4-1: Existing Mitigation Capabilities				
Strategy	Capability Type	Description	Hazards Mitigated	Effectiveness / Improvements since 2014
Section 210-4.3.D Definitive Plan – Contents	Subdivision Regulation	Requires a Definitive Plan for new subdivisions, including topography, location of natural systems, waterways and natural drainage courses.	Flooding, Landslides	Somewhat effective for mitigation or preventing localized flooding of roads and other infrastructure. The Subdivision Rules and Regulations were updated since the last Hazard Mitigation Plan and the Definitive Plan is now required to include an erosion and sedimentation control plan.
Section 210-1.3 D Performance Guaranty Required	Subdivision Regulation	Performance guaranty ensures that subdividers cover the cost of construction and improvements for projects.	Flooding, Landslides	Somewhat effective for mitigation or preventing localized flooding of roads and other infrastructure.
Section 210-5.1 Street Standards	Subdivision Regulation	Design standards include road grades by street class (6%, 9%, 12%) as well as water course easements, open spaces, and the protection of natural features.	Flooding, Severe Winter Storms, Landslides	Somewhat effective for mitigation or preventing localized flooding of roads and other infrastructure. Somewhat

Table 4-1: Existing Mitigation Capabilities				
Strategy	Capability Type	Description	Hazards Mitigated	Effectiveness / Improvements since 2014
				effective for controlling impacts from stormwater runoff.
Section 210-5 Required Improvements	Subdivision Regulation	Required improvements include grass plots and trees and the adequate disposal of surface water. All planted street trees are required to be deciduous shade trees.	Flooding, Severe Winter Storms, Landslides	Somewhat effective for mitigation or preventing localized flooding of roads and other infrastructure. Somewhat effective for controlling impacts from stormwater runoff.
Section 210-6.8 Utilities	Subdivision Regulation	All electrical, telephone, fire alarm, and other wires and cables should be installed underground unless there is a special circumstance.	Flooding, Severe Winter Storms, Hurricanes/ Tropical Storms, Severe Thunderstorms	Effective for ensuring that utility service is uninterrupted by severe storms in new areas of residential development.
Section 210-4.3.E Environmental Impact Report	Subdivision Regulation	Subdivisions of ten or more lots or ten acres in size are required to submit a detailed impact report. The report must include information about the topography, geology and soil characteristics of the subdivision, in addition to information about the subsurface and surface water features in the subdivision.	Flooding, Landslides	This is a new section in the Town's subdivision regulations since the last plan update. Effective for protecting watercourses and streams.

Table 4-1: Existing Mitigation Capabilities				
Strategy	Capability Type	Description	Hazards Mitigated	Effectiveness / Improvements since 2014
Section 2230 Dimensional Schedule - Maximum Lot Coverage	Zoning bylaw	Based on the district, the dimensional schedule allows for the maximum percentage of the total lot that can be covered with impervious surfaces. The percentage can be increased via a Special Permit process (see below).	Flooding	Somewhat effective for ensuring that permitted projects do not increase flooding potential.
Section 2350 Special Permits to Increase Maximum Lot Coverage	Zoning bylaw	In Zone B, an additional 35% lot coverage beyond the maximum 35% may be granted providing certain criteria are met. Site design, materials and construction processes shall be designed to avoid erosion damage, sedimentation or uncontrolled surface runoff.	Flooding, Landslides	Somewhat effective for ensuring that permitted projects do not increase flooding potential.
Section 3310 Erosion Control	Zoning bylaw	Grading or construction on, or which result in slopes of 25% or greater on 50% or more of lot area, or on 43,560 sq. feet or more on a single parcel, shall be allowed only under Special Permit from the Planning Board, which shall be granted only upon demonstration that adequate provisions have been made to protect against erosion, soil instability, uncontrolled surface water runoff, or other environmental degradation. A Special Permit is required for grading or construction on slopes greater than 25%. The Building Inspector may require that design of proposed development be	Flooding	Somewhat effective for ensuring that permitted projects do not increase flooding potential. Effective for mitigating or preventing localized flooding of roads and other infrastructure. Effective for controlling impacts from stormwater runoff.

Table 4-1: Existing Mitigation Capabilities				
Strategy	Capability Type	Description	Hazards Mitigated	Effectiveness / Improvements since 2014
		modified to prevent erosion or uncontrolled surface water runoff.		
Section 3320 Floodplain Overlay District	Zoning bylaw	All development in the district, including structural and non-structural activities, whether permitted by right or by Special Permit, must be in compliance with wetlands laws.	Flooding	Somewhat effective for minimizing impacts of development on flood levels within the floodplain. Consider mapping Fluvial Erosion Hazard (FEH) areas in town that are susceptible to erosion during major flooding events, but that might be outside of the 100-year floodplain, and add a Fluvial Erosion Hazard Area Overlay District to the zoning bylaw to limit development in these areas.
Section 4100 Earth Removal	Zoning bylaw	Removal from any premises of more than 50 cubic yards of sand, gravel, stone, topsoil, or similar materials within any twelve month period shall be allowed only by Special Permit from the Planning Board.	Flooding, Landslides	Effective for controlling impacts from stormwater runoff.
Section 4400 Water Resource Overlay District	Zoning bylaw	Restricts the removal of soil, loam, sand or gravel within four feet of the historical high groundwater table elevation except where the substances are redeposited	Flooding, Landslides, Manmade Hazards	Somewhat effective for ensuring that permitted projects do not increase flooding potential.

Table 4-1: Existing Mitigation Capabilities				
Strategy	Capability Type	Description	Hazards Mitigated	Effectiveness / Improvements since 2014
		<p>within 45 days of removal to achieve a grading greater than four feet above the historical high water mark (requires a Special Permit) or for building foundations, excavations, or utility works (requires a Special Permit).</p> <p>Requires a Special Permit for land uses that result in impervious surfaces covering more than 15% or 2500 square feet of any lot, whichever is greater.</p>		Effective for controlling impacts from stormwater runoff
Section 4600 Performance Standards	Zoning bylaw	Increase in stormwater runoff to neighboring properties or roads is prohibited.	Flooding, Landslides	Effective for controlling impacts from stormwater runoff for specified industrial and commercial projects.
Section 5300 Special Permit	Zoning bylaw	Special Permits shall be granted only upon a determination that the proposed use will not have adverse effects which outweigh its beneficial effect on either the neighborhood or the Town.	Flooding	Somewhat effective for ensuring that permitted projects do not increase flooding potential. Consider adding impact on the potential for flooding as a criterion for a Special Permit.
Section 5400 Site Plan Review	Zoning bylaw	Ensures that new development is designed in a manner which reasonably protects public safety, the environment, and the visual character of the neighborhood and the town.	Flooding	Somewhat effective for ensuring that permitted projects do not increase flooding potential. Effective for controlling

Table 4-1: Existing Mitigation Capabilities

Strategy	Capability Type	Description	Hazards Mitigated	Effectiveness / Improvements since 2014
		Requires the plan to include existing built and natural features on the site, a surface drainage strategy that prevents pollution and increased drainage off-site, and existing vegetation that will be left undisturbed and proposed planting areas.		impacts from stormwater runoff.
Section 5700 Open Space Development	Zoning bylaw	At a minimum, at least 35% of the total parcel shall be set aside as common open space. The minimum required common open space shall not include wetlands, floodplains, and slopes greater than 25%.	Flooding	Somewhat effective for ensuring that some permitted projects provide for increase flooding prevention capacity.
Town of Orange Open Space and Recreation Plan	Plan	Inventories natural features and promotes natural resource preservation in the town, including areas in the floodplain; such as wetlands, aquifer recharge areas, farms and open space, rivers, streams and brooks.	Flooding	Effective in identifying sensitive resource areas, including floodplains. The plan was recently updated in 2016. Encourages open space and farmland preservation to provide flood storage capacity. Continue to implement the Five-Year Action Plan strategies, particularly those dealing with protection of forests, farmland and floodplain forests.

Table 4-1: Existing Mitigation Capabilities				
Strategy	Capability Type	Description	Hazards Mitigated	Effectiveness / Improvements since 2014
Participation in the National Flood Insurance Program (NFIP)	Program	As of December 2018, 6 property owners in Orange have flood insurance policies.	Flooding	Somewhat effective, provided that the town remains enrolled in the NFIP. Orange should evaluate whether to become part of FEMA's Community Rating System.
State Building Code	Regulation	The Town has adopted the Massachusetts State Building Code.	Severe Winter Storms, Hurricanes, Tornados, Earthquakes	Effective.
Section 4500 Personal Wireless Communications Facilities (WCFs)	Zoning bylaw	<p>WCFs shall be no higher than ten feet above the average height of buildings within 300 feet of the proposed facility.</p> <p>WSFs of up to 150 feet in height may be permitted by Special Permit.</p> <p>In order to ensure public safety, the minimum distance from the base of any ground-mounted WSF to any property line, road, habitable dwelling, business or institutional use, or public recreational area shall be the height of the facility/mount, including any antennas or other appurtenances.</p>	Hurricanes, Tornados	Effective.

Table 4-1: Existing Mitigation Capabilities				
Strategy	Capability Type	Description	Hazards Mitigated	Effectiveness / Improvements since 2014
Section 2230 Use Regulation Schedule - mobile homes	Zoning bylaw	Town of Orange Zoning Bylaw prohibits new mobile homes and mobile home parks.	Hurricanes, Tornadoes	Effective.
Section 210-5.6 Required Improvements – Utilities	Subdivision Regulation	The Town of Orange requires that all electrical, telephone, fire alarm, and other wires are installed underground unless there is a special circumstance.	Hurricanes, Tornadoes	Effective. The Town's Subdivision Regulations were updated in 2013 to require the installation of wires underground.
Shelters	Program	The Town has designated sheltering facilities for severe weather events.	Hurricanes, Tornadoes, Earthquakes	Somewhat effective. A contingency sheltering plan is needed for when the schools (current sheltering facilities) go under construction. Additional education and outreach is needed so residents know which shelters are open and what facility they should use based on their location.
Burn Permits	Regulation	Residents are permitted to obtain burn permits over the phone. Fire Department personnel provide information on safe burn practices.	Wildfire	Effective.

Table 4-1: Existing Mitigation Capabilities				
Strategy	Capability Type	Description	Hazards Mitigated	Effectiveness / Improvements since 2014
Subdivision Review	Regulation	The Fire Department is involved in the review of subdivision plans.	Wildfire	Effective.
Public Education and Outreach	Program	The Fire Department has an ongoing educational program in the schools.	Wildfire	Effective. Participate in the Firewise Communities/USA Program, which encourages and acknowledges actions that minimize home loss to wildfire, and teaches how to prepare for a fire before it occurs.
Dam Permits	Regulation	State law requires a permit for the construction of any dam.	Dam Failure	Effective. Ensures dams are adequately designed.
Dam Inspections	Program	DCR has an inspection schedule that is based on the hazard rating of the dam (low, significant, high hazard).	Dam Failure	Low. The DCR does not have adequate staff and resources to inspect dams according to the required schedule. Map inundation areas for all significant hazard dams. Educate owners of dams of their inspection responsibilities.
Evacuation Plans	Program	Evacuation plans would ensure the safety of the citizens in the event of dam failure.	Dam Failure	Not effective, as they have not yet been prepared. Owners of Significant Hazard dams should prepare up-to-date evacuation

Table 4-1: Existing Mitigation Capabilities				
Strategy	Capability Type	Description	Hazards Mitigated	Effectiveness / Improvements since 2014
				plans in cooperation with the town.
Section 2350 - Special Permit for Lot Coverage Increase	Zoning bylaw	Ensures that runoff from impermeable surfaces drain into catchment areas or structures designed to trap pollutants.	Manmade Hazards	Effective for all new construction, reconstruction, or expansion of existing buildings and new or expanded uses.
Reverse 911 (Code RED)	Program	Reverse 9-11 program to allow for town to send emergency alerts to residents. Program considered effective if contact list is maintained, if the system is used regularly, and multiple town officials have access and training for use of this system.	All Hazards	Effective.
Municipal Vulnerability Preparedness Plan	Plan	Orange is in the process of completing their MVP Plan. Once complete, the Town will be eligible to apply for funding for projects that can increase community resilience.	All Hazards	Effective.

4.3 HAZARD MITIGATION GOAL STATEMENTS AND ACTION PLAN

As part of the hazard mitigation planning process undertaken by the Orange Hazard Mitigation Planning Committee, existing gaps in protection and possible deficiencies were identified and discussed. The Committee then developed general goal statements and mitigation action items that, when implemented, will help to reduce risks and future damages from multiple hazards. The goal statements, action items, Town department(s) responsible for implementation, and the proposed timeframe for implementation for each category of hazard are described below. It is important to note that the Town of Orange has limited capabilities and resources (especially staffing) to be able to expand and improve upon existing policies and programs when the town identifies a need for improvement.

Hazard Mitigation Goals

Based on the findings of the Risk Assessment, public outreach, and a review of previous town plans and reports, the Orange has developed the following goals to serve as a framework for mitigating the hazards identified in this plan:

- To provide adequate shelter, water, food and basic first aid to displaced residents in the event of a natural disaster.
- To provide adequate notification and information regarding evacuation procedures, etc., to residents in the event of a natural disaster.
- To minimize the loss of life, damage to property, and the disruption of governmental services and general business activities due to natural hazards.

Prioritization of Hazards

The Committee examined the results of the Risk Assessment (see Section 3) and used the results to prioritize the identified hazards. The Committee evaluated the natural hazards that can impact the town based on probability of occurrence, severity of impacts, area of occurrence and preparedness. Those hazards receiving the highest Overall Hazard Vulnerability Rating were assigned the highest priority, as shown in Table 4-2. The highlighted hazards in Table 4-2 where those identified as High Priority in the 2020 MVP Workshop and Plan.

Table 4-2: Orange Hazard Priority Level Rating		
Natural Hazard	Overall Hazard Vulnerability Rating	Priority Level
Severe Winter Storms	1-High Risk	Medium
Flooding	3-Low Risk	High
Tornadoes	2-Medium Risk	Low
Dam Failure (other dams and beaver dams)	1-High Risk	High

Table 4-2: Orange Hazard Priority Level Rating		
Natural Hazard	Overall Hazard Vulnerability Rating	Priority Level
Hurricanes / Tropical Storms	1-High Risk	Medium
Severe Thunderstorms / Wind / Microbursts	1-High Risk	High
Extreme Temperatures	3-Low Risk	Medium
Earthquakes	3-Low Risk	Low
Landslides	2-Medium Risk	High
Drought	2-Medium Risk	Medium
Wildfires	1-High Risk	Medium
Invasive Species	1-High Risk	Medium

Prioritization of Action Items

The Hazard Mitigation Committee identified several strategies that are currently being pursued, and other strategies that will require additional resources to implement. Strategies are based on previous experience, as well as the hazard identification and risk assessment in this plan.

Prioritization Methodology

The Orange Hazard Mitigation Planning Committee reviewed and prioritized a list of mitigation strategies using the following criteria:

- **Application to high priority or multiple hazards** – Strategies are given a higher priority if they assist in the mitigation of hazards identified as high priorities (Table 4-2) or apply to several natural hazards.
- **Time required for completion** – Projects that are faster to implement, either due to the nature of the permitting process or other regulatory procedures, or because of the time it takes to secure funding, are given higher priority.
- **Estimated benefit** – Strategies which would provide the highest degree of reduction in loss of property and life are given a higher priority. This estimate is based on the Hazard Identification and Risk Assessment Chapter, particularly with regard to how much of each hazard’s impact would be mitigated.

- **Cost effectiveness** – In order to maximize the effect of mitigation efforts using limited funds, priority is given to low-cost strategies. For example, regular tree maintenance is a relatively low-cost operational strategy that can significantly reduce the length of time of power outages during a winter storm. Strategies that have identified potential funding streams, such as the Hazard Mitigation Grant Program, are also given higher priority.

The following categories are used to define the priority of each mitigation strategy:

- **Low** – Strategies that would not have a significant benefit to property or people, address only one or two hazards, or would require funding and time resources that are impractical.
- **Medium** – Strategies that would have some benefit to people and property and are somewhat cost effective at reducing damage to property and people.
- **High** – Strategies that provide mitigation of high priority hazards or multiple hazards and have a large benefit that warrants their cost and time to complete.
- **Very High** – extremely beneficial projects that will greatly contribute to mitigation of high priority and multiple hazards and the protection of people and property. These projects are also given a numeric ranking within the category.

Cost Estimates

Each of the following implementation strategies is provided with a cost estimate. Projects that already have secured funding are noted as such. Where precise financial estimates are not currently available, categories were used with the following assigned dollar ranges:

- **Low** – cost less than \$25,000
- **Medium** – cost between \$25,000 – \$100,000
- **High** – cost over \$100,000

Cost estimates take into account the following resources:

- Town staff time for grant application and administration (at a rate of \$25 per hour)
- Consultant design and construction cost (based on estimates for projects obtained from town and general knowledge of previous work in town)

- Town staff time for construction, maintenance, and operation activities (at a rate of \$25 per hour)

Project Timeline

The timeframe for implementation of the action items are listed in the Action Plan as Year 0-1, which is the first year following plan adoption, and subsequent years after plan adoption through the 5 year life of the plan (Year 2, Year 3, Year 4 and Year 5). The Committee recognized that many mitigation action items have a timeframe that is ongoing due to either funding constraints that delay complete implementation and/or the action item should be implemented each of the five years of the plan, if possible. Therefore, a category of Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5), as appropriate was added.

Even when the political will exists to implement the Action Items, the fact remains that Orange is a small town that relies heavily on a small number of paid staff, many of whom have multiple responsibilities, and a dedicated group of volunteers who serve on town boards. However, some Action Items, when implemented by Town staff and volunteers, result in a large benefit to the community for a relatively small cost.

For larger construction projects, the town has limited funds to hire consultants and engineers to assist them with implementation. For these projects, the Town may seek assistance through the Franklin Regional Council of Governments (FRCOG). However, the availability of FRCOG staff can be constrained by the availability of grant funding.

The 2020 Orange Hazard Mitigation Prioritized Action Plan is shown in Table 4-3. Potential funding sources for mitigation action items are listed when known. Other potential funding sources are listed in Table 5-1 of this plan. When Town funds are listed as a source to fund hazard mitigation projects or activities, either in part (match) or in full, these funds would be obtained from the town's "general fund".

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Table 4-3: 2020 Orange Hazard Mitigation Prioritized Action Plan									
Action Type	Action Description	Hazards Addressed	Responsible Department / Board	Estimated Cost	Potential Funding Source	Estimated Timeframe	Benefits: Society (S) Infrastructure (I) Environment (E)	2014 Priority 2020 Priority	Current Status
Local Plans & Regulations	Identify possible storage locations for emergency equipment that can be shared by Town Officials. Once identified, develop a management program to utilize the shared storage spaces and equipment during emergencies.	All Hazards	Emergency Management Director, Fire Chief, Police Chief	Low-Medium	Town	Year 1	S, I	2020 High	New action item based on needs identified by Orange's emergency personnel during the MVP workshop.
Critical Facilities & Infrastructure	Hire a consultant to determine appropriate flood proofing measures for the wastewater treatment plant, which is located within the floodplain.	Flooding, Hurricanes	Emergency Management Director, Orange Wastewater Treatment Facility Staff	Medium-High	Town, MVP	Year 2	I	2020 High	New action item based on vulnerabilities identified during the Town's MVP workshop.
Critical Facilities & Infrastructure	Conduct a town-wide assessment of drainage structures and drainage driven flood issues to determine where upgrades should be made, especially in the downtown area.	Flooding, Hurricanes, Severe Thunderstorms	Planning Board, Emergency Management Director	Medium	Town, MVP	Year 2	I	2020 Medium	New action item based on vulnerabilities identified during the Town's MVP workshop.
Local Plans & Regulations	Continue to review and update, as appropriate, Town land use regulations to include climate resiliency provisions such as Best Management Practices for River Corridor areas (FRCOG's River Corridor Toolkit), further restricting or limiting new development within the 100-year floodplain and River Corridor, Low Impact Development (LID) stormwater practices, etc. Special attention should be paid to the Mill Buildings throughout Town, as many are in line to be redeveloped and are under private ownership. The National Fire Protection Association's "Firewise" standards should also be incorporated into this update to reduce the impact of wildfires on the built environment.	All hazards	Planning Board	Low	Department of Housing and Urban Development, Town, Volunteers	Year 1	S, I, E	2020 Medium	New action item.
Local Plans & Regulations	Continue to participate in the Franklin County Regional Emergency Planning Committee (REPC), which is currently working to complete and operationalize the Debris Management Plan. Coordinate with state and regional agencies to identify a location(s) in the Town for the temporary storage of contaminated and/or hazardous flood debris.	Multiple Hazards	DPW, Franklin County REPC	Low	MVP, Town	Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5), as appropriate.	S, E	2020 Medium	New action item. Orange currently has two locations for debris collection: brush and wood debris are collected at the transfer station, and logs are collected at the Highway Department. As REPC continues to develop a debris management plan, the Town can coordinate with the Committee.

Table 4-3: 2020 Orange Hazard Mitigation Prioritized Action Plan									
Action Type	Action Description	Hazards Addressed	Responsible Department / Board	Estimated Cost	Potential Funding Source	Estimated Timeframe	Benefits: Society (S) Infrastructure (I) Environment (E)	2014 Priority 2020 Priority	Current Status
Public Education & Outreach	Continue to distribute outreach materials to residents that explain how to safely dispose of household hazardous waste at designated municipal collection sites. Additionally, continue to publicize the biannual collection dates.	Flooding, Manmade Hazards	Emergency Management Director, Department of Public Works, Health Department	Low-Medium	MVP, Town	Year 2	S, I, E	2020 Medium	New action item. The Town of Orange is a part of the Franklin County Solid Waste District, which hosts 2 collection dates per year with 4 collection sites set up in the county. Collection efforts in the past have been successful and the Town would like to continue to promote education and outreach.
Critical Facilities & Infrastructure	Identify Town-owned forested areas that are at higher risk for wildfires (near residential areas, high-wire utilities, etc.) to implement climate resilient forest management practices that reduce the risk of fire hazards (such as the removal of slash).	Wildfire	Conservation Commission, Planning Department, Fire Department	Low-Medium	MVP, Town, DCR	Year 3	S, I, E	2020 Low	New action item. This is a low priority because there are not many Town owned forested areas. Recent wildfires in Town were located on Tully Mountain, which is a state owned property. The Town is working to coordinate access for fires on state owned properties, but ultimately is not responsible for debris management.
Critical Facilities & Infrastructure Public Education & Outreach	Develop a contingency plan for the Town's designated emergency shelters and disseminate this information to appropriate Town departments, as well as Town residents. When evaluating facilities as options for public shelters, assess vulnerability to severe hazards and determine any necessary retrofitting measures. Conduct public education and outreach so residents know which locations are appropriate for sheltering, and know which number to call for updated information in an effort to minimize calls to the 911 operator during a severe weather event. Consider developing an emergency hotline to use in concert with the CodeRED system so residents can get on demand updates.	All hazards	Building Inspector, Emergency Management Director, Director of Community Development	Low	Town	Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5) as appropriate	S	2014 Medium 2020 High	Carried forward from the 2014 plan and updated for the 2020 plan. The Town's schools are designated emergency shelters, but they will soon be under construction and other sheltering locations will need to be evaluated. The Director of Community Development will conduct a reuse study of the Butterfield School, which could potentially be used as a shelter.

Table 4-3: 2020 Orange Hazard Mitigation Prioritized Action Plan									
Action Type	Action Description	Hazards Addressed	Responsible Department / Board	Estimated Cost	Potential Funding Source	Estimated Timeframe	Benefits: Society (S) Infrastructure (I) Environment (E)	2014 Priority 2020 Priority	Current Status
Education & Awareness	Improve public awareness of the risk of high wind events. Provide information to property owners on how to properly install temporary window coverings before a storm and appropriate wind retrofits for existing buildings.	Tornados, Severe Wind	Emergency Management Director	Low	Town, Volunteer Time	Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5), as appropriate.	S, I	2014 Medium 2020 High	Carried forward from the 2014 plan and updated for the 2020 plan. The Fire Department can get weather information from their own weatherbug station and quickly put out warnings. The Fire Chief would like to work on public education and outreach before the 2020 hurricane season starts.
Education & Awareness	Conduct ongoing education on fire safety, such as the Firewise Communities/USA Program, which encourages and acknowledges actions that minimize home loss to wildfire.	Wildfire	Fire Department	Low	Town	Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5) as appropriate	S, I, E	2014 High 2020 High	Carried forward from the 2014 plan and updated for the 2020 plan. The Fire Department participates in National Fire Awareness Week activities the first week in October. This year, the Fire Chief would like to adjust the curriculum to reflect what is going on nationally in terms of wildfire risk.
Critical Facilities & Infrastructure/ Local Plans & Regulations	Consider hiring a consultant to map Fluvial Erosion Hazard (FEH) areas in town, and adding a Fluvial Erosion Hazard Area Overlay District bylaw to the zoning bylaws to limit development in FEH areas along rivers and streams that are highly susceptible to flood-related erosion.	Flooding, Hurricanes	Planning Board	Medium	Town, FRCOG, MVP, HGMP	Year 1	S, I, E	2014 High 2020 High	Carried forward from the 2014 plan and updated for the 2020 plan.
Critical Facilities & Infrastructure	Develop a culvert management plan that identifies the locations of culverts in town, existing and potential issues and the extent of flooding caused at each location, and possible solutions. The plan should prioritize projects in the locations that require intervention, including South Park, Town Farm Road, and West River Street.	Flooding, Dam Failure	Highway Department, Conservation Commission	Medium	Town, MVP, Community Compact	Year 2	S, I, E	2014 Medium 2020 High	Carried forward from the 2014 plan and updated for the 2020 plan. The Town has many undersized and aging culverts and would like to know where they are located and begin prioritizing repairs and replacements.
Critical Facilities & Infrastructure	Develop a computerized tracking system for departments to record costs and property damages from natural hazard events. The tracking system will allow Town Departments to digitize and manage records as needed, and track assets. For example, the Tree Warden could use the	All hazards	Emergency Management Director, Highway Department, Fire Chief, Police Chief	Medium	Town, Volunteers	Year 2	S, I, E	2014 High 2020 Medium	Carried forward from the 2014 plan and updated for the 2020 plan. The Town selected a vendor for the tracking system but further efforts have been delayed due to the COVID-19

Table 4-3: 2020 Orange Hazard Mitigation Prioritized Action Plan									
Action Type	Action Description	Hazards Addressed	Responsible Department / Board	Estimated Cost	Potential Funding Source	Estimated Timeframe	Benefits: Society (S) Infrastructure (I) Environment (E)	2014 Priority 2020 Priority	Current Status
	system to keep track of downed trees and make updates as issues are resolved.								<p>pandemic. Next steps will include determining how to implement the system across Town departments, determining which records should be digitized first, and securing funds to complete this work.</p> <p>Acquiring fireproof cabinets could also be considered as a part of this action item so that scanned records can be properly stored.</p>
Local Plans & Regulations	Continue to implement the Orange Open Space and Recreation Plan's Seven-Year Action Plan strategies, particularly those dealing with the protection of farmland, forestland, and floodplain forests. As a part of this review, consider identifying which parcels of open space could be used to develop resiliency.	Flooding	Planning Board, Board of Selectmen, Conservation Commission, Agricultural Commission	Medium	Town, Volunteers	Year 2	E	2014 Medium 2020 Medium	Carried forward from the 2014 plan and updated for the 2020 plan.
Critical Facilities & Infrastructure	Determine the feasibility of either replacing the oldest, western-most water main crossing the Millers River in order to mitigate the potential of the pipe being destroyed by flooding in the river, or finding a back-up drinking water supply on the north side of the Millers River.	Flooding	Water Department	Medium	Town	Year 2	S, I	2014 Medium 2020 Medium	Carried forward from the 2014 plan and updated for the 2020 plan. The Orange Water Department hired an engineer to design a new river crossing in FY '19, but have not yet received the completed design. The Water Superintendent is actively working on this project.
Education & Awareness	Provide training to volunteer board members and the Building Inspector about the risk of landslides and mitigating the risk through the enforcement of existing land use regulations (zoning bylaws, subdivision regulations, building codes) that direct development to stable slopes and soils to reduce the risk of landslides. Reduce the risk of landslides at existing development by requiring that surface water and groundwater are properly managed as part of the permit process.	Landslides	Building Inspector, Conservation Commission, Planning Board, Zoning Board of Appeals	Low	Town, Volunteers, DLTA	Year 0-1, to be reviewed annually and implemented in subsequent years (Years 2-5), as appropriate.	S, I, E	2014 Medium 2020 Medium	Carried forward from the 2014 plan and updated for the 2020 plan. The Community Development Director would like to assess how construction site management can be added to zoning bylaws to ensure there is oversight that will limit risks associated with landslides.

Table 4-3: 2020 Orange Hazard Mitigation Prioritized Action Plan									
Action Type	Action Description	Hazards Addressed	Responsible Department / Board	Estimated Cost	Potential Funding Source	Estimated Timeframe	Benefits: Society (S) Infrastructure (I) Environment (E)	2014 Priority 2020 Priority	Current Status
Critical Facilities & Infrastructure	Identify feasible options, such as placing main feeder lines underground, to reduce risk to critical municipal facilities and infrastructure in areas where repetitive outages occur.	Hurricanes, Severe Wind, Severe Thunderstorms, Severe Winter Storms	Board of Selectmen, Planning Board, utility company	High	Town	Dependent on availability of Town staff	S, I	2014 High 2020 Low	Carried forward from the 2014 plan and updated for the 2020 plan.

Table 4-4: Orange Completed or Obsolete 2020 Hazard Mitigation Actions								
Action Type	Action Description	Hazards Addressed	Responsible Department / Board	Estimated Cost	Potential Funding Source	Benefits: Society (S) Infrastructure (I) Environment (E)	Priority in Past Plan	Current Status
Critical Facilities & Infrastructure	Rehabilitate the bridge connecting Wendell Depot Road and West Orange Road to improve emergency access.	All Hazards	Emergency Management Director, Select Board	Medium-High	Mass DOT	S, I	High	The need to rehabilitate the bridge was identified as an action item by Orange's emergency personnel during the MVP workshop in October 2019. As of the writing of this plan in August 2020, MassDOT is working to finish repairs and all work is expected to be completed by June 2021.
Critical Facilities & Infrastructure	Ensure that utility companies implement five-year action plans, which include regular tree maintenance to reduce the number of limbs near overhead power lines, to reduce risk to infrastructure from high wind hazards.	Hurricanes, Severe Winter Storms, Severe Wind	Highway Department	Low	Town	S, I	High	Obsolete. National Grid completed tree maintenance on a regular basis and after storms – the Town cannot change their schedule.
Local Plans & Regulations	Examine strategies for improving the Towns' existing hazard tree program, which currently completes tree work for residents outside of utility areas. Look for ways to improve the process of identifying tree hazards and to minimize conflict between the DPW and residents. Encourage coordination between Town departments and the Orange Tree Warden to foster safe and effective care of the Town's trees.	Hurricanes, Severe Wind, Severe Winter Storms	Highway Department	Low	Town	S, I, E	High	Completed. The Tree Warden works within the Town's budget to take down trees as needed, and does routine cleanups in the fall, winter, and late spring to mitigate issues.
Local Plans & Regulations	The town should consider updating its current zoning and subdivision regulations, paying particular attention to flooding mitigation and prevention. Special consideration should be given to restricting or limiting new development within the 100-year floodplain and areas prone to localized or catastrophic flooding events.	Flooding	Planning Board	L	Town	I, E	High	The Town of Orange completed a complete revision of their Subdivision Rules and Regulations in November 2013. According to section 210-4.4 Subdivision Standards in the Floodplain, all proposals for development are now reviewed to confirm they will be reasonably safe from flooding.

Table 4-4: Orange Completed or Obsolete 2020 Hazard Mitigation Actions								
Action Type	Action Description	Hazards Addressed	Responsible Department / Board	Estimated Cost	Potential Funding Source	Benefits: Society (S) Infrastructure (I) Environment (E)	Priority in Past Plan	Current Status
Local Plans & Regulations	Revise the Definitive Plan requirements in the Subdivision Rules and Regulations to include identification of impacts and flooding mitigation measures.	Flooding	Planning Board	L	Department of Housing and Urban Development, Town, volunteers	E	High	Completed. Subdivision Rules and Regulations were updated in November 2013.
Local Plans & Regulations	To reduce the risk to infrastructure from high winds associated with hurricanes and tropical storms, consider amending the Subdivision Rules and Regulations to require utility lines be placed underground in all new subdivisions.	Hurricanes	Planning Board, Highway Department	L	Department of Housing and Urban Development, Town, volunteers	I	High	The Town of Orange completed a complete revision of their Subdivision Rules and Regulations in November 2013. Section 210-6.8 Utilities was revised to require that utility wires be placed underground, unless there is a special circumstance.
Local Plans & Regulations	Consider implementing standards to require temporary and permanent erosion control measures for streams and surface water bodies and prohibiting permanent alterations of watercourses or streams.	Flooding	Planning Board	L	Department of Housing and Urban Development, Town, volunteers	E	High	Completed. Zoning bylaws were updated in March 2015.
Local Plans & Regulations	Request FEMA to update the Flood Insurance Rate Maps (FIRM), which depict the 100-year floodplain, for Orange and other Franklin County towns. The current map for Orange was developed in 1982.	Hurricanes	Emergency Management Director, Board of Selectmen	L	Town	I, E	Medium	Obsolete. In 2018, FEMA initiated the process to update the floodplain maps for Franklin County Towns. This process will take 5-10 years to complete.
Education & Awareness	Participate in trainings, as needed, to ensure new buildings are designed and constructed to reduce the risk of damage from high winds. Encourage the construction of new homes with basements or crawl spaces to provide shelter during a tornado, hurricane or other storm event with high winds.	Tornados, Severe Wind	Building Inspector	Low	Town	I	High	Obsolete. Orange has their own Building Commissioner and this is considered part of the job duties.
Local Plans & Regulations	The town should evaluate whether to join FEMA's Community Rating System.	Flooding	Board of Selectmen, Conservation Commission	Low	Town	S, I	Medium	Obsolete. The Community Rating System is cost prohibitive for small towns.
Education & Awareness	Educate private dam owners of their inspection responsibilities, and work with significant hazard dam owners to prepare up-to-date evacuation plans.	Dam Failure	Board of Selectmen, Emergency Management Director, Water Department	Low	Town	S, I, E	Medium	Obsolete. This is the state's responsibility.
Critical Facilities &	Assess the ownership and maintenance needs for municipally owned dams, and the potential for dam removal. As a part of	Dam Failure	Board of Selectmen,	Low	Town	S, I, E	Medium	Complete. The Town does this.

Table 4-4: Orange Completed or Obsolete 2020 Hazard Mitigation Actions								
Action Type	Action Description	Hazards Addressed	Responsible Department / Board	Estimated Cost	Potential Funding Source	Benefits: Society (S) Infrastructure (I) Environment (E)	Priority in Past Plan	Current Status
Infrastructure	this, Update dam inspections and update internal processes for tracking status & conditions. Ensure contact information for private dam owners is up to date.		Emergency Management Director, Water Department					

5 PLAN ADOPTION AND MAINTENANCE

5.1 PLAN ADOPTION

The Franklin Regional Council of Governments (FRCOG) provided support to the Orange Hazard Mitigation Committee as they underwent the planning process. Town officials such as the Emergency Management Director and the Town Administrator were invaluable resources to the FRCOG and provided background and policy information and municipal documents, which were crucial to facilitating completion of the plan.

When the preliminary draft of the Orange Hazard Mitigation Plan was completed, copies were disseminated to the Committee for comment and approval. The Committee was comprised of representatives of Town boards and departments who bear the responsibility for implementing the action items and recommendations of the completed plan (see the list of Committee members on the front cover).

Copies of the Final Review Draft of the Hazard Mitigation Plan for the Town of Orange were distributed to Town boards and officials, and to surrounding towns for review. Copies were made available at the Town Hall and the library, and a copy of the plan was also posted on the Town website for public review. Once reviewed and approved by MEMA, the plan was sent to the Federal Emergency Management Agency (FEMA) for their approval. FEMA granted approval pending adoption on December 31, 2021 and on January 27, 2021 the Orange Board of Selectboard voted to adopt the plan (see Appendix C).

5.2 PLAN MAINTENANCE PROCESS

The implementation of the Orange Hazard Mitigation Plan will begin following its approval by MEMA and FEMA and formal adoption by the Orange Board of Selectmen. Specific Town departments and boards will be responsible for ensuring the development of policies, bylaw revisions, and programs as described in the Action Plan (Table 4-3). The Orange Hazard Mitigation Planning Committee will oversee the implementation of the plan.

Monitoring, Evaluating, and Updating the Plan

The measure of success of the Orange Hazard Mitigation Plan will be the number of identified mitigation strategies implemented. In order for the Town to become more disaster resilient and better equipped to respond to natural disasters, there must be a coordinated effort between elected officials, appointed bodies, Town employees, regional and state agencies involved in disaster mitigation, and the general public.

Implementation Schedule

Annual Meetings

The Orange Hazard Mitigation Planning Committee will meet on an annual basis or as needed (i.e., following a natural or other disaster) to monitor the progress of implementation, evaluate the success or failure of implemented recommendations, and brainstorm for strategies to remove obstacles to implementation. Following these discussions, it is anticipated that the Committee may decide to reassign the roles and responsibilities for implementing mitigation strategies to different Town departments and/or revise the goals and objectives contained in the plan. At a minimum, the Committee will review and update the plan every five years. The meetings of the Committee will be organized and facilitated by the Orange Town Administrator and the Emergency Management Director.

Bi-Annual Progress Report

The Emergency Management Director will prepare and distribute a biannual progress report in years two and four of the plan. Members of the Local Planning Committee will be polled on any changes or revisions to the plan that may be needed, progress and accomplishments for implementation, failure to achieve progress, and any new hazards or problem areas that have been identified. Success or failure to implement recommendations will be evaluated differently depending on the nature of the individual Action Items being addressed, but will include, at a minimum, an analysis of the following: 1) whether or not the item has been addressed within the specified time frame; 2) whether actions have been taken by the designated responsible parties; 3) what funding sources were utilized; 4) whether or not the desired outcome has been achieved; and 4) identified barriers to implementation. This information will be used to prepare the bi-annual progress report which may be attached as an addendum, as needed, to the local hazard mitigation plan. The progress report will be distributed to all of the local implementation group members and other interested local stakeholders. The Emergency Management Director and the Committee will have primary responsibility for tracking progress and updating the plan.

Five-Year Update Preparation

During the fourth year after initial plan adoption, the Emergency Management Director will convene the Committee to begin preparations for an update of the plan, which will be required by the end of year five in order to maintain approved plan status with FEMA. The team will use the information from the annual meetings and the biannual progress reports to identify the needs and priorities for the plan update.

Updated Local Hazard Mitigation Plan – Preparation and Adoption

FEMA's approval of this plan is valid for five years, by which time an updated plan must be approved by FEMA in order to maintain the town's approved plan status and its eligibility for FEMA mitigation grants. Because of the time required to secure a planning grant, prepare an updated plan, and complete the approval and adoption of an updated plan, the local Hazard Mitigation Planning Committee should begin the process by the end of Year 3. This will help the town avoid a lapse in its approved plan status and grant eligibility when the current plan expires.

The Committee may decide to undertake the update themselves, request assistance from the Franklin Regional Council of Governments, or hire another consultant. However the Committee decides to proceed, the group will need to review the current FEMA hazard mitigation plan guidelines for any changes. The updated Orange Hazard Mitigation Plan will be forwarded to MEMA and to FEMA for approval.

As is the case with many Franklin County towns, Orange's government relies on a few public servants filling many roles, upon citizen volunteers and upon limited budgets. As such, implementation of the recommendations of this plan could be a challenge to the Committee. As the Committee meets regularly to assess progress, it should strive to identify shortfalls in staffing and funding and other issues which may hinder Plan implementation. The Committee can seek technical assistance from the Franklin Regional Council of Governments to help alleviate some of the staffing shortfalls. The Committee can also seek assistance and funding from the sources listed in Table 5-1.

Table 5-1: Potential Funding Sources for Hazard Mitigation Plan Implementation

Program	Type of Assistance	Availability	Managing Agency	Funding Source
National Flood Insurance Program	Pre-disaster insurance	Rolling	DCR	Property Owner, FEMA
Community Assistance Program	State funds to provide assistance to communities in complying with NFIP requirements	Annually	DCR	FEMA/NFIP
Community Rating System (Part of the NFIP)	Flood insurance discounts	Rolling	DCR	Property Owner
Flood Mitigation Assistance (FMA) Program	Cost share grants for pre-disaster planning & projects	Annual	MEMA	75% FEMA/ 25% non-federal
Hazard Mitigation Grant Program (HMGP)	Post-disaster cost-share Grants	Post Disaster	MEMA	75% FEMA/ 25% non-federal
Pre-Disaster Mitigation (PDM) Program	National, competitive grant program for projects & planning	Annual	MEMA	75% FEMA/ 25% non-federal
Small Business Administration Disaster Loans	Post- disaster loans to qualified applicants	Ongoing	MEMA	Small Business Administration
Public Assistance Program	Post-disaster aid to state and local governments	Post Disaster	MEMA	FEMA/ plus a non-federal share
Dam & Seawall Repair & Removal Program	Grant and loan funds for design, permitting, and construction of repair or removal of dams	Annual	EEA	Dam and Seawall Repair or Removal Fund
Emergency Management Performance Grant (EMPG)	Funding to assist local emergency management departments in building and maintaining an all-hazards emergency preparedness system, including planning; organizational support; equipment; training; and exercises	When funds are available	MEMA	
Volunteer Fire Assistance (VFA) Program	Grants and materials to towns with less than 10,000 population for technical, financial and other assistance for forest fire related purposes, including training, Class A foam, personal protective gear, forestry tools, and other fire suppression equipment	Annual	DCR	USDA Forest Service

Table 5-1: Potential Funding Sources for Hazard Mitigation Plan Implementation

Program	Type of Assistance	Availability	Managing Agency	Funding Source
Federal 604b Water Quality Management Planning Grant	Funding for assessment and planning that identifies water quality problems and provides preliminary designs for Best Management Practices to address the problems	Annual	MA DEP	EPA Clean Water Act
Section 319 Nonpoint Source Competitive Grant Program	Provides grants for wide variety of activities related to non-point source pollution runoff mitigation	Annual	MassDEP	EPA
Economic Development Administration Grants and Investment	Provides grants for community construction projects, which can include mitigation activities	Rolling	FRCOG	U.S. Department of Commerce, EDA
Emergency Watershed Protection	A disaster recovery program made available in emergency situations when neither the state nor the local community is able to repair a damaged watershed	Post-Disaster	NRCS MA	USDA NRCS
Agricultural Management Assistance	Funding for producers to develop or improve sources of irrigation water supply, construct new or reorganize irrigation delivery systems on existing cropland to mitigate the risk of drought	Rolling	NRCS MA	USDA NRCS
Conservation Stewardship Program	Agricultural producers and forest landowners earn payments for actively managing, maintaining, and expanding conservation activities – like cover crops, rotational grazing, ecologically-based pest management, buffer strips, and pollinator and beneficial insect habitat – while maintaining active agricultural production	Rolling	NRCS MA	USDA NRCS
Environmental Quality Incentives Program (EQIP)	Provides technical and financial assistance to forestry & agricultural producers to plan and install conservation practices that address natural resource concerns including water quality degradation, water conservation, reducing greenhouse gases, improving wildlife habitat, controlling invasive plant species, and on-farm energy conservation and efficiency.	Rolling	NRCS MA	USDA NRCS
Agricultural Lands Conservation Program (ACEP)	Provides financial and technical assistance to help conserve agricultural lands and wetlands.	Rolling	NRCS MA	USDA NRCS

Table 5-1: Potential Funding Sources for Hazard Mitigation Plan Implementation

Program	Type of Assistance	Availability	Managing Agency	Funding Source
Forest Stewardship Program	Supports private landowners and municipalities to manage woodlands for timber, soil and water quality, wildlife and fish habitat, and recreation	Rolling	DCR / MA Woodlands Institute	USDA Forest Service
Community Forest Stewardship Implementation Grants for Municipalities	Municipalities that manage a town forest or have water supply land currently enrolled in the Forest Stewardship Program apply for 75-25 matching reimbursement grants to implement their forest stewardship plan	Rolling as funding permits	DCR	USDA Forest Service
USDA Community Facilities Direct Loan & Grant	Provides grants and loans for infrastructure and public safety development and enhancement in rural areas	Annual	USDA Rural Development MA	USDA Rural Development
Transportation Improvement Program	Prioritized, multi-year listing of transportation projects in a region that are to receive Federal funding for implementation. Projects are limited to certain roadways and are constrained by available funding for each fiscal year. Any transportation project in Franklin County that is to receive federal funding must be listed on the TIP.	Rolling	Franklin County Transportation Planning Organization / FRCOG	80% Federal / 20% State
Chapter 90 Program	Funds maintaining, repairing, improving and constructing town and county ways and bridges which qualify under the State Aid Highway Guidelines	Annual	Mass DOT	State Transportation Bond
Culvert Replacement Municipal Assistance Grant	Funds replacement of undersized, perched, and/or degraded culverts located in an area of high ecological value with better designed crossings that meet improved structural and environmental design standards and flood resiliency criteria	Annual	MA Division of Ecological Restoration	State Appropriation
MassWorks Infrastructure Program	Funds for public infrastructure such as roadways, streetscapes, water, and sewer	Annual	EOHED	State Appropriation
Municipal Small Bridge Program	5 year program (FY17 – FY21) to assist cities and towns with replacing or preserving bridges with spans between 10' and 20'	Bi-Annual	MassDOT	State Appropriation

Table 5-1: Potential Funding Sources for Hazard Mitigation Plan Implementation

Program	Type of Assistance	Availability	Managing Agency	Funding Source
Municipal Vulnerability Preparedness (MVP) Planning and Action Grant Programs	Funding to support cities and towns to begin the process of planning for climate change resiliency and implement priority projects; projects proposing nature-based solutions that rely on green infrastructure or conservation and enhancement of natural systems to improve community resilience are given priority for implementation funding through the MVP Action Grant	Annual	EEA	State Appropriation
Land and Water Conservation Fund Grant Program	Funding for municipalities for the acquisition of parkland, development of a new park, renovation of an existing park, development of trails in an existing conservation or recreation area, or the acquisition of conservation land	Annual	EEA	National Park Service
Drinking Water Supply Protection Grant	Provides financial assistance to public water systems and municipal water departments for the purchase of land in existing Department of Environmental Protection (DEP)-approved drinking water supply protection areas, or land in estimated protection areas of identified and planned future water supply wells or intakes	Annual	EEA	EEA
Landscape Partnership Grant	Funding for large-scale (min. 500 acres), joint conservation projects completed in partnership with federal, state, and local governments, and non-profits	Annual	EEA	EEA
Conservation Partnership Grant	Funds acquisition of conservation or recreation land by non-profit entities	Annual	EEA	EEA
LAND – Local Acquisitions for Natural Diversity	Funding for municipal conservation and agricultural commissions to acquire interests in land that will be used for conservation and passive recreation purposes	Annual	EEA	EEA
PARC - Parkland Acquisitions and Renovations for Communities	Funding for municipalities to acquire parkland, build a new park, or to renovate an existing park	Annual	EEA	EEA

Table 5-1: Potential Funding Sources for Hazard Mitigation Plan Implementation

Program	Type of Assistance	Availability	Managing Agency	Funding Source
Table Acronym Key: DCR = MA Department of Conservation & Recreation; FEMA = Federal Emergency Management Agency; MEMA = MA Emergency Management Agency; EEA = MA Executive Office of Energy & Environmental Affairs; USDA = U.S. Department of Agriculture; NRCS = Natural Resource Conservation Service; EDA = U.S. Economic Development Administration; EPA = U.S. Environmental Protection Agency; FRCOG = Franklin Regional Council of Governments; MassDOT = MA Department of Transportation; EOHED = MA Executive Office of Housing & Economic Development				

Incorporating the Plan into Existing Planning Mechanisms

2014 Hazard Mitigation Plan

The Town of Orange has taken steps to implement findings from the 2014 Hazard Mitigation Plan into the following policy, programmatic areas and plans: the 2016 Open Space and Recreation Plan, the 2020 Municipal Vulnerability Preparedness plan, and ongoing work of the Planning Board to update the Town's zoning bylaws and subdivision regulations with practices to better mitigate localized flooding.

2020 Hazard Mitigation Plan

Upon approval of the Orange Hazard Mitigation Plan by FEMA, the Committee will provide all interested parties and implementing departments with a copy of the plan, with emphasis on Table 4-3: 2020 Orange Hazard Mitigation Prioritized Action Plan. The Committee should also consider initiating a discussion with each department on how the plan can be integrated into that department's ongoing work. At a minimum, the plan should be distributed to and reviewed with the following entities:

- Fire Department
- Emergency Management Director
- Police Department
- Public Works / Highway Department
- Planning Board
- Zoning Board of Appeals
- Conservation Commission
- Franklin County Regional Emergency Planning Committee
- Building Inspector/FCCIP
- Select Board

Some possible planning mechanisms for incorporating the Orange Hazard Mitigation Plan into existing planning mechanisms to the fullest extent possible could include:

- Incorporation of relevant Hazard Mitigation and climate change information into the next Open Space and Recreation Plan. There are opportunities to discuss findings of the hazard mitigation plan and incorporate them into the Environmental Inventory and Analysis section of the OSRP and to include appropriate action items from the hazard mitigation plan in the OSRP Action Plan.

- Any future development of master plans and scenic byway plans could incorporate relevant material from this plan into sections such as the Natural Resources section and any action plans.
- When the Final Draft Hazard Mitigation Plan for the Town of Orange is distributed to the Town boards for their review, a letter asking each board to endorse any action item that lists that board as a responsible party would help to encourage completion of action items.
- The Planning Board could include discussions of the Hazard Mitigation Plan Action Items in one meeting annually and assess progress. Current Subdivision Rules and Regulations and Zoning Bylaws should be reviewed and revised by the EMD, Planning Board and Select Board based upon the recommendations of this plan. Technical assistance from the FRCOG may be available to assist in the modification of Orange's current Bylaws.

Continued Public Involvement

The Town of Orange is dedicated to continued public involvement in the hazard mitigation planning and review process. During all phases of plan maintenance, the public will have the opportunity to provide feedback. The 2020 Plan will be maintained and available for review on the Town website through 2025. Individuals will have an opportunity to submit comments for the Plan update at any time. Any public meetings of the Committee will be publicized. This will provide the public an opportunity to express their concerns, opinions, or ideas about any updates/changes that are proposed to the Plan.

Appendix A – Public Participation

MEETING AGENDA

TOWN OF ORANGE

MULTI-HAZARD MITIGATION PLAN UPDATE PROJECT

Thursday, July 25, 2019

Orange Town Hall

9:00 a.m. – 10:30 a.m.

Project Facilitator: Franklin Regional Council of Governments

1. Introductions
2. Overview of Project and Timeline
3. Overview of Hazards and Climate Change Stressors
4. Discuss Municipal Vulnerability Preparedness (MVP) Grant
5. Discussion of Orange's Risk to Each Hazard Based on the Location, Extent, Probability, and Severity of Hazards
 - a. Review of Draft Critical Facilities & Infrastructure Map
 - b. Review of Environmental Resources Map
6. Schedule Next Meeting



Orange Multi-Hazard Mitigation Plan Update

Project Meeting

July 25, 2019

Sign-in Sheet

Please Print Clearly

Name	Affiliation	Mailing Address/ Email	Phone Number
Jim Young	Fire / EMD	50 Enticld. Dr. Orange jyoung@townoforange.org	978-569-7816
Brenda Anderson	OPD / Business owner	400 EAST RIVER ORANGE police-admin@townoforange.org	978 544 2129 x302
Mercedes Clingerman	Planning Board	135 East Main St Orange planmy@townoforange.org	
Kenneth Wyle	Water Superintendent	16 West Myrtle St. Orange MA 01364 watersuper@townoforange.org	978-544-1115
Rhél Harrie	Building Commissioner	135 East Main St. pharris@townoforange.org	928-544-1103
Xander Sylam	FRIOG	asylam@frio.org	415-265-5302
Gabe Voelker	T.A.	76 William Rue Rd New Salem Ma gvoelker@townoforange.org	978-835-1561-cell

MEETING AGENDA

TOWN OF ORANGE

MULTI-HAZARD MITIGATION PLAN UPDATE PROJECT

Thursday, September 26, 2019

Orange Town Hall

9:00 a.m. – 10:30 a.m.

Project Facilitator: Franklin Regional Council of Governments

1. Introductions
2. Review and Discuss Follow-up Materials from First Meeting (specifically Tier II information)
3. Discussion of Orange's Risk to Each Hazard Based on the Location, Extent, Probability, and Severity of Hazards
4. Discussion of Recent Hazard Events and Review of Second Drafts of the Critical Facilities & Infrastructure Map and Environmental Resources Map
5. Plan MVP Workshop Scheduled for Tuesday, October 22nd from 8:30 am -2:00 pm
6. Schedule Next Meeting



Orange Multi-Hazard Mitigation Plan Update

Project Meeting

September 26, 2019

Sign-in Sheet

Please Print Clearly

Name	Affiliation	Mailing Address/ Email	Phone Number
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James Young	Fire / EMD	jyoung@townoforange.org	978-569-7816
Ken Wysz	Water Dept.	watersuper@townoforange.org	978-544-1115
Gebe Voelker	T.A.	gvoelker@townoforange.org	978-544-1100
Amanda Carey	Admin Asst	acarey@townoforange.org	11
Brenda Anderson	OPD / ^{business}	police-admin@townoforange.org	978-544-2129
Xavier Sydn	FRCOG	asylvan@frco.org	
Kimberly MacPhee	FRCOG	kmacphee@frco.org	

Town of Orange
Municipal Vulnerability Preparedness (MVP) Workshop
Community Resilience Building Framework
October 22, 2019 9:00 a.m. – 2:00 p.m.

AGENDA

1. Welcome and Introductions (9:00 a.m.)
2. Summary of MVP Program, Climate Change and Hazard Information, and Expected Workshop Outcomes (9:15 a.m.)
3. Identify Past, Current and Future Hazards (9:45 a.m.)
4. Determine Top Priority Hazards (10:15 a.m.)
5. Break (10:45 a.m.)
6. Identify and Map Community Vulnerabilities and Strengths for Three Sectors (11:00 a.m.)
 - a. Infrastructure
 - b. Societal
 - c. Environmental
7. Break for Lunch (12:00 p.m.)
8. Identify and Prioritize Community Resiliency Actions (12:45 p.m.)
9. Determine Overall Priority Actions for Orange (1:30 p.m.)
10. Follow-up actions and next steps (1:50 p.m.)
11. Workshop Ends (2:00 p.m.)

Orange Municipal Vulnerability Preparedness Workshop- List of Participants

October 22nd, 2019

CRB Workshop Participants: Department/Commission/Representative:

James Young, Orange Fire Department
Tom Bates, Mahar Regional School
Colin Killay, Orange Highway Department
David Small, Athol Planning Board
Mercedes Clingerman, Orange Planning Board
Jami Kolosewicz, Orange Board of Health
Kenneth Wysk, Orange Water Department
Phil Harris, Orange Building Commissioner
Deb Habib, Seeds of Solidarity
Pat Larson, Quabbin Harvest
Alex MacLeod, Launch Space
Julie Davis, Quabbin Harvest
Andrew Smith, Massachusetts Executive Office of Energy and Environmental Affairs
Brenda Anderson, Local business
James Sullivan, Orange Police Department

CRB Workshop Project Team: Organization and Role

Town of Orange

Gabe Voelker, Town of Orange Administrator
Amanda Carey, Town of Orange Administrative Assistant

Franklin Regional Council of Governments:

Kimberly Noake MacPhee, Lead Presenter
Megan Rhodes, Co-Facilitator
Helena Farrell, Scribe
Xander Sylvain, Scribe
Allison Gage, Scribe

MEETING AGENDA

TOWN OF ORANGE

MULTI-HAZARD MITIGATION PLAN UPDATE PROJECT

Project Facilitator: Franklin Regional Council of Governments

August 25th, 2020 10:00 AM, via Zoom

Join via computer:

<https://us02web.zoom.us/j/87347143585?pwd=SHRGYXRaQVdITUN0MUh3WkxJWVFhQT09>

Join via phone: 1-929-436-2866; Meeting ID: 873 4714 3585; Password: 278590

1. Introductions
2. Review Draft 2020 Multi-Hazard Mitigation Prioritized Action Plan
3. Review any outstanding questions on the hazard profiles
4. Schedule Public Forum

Orange Hazard Mitigation Plan Update Meeting

August 25th, 2020

Meeting held via zoom; participants are listed as follows:

1. Alec Wade, Director of Community Development, Town of Orange
2. Mercedes Clingerman, Orange Planning Board
3. Colin Killay, Orange Highway Superintendent
4. Brenda Anderson, Representative for local businesses
5. Kimberly Noake MacPhee, FRCOG
6. Allison Gage, FRCOG



Town of Orange

Multi-Hazard Mitigation Plan

DRAFT AVAILABLE for REVIEW

September 23rd, 2020

Dear Stakeholder:

Increasingly, we find ourselves responding to more unpredictable and severe weather events that damage the Town of Orange's infrastructure, natural resources, and local economy, and threaten the health and welfare of residents. The costs and impacts to the Town remind us that we need to continue working to reduce our risk and increase our resilience to these extreme storm events. The Orange Multi-Hazard Mitigation Plan Update Committee, in partnership with the Franklin Regional Council of Governments (FRCOG) Planning Department, has prepared a draft 2020 Multi-Hazard Mitigation Plan that is ready for public review. Once the 2020 Plan is approved by FEMA and adopted by the Town, Orange will be eligible for state and Federal grant monies to fund pre- and post-disaster mitigation projects. The purpose of this Multi-Hazard Mitigation Plan update is to identify natural and other hazards that may impact the community; conduct a risk assessment to identify infrastructure at the highest risk for being damaged by hazards; inventory and assess current Town hazard mitigation policies, programs, and regulations; and identify action steps to prevent damage to property and loss of life.

A draft version of the 2020 Multi-Hazard Mitigation Plan is available on the Town's website for your review and can be accessed here: https://www.townoforange.org/sites/g/files/vyhlif1036/f/uploads/orange_hazard_mitigation_plan_public_comment_draft.pdf

A paper copy is also available at the Town Office on 6 Prospect Street in Orange.

A public forum will be held at 6:00pm on Wednesday, September 30th during the Board of Selectmen meeting.

Public Comment Period to run until October 7th, 2020

Comments can be submitted to:

Alec Wade

Director of Community Development

6 Prospect Street

Orange, MA 01364

awade@townoforange.org

Allison Gage

From: Allison Gage
Sent: Wednesday, September 23, 2020 2:00 PM
To: Allison Gage
Cc: 'awade@townoforange.org'
Subject: Orange Hazard Mitigation Plan - Public Comment Period
Attachments: Orange FLYER_HazMit Plan DRAFT available.pdf

Good afternoon,

I am writing to let you know Orange's draft Hazard Mitigation Plan is available for review and the public comment period is open until October 7th. The plan is posted online here:
https://www.townoforange.org/sites/g/files/vyhlif1036/f/uploads/orange_hazard_mitigation_plan_public_comment_draft.pdf. If you would like to submit a comment, please contact Alec Wade at awade@townoforange.org. Additional information is on the attached flyer.

Thank you,
Allison

Allison Gage

Land Use & Natural Resources Planner
Franklin Regional Council of Governments
12 Olive Street, Suite 2
Greenfield, MA 01301
413-774-3167 x136
www.frcog.org

TOWN OF ORANGE
Select Board Meeting (Via Zoom)
September 30, 2020
Final Minutes

The meeting is recorded and aired by AOTV.

PRESENT: Ryan Mailloux, Chair; Jane Peirce, Vice Chair; Thomas Smith, Clerk; Alexandre Schwanz, member.

Absent: Pat Lussier

Other Town Employees Present: Gabe Voelker, Town Administrator, Alec Wade, Director of Planning and Community Development; Nancy Blackmer, Town Clerk. Matt Fortier, Board of Health; Jamie Sullivan, Police Chief.

Public: Via Zoom – Ann Reed

I. CALL THE MEETING TO ORDER – Ryan Mailloux called the meeting to order at 6:30 p.m.

II. SCHEDULED APPOINTMENTS –

a. Nancy Blackmer, Town Clerk appeared via Zoom for the following items:

i. Sign Warrant for November Election – The Board was presented the Warrant for the November elections for the President, Senators, Two Questions. Needs to be signed so it can be posted. **Jane Peirce made a motion to sign the warrant for the November 3 election. Tom Smith seconded. No questions. Roll call vote: Jane Peirce, aye; Alexandre Schwanz, aye; Tom Smith, aye; Ryan Mailloux, aye. Motion carries.**

ii. Electioneering During Early and Absentee Voting – Nancy Blackmer read MGL Chapter 54 Section 65 – Electioneering During Early and Absentee Voting: “Whereas, Chapter 54, Section 65 of the General Laws of Massachusetts prohibits “electioneering” (the display or distribution of material intended to influence the actions of voters) at or within 150 feet of the entrance of polling places at an election of federal, state or local offices:

Whereas, an increasing percentage of Orange voters are taking advantage of their right and opportunity to vote in-person by absentee ballot or during the Early Voting Period established by the Legislature, and come to the Town offices at 6 Prospect Street in order to obtain absentee ballots or cast early ballots;

Whereas, such voters should be given the same right and opportunity to cast or obtain ballots free of electioneering activity as is enjoyed by voters who cast their vote on the day of the election;

Whereas, observance of the 150-foot rule established by Chapter 54, Section 65 at the Town offices during in-person absentee voting or the Early Voting Period would not unduly restrict the ability of a person to display or distribute campaign messages to prospective voters approaching the Town offices; and

Whereas, the Town Administrator has the care, custody and control of the Town offices at 6 Prospect Street and the surrounding sidewalks and may regulate activity thereon;

The Board of Selectmen adopts the following regulation for the period designated for in-person absentee voting and the State's Early Voting Period:

No poster, card, handbill, placard, picture or circular intended to influence the action of the voter, other than those expressly authorized by G.L. Chapter 54, Section 65, shall be posted, exhibited, circulated, or distributed in the Town Clerk's office in the building where the Town Clerk's office is located, on the walls thereof, on the premises on which the Town offices at 6 Prospect Street stand within one hundred and fifty feet (150') of the building entrance door to the said Town offices.

Jane made a motion to approve the guidelines of restrictions of campaigning at early voting as read by Nancy Blackmer, seconded by Tom Smith. No further discussion. Roll call vote: Jane Peirce, aye; Alexandre Schwanz, aye; Ryan Mailloux, aye; Motion carries.

b. FCRHRA

- i. Approval of Final Quarterly Report for FY18 Orange CDBG – Brian** McHugh spoke to the Board about the rehab of the units. There were 18 for total rehab. He described each of the sections of the units and what were the requirements of these projects. Now in the middle of FY19 program and processing people. A letter was sent to the Board and he'd ask that Ryan signs on behalf of the Board. No questions. **Jane made the motion to approve the final quarterly report for the FY18 Orange CDBG Grant and many thanks to Mr. McHugh on his achievement. Seconded by Tom Smith. No further discussion. Jane Peirce, aye; Alexandre Schwanz, aye; Tom Smith, aye; Ryan Mailloux, aye. Motion carries.**
- ii. Response to Special Conditions for FY20 Orange CDBG-CV (COVID funding)** The grant that the Town was awarded for the CDBG COVID funds was cut back by 10% so budget was cut back. There are special conditions such as a little bit more information on how to prevent the effects of COVID. They want a little bit more detail. Social Service agencies provided more information. LifePath will deliver home meals. Electronic mediations services will also be provided by other groups. Seeds of Solidarity also responded to how they would take care of reduced exposure of COVID. There is a bit of crossover on the FY19 and FY20 and wants to make sure there is no double-dipping. Budgets have been revised and detail has been provided so it will not be any duplication. Mr. McHugh would like the Board to approve for submission as he feels the groups have responded correctly to special conditions. **Jane Peirce made a motion to approve a letter describing the special conditions for the FY20 CDBG Grant. Seconded by Tom Smith. No further discussion. Roll call vote: Jane**

Peirce aye; Tom Smith, aye; Alexandre Schwanz, aye; Ryan Mailloux, aye. Motion carries.

c. Allison Gage – FRCOG

- i. Hazard Mitigation Plan Public Forum** – Allison gave a PowerPoint presentation to the Board to update the Town's Hazard Mitigation Plan. The Plan is to reduce potential hazards for disasters. 2014 was the last time the Hazard Mitigation Plan was updated for Orange. She showed the difference between the 2014 Plan and the 2020 Plan and the highlighted portions were the new ones added. Climate Change adds to these new additions. She gave an overview of the climate changes such as temperature, precipitation, extreme weather events is likely to increase. The 2020 Plan shows past/present/future events. The Committee went through and ranked the Town's hazards and the events should they occur. Also, after each hazard they identified mitigation strategies using bylaws and shelters. The public comment period on the Action Plan is until October 7, 2020. Once it is approved, a more target presentation on the top hazards will be given as this is an overview. The Plan and Action Plan is posted on the Town website. Jane asks if the maps from 2014 have been updated or still using? Allison stated the maps have been updated. No other questions, Ryan encourages members to look over the Plan up until October 7, 2020.

III. GENERAL BUSINESS

- a. Halloween Discussion** – Chief Sullivan and Matt Fortier entered into the Chat Room to discuss Halloween. Matt spoke to the Board stating Orange has been COVID free due to the residents doing a great job social distancing, wearing masks and practicing good hygiene. Everyone is asking if Trick or Treating is allowed on Halloween. The State has referred to the CDC and has given very little guidance. Matt stated that if Halloween is cancelled in Orange, it would possibly lead to residents going to other areas that are not as safe as Orange. He feels that if Halloween is managed with a timeframe, using hand sanitizer, not leaving light on should anyone be sick in that household. Chief Sullivan stated residents know what needs to be done in order to stay safe such as meeting at the end of the driveway, wear a mask etc. He's more worried about having house parties of Trick or Treat is not allowed. He also stated that it would be a spotter for further down the road that if after Halloween there is a spike in cases, then they can revisit and do differently. Overall he feels everyone knows what to do to be safe. Ryan feels the Board should support Halloween by setting a timeframe, use masks and sanitizer. Chief also stated it will be reevaluated right up until the day of Halloween. Jane stated the community has been incredible at maintaining hygiene and keeping COVID free. Best to keep local and set hours. Tom stated he is supportive of having Halloween and keep it within Orange. Tom recommends 5-8 p.m. **Jane Peirce made the motion to have Halloween on October 30, 2020 between the hours of 5-8 p.m. Seconded by Tom Smith. No further discussion. Roll call vote: Jane Peirce, aye; Alexandre Schwanz, aye; Tom Smith, aye; Ryan Mailloux, aye. Motion carries.**
- b. Resignation of Karon Parker from the Orange Elementary School Committee and thank you letter** – Ryan Mailloux read the following letter:

- i. To Whom It May Concern: Please let this letter be my official letter of resignation from the Orange Elementary School Committee, effective immediately. During this COVID pandemic I have found it difficult to fully focus on the very important topics at hand with the committee(s). Thank you for the opportunity to work with the school committees. Best Regards, Karon Parker.
Jane made the motion to accept the resignation letter from Karon Parker for the Orange Elementary School Committee and send her a letter thanking her. Seconded by Tom Smith. No further discussion. Roll call vote – Jane Peirce, aye; Alexandre Schwanz, aye; Tom Smith, aye; Ryan Mailloux, aye. Motion carries.
- c. **Discussion on Public Input** – Alexandre Schwanz stated that since the fifth Board member is not present, he'd like to move this discussion to the next meeting when the full Board is present.
- d. **Discussion on Sewer Commissioners** – Alexandre Schwanz stated that since the fifth Board member is not present, he'd like to move this discussion to the next meeting when the full Board is present.
- e. **Accept Contract for Hill International** – Gabe gave a brief synopsis to the Board of this item on the agenda. It is basically a standard contract between Hill and RDA on the building of the Elementary School. MSBA requires the Chair sign the contracts. Hill works for the Town as the Project Manager and RDA is the architects doing the planning and designing of the school. Ryan states that he is on the School Building Project Committee so actually can make a motion for item "g". **Jane Peirce made a motion that Ryan Mailloux as Chair sign all contracts and supporting documents through the MSBA for the school building project. Seconded by Tom Smith. No further discussion. Roll call vote – Jane Peirce, aye; Alexandre Schwanz, aye; Tom Smith, aye; Ryan Mailloux, aye. Motion carries.**
- f. **Accept Contract for RDA** – see "e" above
- g. **Authorization for the Chairman, Ryan Mailloux, to sign all contracts for the MSBA and the School Building Projects** – see "e" above.

IV. ANNOUNCEMENTS – Ryan Mailloux read the following announcements:

- a. Vote by Mail postcards were mailed recently by the Secretary of State's office. If you returned a card previously requesting a ballot, you will not receive another card. If you did not receive a card and wish to vote by mail for the November 3rd election, you can download an application from the Town's website – www.townoforange.org – and mail it to the Town Clerk. Ballots for the November election should be mailed by early October. All applications for vote by mail ballots must be postmarked by October 20. Vote by mail ballots can be returned by mail or dropped in the green labeled Early Voting Ballots Here. This box is emptied several times each day. It is recommended that you request your ballot early and return it quickly so that you will be assured your ballot is counted. You can track you ballot at <https://www.sec.state.ma.us/wheredoivotema/track/trackmyballot.aspx>
- b. Early Voting in person will begin on Saturday, October 17 and run until Thursday, October 29. The hours are Saturday and Sunday 9-1, Monday through Thursday 9-12:30

and 1-4. The Town Hall is closed on Fridays so there is no Early Voting on Fridays. Early Voting will be held in the Town Hall.

- c. The last day to register to vote for the November 3rd election is Saturday, October 22. You can register to vote online at www.registertovotema.com or applications are available in a box outside town hall (next to the Early Voting box). Complete the application and return it to the Town Clerk's Office.
- d. The election will be held on November 3 at St. Mary's Parish Center on 20 West Myrtle Street. The polls will open from 7:00 a.m. until 8:00 p.m.
- e. The Community Development Department will be hosting its first ever 'Orange Community Forum' at 6 p.m. on Monday, October 5. This virtual event will provide Orange residents the opportunity to weigh in on grant opportunities and projects for the coming year. All are invited to attend and participate, or tune in live with AOTV. To register, please contact the Director of Community Development at awade@townoforange.org.
- f. The Town of Orange has partnered with the City of Greenfield to provide micro-enterprise grants to businesses of 5 or fewer. These grants are intended to support businesses struggling due to COVID 19. First round applications are due on October 15th and the application can be found on the City of Greenfield website. If you require more information, please contact the Orange Director of Community Development at awade@townoforange.org.
- g. The Town of Orange is undergoing a parking management study and zoning review. If you or someone you know would like to assist in the review or volunteer for focus groups, please send your name, contact info and an explanation of your interest to awade@townoforange.org.

V. OPEN TIME FOR THE PUBLIC – The public is asked to register in advance for this webinar by visiting:

https://vs02web.zoom.us/webinar/register/WN_tiwWsu7zQ3COJAHLYc5g_Q

After registering, the public member will receive a confirmation email containing information about joining the webinar.

Ann Reed made a comment in regards the Hazard Mitigation Plan and asks the Board as to how they approach it with moderation whereas climate change is the premise and that there is not the counter-science is weighed in as well. Not everyone believes and projects all this climate change as presented. Jane asked Ann to present the Board with documentation to alternate theories to counteract the information that was presented at tonight's Mitigation presentation. She asks the Board to approach with an open mind.

No other members of the public for discussion.

VI. WORKING SESSION

- a. **Personnel Policies 2.6 through 2.10** – Trish is not attending this evening's meeting so any changes will be brought to her attention.

Policy 2.6 – Technology – Jane had a few items that need to be included such as written communications about confidentiality. Also something that requires using computers and passwords and if the employee leaves, the passwords are needed. Also, there needs to be something about bringing in thumb drives or using outside equipment and the possibility of picking up an outside virus. Suzor needs to be asked about this such as a block being put on so it does not happen. Alexandre commented on the second page such as using personal mobile device as how restrictive it is. He stated he is connected to his cell phone even when he is working. He feels the writing of this policy is a bit restrictive on the use of the mobile device. Other wording should be used. During modern times, the cell phone is an extension of oneself and Alexandre does not want a policy that is too restrictive. Tom felt it was okay as written. Rewording will be passed along to Trish.

Policy 2.7 – Travel and Expense Reimbursement – Ryan likes the idea of tips being increased to 20%. Jane feels it is a generous policy. **Jane made the motion to accept this policy and seconded by Tom Smith. Gabe made mention that the Town of Orange rarely uses dining reimbursement. No further discussion. Roll call vote: Jane Peirce, aye; Alexandre Schwanz, aye; Tom Smith, aye; Ryan Mailloux, aye. Motion carries.**

Policy 2.8 – Use of Town Property and Vehicles – Jane adds that use of electronic devices while driving a vehicle is prohibited. Tom asks if smoking in town vehicle is allowed. Jane states the No Smoking Policy does state on Town Property and actually a town vehicle is town property. Gabe suggests smoking should be added to this policy. It will be brought to Trish.

Policy 2.9 – Work from Home Policy – Jane asks if the Town provides laptops. Gabe states the Town is moving in that direction. Gabe says it is under Emergency Management where in the future, the Town can be run still utilizing Town laptops. Also so employees do not use personal computers. The Accountant, Town Clerk and Town Planner now has laptops so the Town is moving in that direction. Ryan states it is a well written policy. **Jane made the motion to approve 2.9 Work from Home Policy and seconded by Tom Smith. No further discussion. Roll call vote: Jane Peirce aye; Alexandre Schwanz, aye; Tom Smith, aye; Ryan Mailloux, aye; Motion carries.**

Policy 2.10 – Workplace Violence, Prevention and Safety Policy – **No discussion and no need for changes. Jane Peirce made the motion to approve this policy as written. Tom Smith, seconded. No further discussion. Roll call vote: Jane Peirce, aye; Alexandre Schwanz, aye; Tom Smith, aye; Ryan Mailloux, aye; Motion carries.**

At the next meeting, the Board will work on Policy 3.1 through 3.5

VII. APPROVAL OF THE MINUTES

- a. August 5, 2020**
- b. August 19, 2020**
- c. August 26, 2020**
- d. September 2, 2020**
- e. September 16, 2020**

The Board received the above minutes and reviewed. **On a motion by Jane Peirce and seconded by Tom Smith, the above minutes were approved as written. No discussion. Roll call vote: Jane Peirce, aye; Alexandre Schwanz, aye; Tom Smith, aye; Ryan Mailloux, aye. Motion carries.**

VIII. TOWN ADMINISTRATOR'S REPORT

Gabe stated that the Town has been very active. She asks the public to attend the Forum that Alec is holding on October 5 at 6 p.m. This is a perfect time for the Town to participate and hear what the plans are for the month of October.

IX. BOARD OF SELECTMEN'S REPORT

Alexandre Schwanz did have the opportunity to participate in the dedication of Hazel's Park for Hazel Lackey. He thanks the public who participated.

Jane stated that Rick Shaughnessy has begun to hide geocaches in Bicentennial Park. She also stated the North Main Street project is still being worked on. The Town is still paying the funding and State paying the construction. The engineering design has had a monkey wrench thrown in due to Covid. The state funding through FRCOG. It's a TIPF and the consequence is the Town has been bumped to 2024 because StanTech is to blame and the Principal needs to be spoken to. The Board will make a statement to StanTech that they need to follow through on schedule and they dropped the ball. A letter will be written.

Tom Smith wished Kevin Donelan a wonderful retirement. He gave Kevin's employment history and he has earned this retirement.

The Orange Merchant's Group will be meeting tomorrow night and one item on the agenda is the lamp decorating and hope to continue with that for this winter season

Tom also updated on the South Main/East River Street property. He read a statement from Alec Wade about the South Main and East River property. It read:

Regarding the property at the corner of South Main Street and East River Street – Over the Summer, the planning board issued an extension to the Property Owner at the corner of South Main and East River Streets. AS part of the conditions to this extension, the property owner will be responsible for the continued maintenance of the site until build out. This has resulted in the much cleaner cut and presentable lot that citizens have been seeing. With the special permit extension, I am confident that the property owner will make every effort to complete their construction by Summer 2021. If they cannot do so, the planning board has expressed their intent to revisit the project and hold the property owner accountable. Recently, the property owner

assisted in the preparation of a grant application through my office. I felt they were great neighbors to work with and I am excited to see their project get underway in the next construction season.

Ryan has not updates to share this evening.

X. UPCOMING MEETINGS – October 14, 2020

XI. EXECUTIVE SESSION

- a. **M.G. L. c.30A, Sec.21 (a) Reason 3. To discuss strategy with respect to collective bargaining or litigation if an open meeting may have a detrimental effect on the borrowing or litigating position of the public body and the chair so declares.**
- b. **Approval of Executive Session Minutes**
 - i. **April 20, 2020**
 - ii. **June 17, 2020**
 - iii. **July 15, 2020**

XII. ADJOURNMENT – Jane made a motion to adjourn the meeting at 7:50 p.m. to enter into executive session and not to return to regular session. Seconded by Tom Smith. Roll call vote: Jane Peirce, aye; Alexandre Schwanz, aye; Tom Smith, aye; Ryan Mailloux, aye. Meeting adjourned.

Respectfully submitted,



BettyLou Mallet
Minutes Recorder

Approved by Orange Select Board – 10/14/20

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2020 Orange Hazard Mitigation Plan Public Comment

POSTED ON: SEPTEMBER 22, 2020 - 2:45PM

Increasingly, we find ourselves responding to more unpredictable and severe weather events that damage the Town of Orange's infrastructure, natural resources, and local economy, and threaten the health and welfare of residents. The costs and impacts to the Town remind us that we need to continue working to reduce our risk and increase our resilience to these extreme storm events. The Orange Multi-Hazard Mitigation Plan Update Committee, in partnership with the Franklin Regional Council of Governments (FRCOG) Planning Department, has prepared a draft 2020 Multi-Hazard Mitigation Plan that is ready for public review. Once the 2020 Plan is approved by FEMA and adopted by the Town, Orange will be eligible for state and Federal grant monies to fund pre- and post-disaster mitigation projects. The purpose of this Multi-Hazard Mitigation Plan update is to identify natural and other hazards that may impact the community; conduct a risk assessment to identify infrastructure at the highest risk for being damaged by hazards; inventory and assess current Town hazard mitigation policies, programs, and regulations; and identify action steps to prevent damage to property and loss of life.

A draft version of the 2020 Multi-Hazard Mitigation Plan is available on the Town's website for your review and can be found [here](#). A draft of the action plan can also be found [here](#).

A paper copy is also available at the Town Office on 6 Prospect Street in Orange.

Public Comment Period to run until October 7th, 2020

Comments can be submitted to:

Alec Wade

Director of Community Development

6 Prospect Street

Orange, MA 01364

awade@townoforange.org

2020 Orange Hazard Mitigation Action Plan

A Vision for Downtown Orange

Butterfield Park Renovations

Com. Dev. Strategy (2015)

Commercial Property Assessed Clean Energy Program (PACE)

EDIC ED Plan

East Main Pocket Park Vision

Exit 15 Job Creation Corridor

Forging Ahead (UMASS Study)

Lower Millers Trail Project

Main Streets Turning Study

OIC Parking Expansion Plan

Orange Goes For The Green

Orange Greenway (Draft)

Orange Hazard Mitigation Plan Public Comment Draft



[www.recorder.com /North-Quabbin-Notebook-October-5-36552024](https://www.recorder.com/North-Quabbin-Notebook-October-5-36552024)

Orange Notebook: Oct. 5, 2020

By TALIA GODFREY -

3-3 minutes

Published: 10/4/2020 3:16:28 PM

Draft 2020 Multi-Hazard Mitigation Plan ready for public review

ORANGE — The Orange Multi-Hazard Mitigation Plan Committee, in partnership with the Franklin Regional Council of Governments' Planning Department, has prepared a draft 2020 Multi-Hazard Mitigation Plan that is ready for public review. Once the 2020 plan is approved by FEMA and adopted by Orange, the town will be eligible for state and federal grant money to fund pre- and post-disaster mitigation projects.

The purpose of this plan update is to: identify natural and other hazards that may impact the community; conduct a risk assessment to identify infrastructure at the highest risk of being damaged by hazards; inventory and assess current town hazard mitigation policies, programs, and regulations; and identify action steps to prevent damage to property and loss of life.

The public comment period will run until Wednesday. Comments may be submitted to: Alec Wade, Director of Community Development, 6 Prospect St., Orange, MA 01364, awade@townoforange.org.

The draft plan is available at bit.ly/3jy9PD7.

Selectboard authorizes Mailloux to sign contracts

ORANGE — The Selectboard voted unanimously Wednesday to authorize Chairperson Ryan Mailloux to sign all contracts for the Massachusetts School Building Authority and the town's school building projects.

The MSBA is a quasi-independent public authority that provides grants that partially fund municipal and regional school districts for kindergarten through high school construction and renovation projects in the commonwealth.

The Selectboard passed the motion without debate or issue.

American Legion to meet Oct. 14

ORANGE — The first meeting of American Legion Post 172, and a chance to show support to the officers of 2020-21, is slated for at 7 p.m. on Oct. 14.

Following that meeting, the Sons of The American Legion Squadron 172 will meet. Meetings are held on the second Wednesday of the month. Social distancing will be practiced to help prevent the spread of COVID-19.

In July 2019, President Trump signed into law the LegionAct, a bipartisan piece of legislation extending eligibility for American Legion membership to honorably discharged veterans who served since World War II. Sen. Thom Tillis (R-N.C) introduced the legislation with Sen. Kyrsten Sinema (D-AZ). Veterans who were honorably discharged but whose service did not fall into the previous defined war eras may now join the American Legion.

The American Legion Auxiliary Unit 172 plans to hold its first meeting Nov. 11 at 7 p.m.



Appendix B – FEMA Plan Review Tool

LOCAL MITIGATION PLAN REVIEW TOOL

Town of Orange, MA

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

Jurisdiction: Town of Orange, MA	Title of Plan: Town of Orange Hazard Mitigation Plan	Date of Plan: November 2, 2020
Single or Multi-jurisdiction plan? SINGLE		New Plan or Plan Update? UPDATE
Regional Point of Contact: Kimberly Noake MacPhee, P.G., CFM Land Use & Natural Resources Planning Program Manager Franklin Regional Council of Governments 12 Olive Street, Suite 2 Greenfield, MA 01301 413-774-3167 x130 Fax: 413-774-3169 KMacPhee@frcog.org		Local Point of Contact: Alec Wade Director of Community Development Town of Orange 6 Prospect Street Orange, MA 01364 978-408-9453 awade@townoforange.org

State Reviewer: Jeffrey Zukowski	Title: MA Hazard Mitigation Planner	Date: 11/21/2020
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FEMA Reviewer: Marie-Annette (Nan) Johnson Sean Loughlin	Title: Region I Community Planner Community Planner	Date: 12/31/2020 2/4/2021
Date Received in FEMA Region I	11/21/2020	
Plan Not Approved		
Plan Approvable Pending Adoption	12/31/2020	
Plan Adopted	1/27/2021	
Plan Approved	2/4/2021	

SECTION 1: REGULATION CHECKLIST

INSTRUCTIONS: The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the Plan by Element/sub-element and to determine if each requirement has been ‘Met’ or ‘Not Met.’ The ‘Required Revisions’ summary at the bottom of each Element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is ‘Not Met.’ Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in this *Plan Review Guide* in Section 4, Regulation Checklist.

1. REGULATION CHECKLIST		Location in Plan (section and/or page number)	Met	Not Met
Regulation (44 CFR 201.6 Local Mitigation Plans)				
ELEMENT A. PLANNING PROCESS				
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))	Section 1, pages 1-5 Appendix A	X		
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))	Section 1, page 5 Appendix A	X		
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))	Section 1, pages 2-4 Appendix A	X		
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))	Section 1, page 5 Throughout plan	X		
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))	Section 5, pages 245-247, 253-254	X		
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))	Section 5, pages 245-247	X		
ELEMENT A: REQUIRED REVISIONS				

1. REGULATION CHECKLIST		Location in Plan (section and/or page number)	Met	Not Met
Regulation (44 CFR 201.6 Local Mitigation Plans)				
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT				
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))	Section 3, pages 19-212	X		
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))	Section 3, pages 19-212	X		
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))	Section 2, pages 6-25 Section 3, pages 26-212	X		
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))	Section 2, pages 10-11 Section 3, page 51	X		
<u>ELEMENT B: REQUIRED REVISIONS</u>				
ELEMENT C. MITIGATION STRATEGY				
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))	Section 2 Section 4, pages 213-231	X		
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))	Section 2, pages 10-11 Section 3, page 51	X		
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))	Section 4, page 232	X		
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))	Section 4, pages 237-243	X		
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))	Section 4, pages 232-243	X		
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))	Section 1, page 3-5; Section 5, page 253-254	X		
<u>ELEMENT C: REQUIRED REVISIONS</u>				

1. REGULATION CHECKLIST		Location in Plan (section and/or page number)	Met	Not Met
Regulation (44 CFR 201.6 Local Mitigation Plans)				
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)				
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))	Section 2, pages 6-18 (8-10)	X		
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))	Section 4, pages 222-231; pages 241-243	X		
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))	Section 4, pages 237-241	X		
<u>ELEMENT D: REQUIRED REVISIONS</u>				
ELEMENT E. PLAN ADOPTION				
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))	HMP Adopted on 1/27/2021 and signed Adoption Certificate on file	X		
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))	This is a single jurisdiction plan.	n/a		
<u>ELEMENT E: REQUIRED REVISIONS</u>				
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)				
F1.				
F2.				
<u>ELEMENT F: REQUIRED REVISIONS</u>				

SECTION 2: PLAN ASSESSMENT

A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Recommended Corrections:

- The appendices A & B have been omitted from the plan's Table of Contents. There is also conflicting information in the Table of Contents with where the Adoption Resolution is located. Correction is needed to locate the Adoption Resolution. Also, consider locating the Adoption Resolution up at the front of the plan after the cover page for more prominence and recognition. Consider identifying the state (MA) in the plan's cover page adoption title (especially for non-local readers), i.e., Town of Orange, MA Hazard Mitigation Plan.

Element A: Planning Process

Strengths:

- Incorporation of the Municipal Vulnerability Preparedness planning process ensured a more comprehensive approach to mitigation. The Town is working together with the FRCOG on regional planning benefitting the collaboration and integration of these hazard mitigation planning elements.
- Multiple methods of virtual public outreach were utilized, allowing for convenient participation opportunities even during the pandemic. Community officials and stakeholders were effectively engaged in the planning process. Their feedback shaped the content of the plan.
- Materials from the plan development process are included and will be a potentially useful reference during future plan updates.
- Excellent readability, plan organization, and use of graphics. Great maps and good documentation throughout and good citations for the sources of information.
- The authorities which regulate development are not just listed but are explained.

Opportunities for Improvement:

- Recommend providing the tool(s) that is to be used for the plan monitoring and evaluation. For example, within each plan update provide the form or a template that will be used to collect and evaluate the plan maintenance information. Then in the next plan update, a summary can be provided along with the form/tool that explains the outcomes of the plan maintenance over the last 5 years. The form/tool might collect information such as the progress of the implementation of the actions and how the action is addressing each of the identified vulnerabilities (connection of action to the Town's problem statements). Also, how this is meeting the Town's mitigation goals and the effectiveness of the planning process including public involvement.

Element B: Hazard Identification and Risk Assessment

Strengths:

- The risk assessment is well organized, very comprehensive, and provides very thorough descriptions of the hazards and vulnerabilities that are easy to read and understand. It places the community's risk in the context of the surrounding areas and even within the state. Well done!
- Vulnerability and risk are described from several important aspects (society/vulnerable populations, health and economic impacts, infrastructure/assets, environment).
- Excellent use of scales to show the magnitude/extent of the hazard.
- Provides clearly stated problem statements for each hazard which describe the vulnerabilities. These statements also address the priorities for these vulnerabilities rather than just for the hazard.
- The plan does an excellent job of identifying how the probability or severity of future hazard events may change in the future due to changes in climate, population, or land use.
- This local Plan coordinates its information and processes well with the most current State Hazard Mitigation Plan.
- The plan does a good job identifying dam hazards both inside the town and upstream communities that may pose a risk.

Opportunities for Improvement:

- Ensure that the Risk Assessment connects with the Community Profile information. The Community Profile information provides a detailed look at the community in terms of its assets, population and development, and features. However, this valuable information like the historic structures are not really addressed within the risk assessment. Recommend improving the connection between this more detailed look at the community assets (in the Profile section) and their vulnerabilities and risk (in the Risk Assessment section – also see comment below regarding changes in development found in the Profile section).
- Vulnerability is used to represent risk in some sections. Vulnerability is not the same as risk and should therefore avoid interchanging these terms. Consider vulnerability to be what could happen to that community asset – what, how and why it is vulnerable or exposed to the impacts from the hazard(s). The risk would be how likely the asset could be impacted given the location, extent, its history/probability and its exposure (e.g. high to low risk).
- The connection between the vulnerability problem statements under each hazard section and the solutions (mitigation actions) can be strengthened in future updates. This can be accomplished in the Mitigation Strategy section or as an appendix. Within the proposed actions table, the action can also be accompanied by the information that identifies which problem(s) the action is addressing. This added information then addresses how the action (solution) will reduce or eliminate the root cause of what's creating the vulnerability in the first place (the problem statement) as identified in the risk assessment.
- Further explore the root causes of the vulnerabilities by asking more "why" questions to get stronger vulnerability problem statements for mitigation. For example, why is the identified part of the town vulnerable to say wildfire? Is it the construction of how the

structures are built (e.g. wood shake roofs, close proximity to other structures, open decks and soffits)? Is it the fuels surrounding the structures (no defensible space, lacking fuel breaks, type of vegetation)? Then the solutions can more effectively address risk reduction for the long term such as replacing wood roofs with more fire-resistant materials. Also introducing standards in site design for new development or redevelopment by providing fuel breaks, defensible space, and construction design.

- Changes in development appears to be only addressed in the Community Profile section through population and trends and with little relation to changes in risk. Changes in a community's development is considered one of the greatest factors for changes in risk and needs to be addressed within the risk assessment. Trends do not fulfill the requirement to *identify the (re-)development that has occurred in the jurisdiction in hazard prone areas or conditions since the last plan approval*. Bring meaning to this by providing more specifics of what this development was and how it has affected the Town's risk. If none, then this must be stated in the risk assessment. (Refer to the FEMA Guidance for the "development" definition.)
- Whenever possible, do provide more historical key events in the previous occurrence hazard information when starting with data in the 1990s. For example, summarize any significant historical information between an event that took place in the early 1900s (or earlier if records exist) and those events starting with data from 1996 using best available information. Often these accounts can be located by the local historic preservation society and in the library. This will further support the probability information. Ensure the history of previous events is updated through 2020 for all hazards.
- Identify key NFIP related data such as variances, important site visits and floodplain management ordinance or model bylaw that are relative to the vulnerability and risk assessment.

Element C: Mitigation Strategy

Strengths:

- The plan provides a comprehensive, detailed description of the community's existing programs, plans, and policies that relate to mitigation.
- The plan highlights the different plans and programs into which the community can and has incorporate(-d) in the mitigation plan.
- The Strategy is comprehensive in alternatives and approaches. Good mitigation actions for both existing and new development. Leads with nature-based solutions for mitigation and resiliency.
- The plan identifies a range of potential resources for implementing the mitigation strategy, increasing opportunities for success.

Opportunities for Improvement:

- The first two goals (out of 3) are preparedness goals and thus leaves only one mitigation goal. A plan can be most effective with a range of 3-5 *mitigation* goals. Consider what is to be achieved by the actions. Using the problem statements can help to develop these goals.

Establish detailed goals that are meaningful to the community and encourage the development of a robust mitigation strategy. Focus the plan's goals on alleviating long-term risks and vulnerabilities.

- Ensure that the focus of the mitigation strategy is on mitigation, rather than preparedness. Mitigation actions reduce or eliminate long-term risk and are different from actions taken to prepare for or respond to hazard events. Mitigation activities lessen or eliminate the need for preparedness or response resources in the future. If there are preparedness actions, it is helpful for the reader to identify these as such to clarify these differences.
- To accomplish this (above comment), examine risk separately from current preparedness and response efforts. While current response capabilities may be considered adequate for minimizing the effects of a disaster, there could still be mitigation actions that would reduce the need to have as many response assets in the first place.
- The greatest potential opportunity in upcoming plan updates lies in further understanding the root causes of the Town's vulnerabilities and developing the solutions that target those root causes. Then demonstrate how progress is being made through these actions towards alleviating or minimizing the identified vulnerabilities (problem statements) for the long term and thus meeting the Town's *mitigation* goals.
- Clarify whether there is an improvement component to replacements and repairs (i.e., a mitigating factor to it). Otherwise, these are not considered mitigation if these are not sustained or are long-term solutions.
- See previous comments found in Element B about improving the connection between the problem statements found in the risk assessment and the individual actions (solutions). Provide more details about what the mitigation actions will entail, the tasks that will be involved, and how these will mitigate the vulnerabilities as determined by the problem statements.
- Identify key NFIP related information such as variances, important site visits and floodplain management ordinance or model bylaw that are relative to the Town's strategy for NFIP continued compliance. Recommend addressing actions that increase the number of properties with flood insurance policies. To expand and strengthen the NFIP continued compliance requirement, check the new MEMA's Floodplain Management Model Bylaw. <https://www.mass.gov/guides/floodplain-management> Massachusetts 2020 Model Floodplain Bylaws. <https://msc.fema.gov/portal>

Element D: Plan Update, Evaluation, and Implementation (*Plan Updates Only*)

Strengths:

- Good background info and updates on the Town's capabilities that avoid or reduce the potential risk in new development, such as zoning bylaws and plans.
- Priorities in the plan recognize current conditions. They are reflective of the planning process, risk assessment, and mitigation strategy.
- Progress on mitigation actions is clear and comprehensive.

- The priorities are compared for any changes between the proposed actions and those that were carried over from the previously approved plan.

Opportunities for Improvement:

- For future updates of the plan, keep in mind that the development in hazard areas is not limited to the flood hazard. An increase in risk can apply to development within or in proximity to *any* hazard area or occurrence.
- Provide more details about any changes in development that may have occurred since the last plan update. Provide more information of what was constructed, proposed, and/or approved for development since the last HM plan was approved. That can also include property acquisitions, rezoning, building permit statistics, significant building renovations or redevelopments or improvements, change of land use, and change in utility service such as new lines to serve existing or new development or other such infrastructure such as new public water or sewer systems, and road upgrades or access. It can also include changes to development policies, regulations, standards, etc. This information must then be addressed within the risk assessment to associate these changes in development with changes in risk to the community.
- Recommend adding more connectivity to what occurred over the last planning period since the previous plan was approved. What changed, what worked or didn't go accordingly and why? Especially in the plan maintenance methods were laid out in the last plan.
- Including a discussion of lessons learned about implementing mitigation actions would strengthen the plan, as would a short narrative on some "success stories" about their implementation.

B. Resources for Implementing Your Approved Plan

Refer to the [Massachusetts Integrated State Hazard Mitigation and Climate Action Plan](#), [Resilient MA Climate Clearinghouse](#), and State's [Climate Action Page](#) to learn about hazards relevant to Massachusetts and the State's efforts and action plan.

Technical Assistance:

FEMA

- [FEMA Climate Change](#): Provides resources that address climate change.
- [FEMA Library](#): FEMA publications can be downloaded from the library website. These resources may be especially useful in public information and outreach programs. Topics include building and construction techniques, NFIP policies, and integrating historic preservation and cultural resource protection with mitigation.
- [FEMA RiskMAP](#): Technical assistance is available through RiskMAP to assist communities in identifying, selecting, and implementing activities to support mitigation planning and risk reduction. Attend RiskMAP discovery meetings that may be scheduled in the state, especially any in neighboring communities with shared watersheds boundaries.

Other Federal

- [EPA Resilience and Adaptation in New England \(RAINE\)](#): A collection of vulnerability, resilience and adaptation reports, plans, and webpages at the state, regional, and community levels. Communities can use the RAINE database to learn from nearby communities about building resiliency and adapting to climate change.
- [EPA Soak Up the Rain](#): Soak Up the Rain is a public outreach campaign focused on stormwater quality and flooding. The website contains helpful resources for public outreach and easy implementation projects for individuals and communities.
- [NOAA C-CAP Land Cover Atlas](#): This interactive mapping tool allows communities to see their land uses, how they have changed over time, and what impact those changes may be having on resilience.
- [NOAA Sea Grant](#): Sea Grant's mission is to provide integrated research, communication, education, extension and legal programs to coastal communities that lead to the responsible use of the nation's ocean, coastal and Great Lakes resources through informed personal, policy and management decisions. Examples of the resources available help communities plan, adapt, and recovery are the Community Resilience Map of Projects and the National Sea Grant Resilience Toolkit
- [NOAA Sea Level Rise Viewer](#) and [Union for Concerned Scientists Inundation Mapper](#): These interactive mapping tools help coastal communities understand how their hazard risks may be changing. The "Preparing for Impacts" section of the inundation mapper addresses policy responses to protect communities.
- [NOAA U.S. Climate Resilience Toolkit](#): This resource provides scientific tools, information, and expertise to help manage climate-related risks and improve resilience to extreme events. The "[Steps to Resilience](#)" tool may be especially helpful in mitigation planning and implementation.

State

- [Massachusetts Emergency Management Agency](#): The Massachusetts State Hazard Mitigation Officer (SHMO) and State Mitigation Planner(s) can provide guidance regarding grants, technical assistance, available publications, and training opportunities.
- Massachusetts Departments of [Conservation and Recreation](#) and [Environmental Protection](#) can provide technical assistance and resources to communities seeking to implement their hazard mitigation plans.

- <https://www.mass.gov/guides/floodplain-management> Massachusetts 2020 Model Floodplain Bylaws. <https://msc.fema.gov/portal>
- [MA Mapping Portal](#): Interactive mapping tool with downloadable data

Not for Profit

- [Kresge Foundation Online Library](#): Reports and documents on increasing urban resilience, among other topics.
- [Naturally Resilient Communities](#): A collaboration of organizations put together this guide to nature-based solutions and case studies so that communities can learn which nature-based solutions can work for them.
- [Rockefeller Foundation Resilient Cities](#): Helping cities, organizations, and communities better prepare for, respond to, and transform from disruption.

Funding Sources:

- [Massachusetts Coastal Resilience Grant Program](#): Funding for coastal communities to address coastal flooding, erosion, and sea level rise.
- [Massachusetts Municipal Vulnerability Preparedness](#) program: Provides support for communities to plan for climate change and resilience and implement priority projects.
- [Massachusetts Water Quality Grants](#): Clean water grants that can be used for river restoration or other kinds of hazard mitigation implementation projects.
- [Grants.gov](#): Lists of grant opportunities from federal agencies (HUD, DOT/FHWA, EPA, etc.) to support rural development, sustainable communities and smart growth, climate change and adaptation, historic preservation, risk analyses, wildfire mitigation, conservation, Federal Highways pilot projects, etc.
- [FEMA Hazard Mitigation Assistance](#) (HMA): FEMA's Hazard Mitigation Assistance provides funding for projects under the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM), and Flood Mitigation Assistance (FMA). States, federally recognized tribes, local governments, and some not for profit organizations are eligible applicants.
- [GrantWatch](#): The website posts current foundation, local, state, and federal grants on one website, making it easy to consider a variety of sources for grants, guidance, and partnerships. Grants listed include The Partnership for Resilient Communities, the Institute for Sustainable Communities, the Rockefeller Foundation Resilience, The Nature Conservancy, The Kresge Climate-Resilient Initiative, the Threshold Foundation's Thriving Resilient Communities funding, the RAND Corporation, and ICLEI Local Governments for Sustainability.
- USDA [Natural Resource Conservation Service](#) (NRCS) and [Rural Development Grants](#): NRCS provides conservation technical assistance, financial assistance, and conservation innovation grants. USDA Rural Development operates over fifty financial assistance programs for a variety of rural applications.