Oxford Hazard Mitigation Plan

French River in Oxford, Massachusetts

Certified by the Board of Selectmen November 15, 2016

Prepared by the **Central Massachusetts Regional Planning Commission**
2 Washington Square, Union Station
Worcester, MA 01604
www.cmrpc.org

&

Local Hazard Mitigation Team
Town of Oxford, Massachusetts

Acknowledgements

The Oxford Board of Selectmen extends its thanks to participants in the Local Hazard Mitigation Team:

Sheri Bemis, Fire Department
Sean Divoll, Public Works
Stephen Esposito, Public Works
Judy Lochner, Conservation Agent
Anthony Saad, Police Department
Richard Donais, Facilities
John Phillips, Resident

The Board likewise offers thanks to the Massachusetts Emergency Management Agency (MEMA) for guidance and feedback regarding this plan.

In addition, thanks are extended to the staff of the Central Massachusetts Regional Planning Commission for process facilitation and preparation of this document.

Central Massachusetts Regional Planning Commission

Andrew Loew, Principal Planner
Paul Dell'Aquila, Principal Planner
Eric Smith, Principal Planner
Mark Widner, Homeland Security Coordinator
John Mauro, Homeland Security Coordinator
Matthew Franz, GIS Analyst
Derrick Mathieu, Assistant Planner

Contents

1.0 INTRODUCTION

1.1 Disaster Mitigation Plan

Congress enacted the Disaster Mitigation Act of 2000 (DMA 2000) on October 10, 2000. Also known as the Stafford Act Amendments, the bill was signed into law by President Clinton on October 30, 2000, creating Public Law 106-390. The law established a national program for pre-disaster mitigation and streamlined the federal administration of disaster relief. Specific rules on the implementation of DMA 2000 were published in the Federal Register in February 2002 and required that all communities must have a Hazard Mitigation Plan in place in order to qualify for future federal disaster mitigation grants following a Presidential disaster declaration. The Hazard Mitigation Plan emphasizes measures that can be taken to reduce or prevent future disaster damages caused by natural hazards. In the context of natural hazard planning, Pre-Disaster Mitigation refers to any action that permanently reduces or eliminates long-term risks to human life and property.

1.2 Plan Purpose

New England weather is renowned for its mercurial and dramatic nature. Late summer hurricanes, major winter blizzards, and summer droughts are all part of climactic atmosphere in Central Massachusetts. These occur frequently enough to be familiar scenes to residents of Oxford. The intersection of these natural hazards with the built environment can transition these routine events into classified natural disasters. Since many towns historically developed along waterways as a corridor for transportation and power, they are have evolved into riverine floodplains. The historical development pattern of Central Massachusetts makes the likelihood of a devastating impact of a natural disaster more likely.

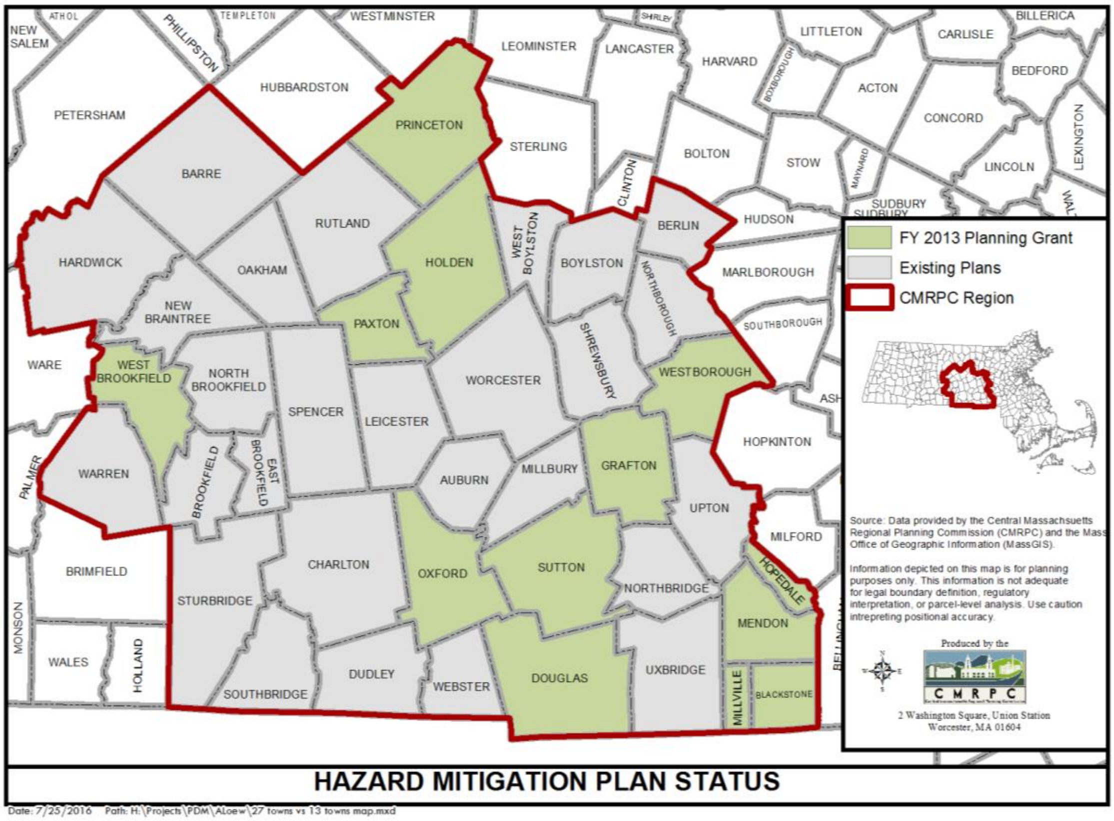
This plan identifies the natural hazards facing the Town of Oxford, assesses the vulnerabilities of the area's critical facilities, infrastructure, residents, and businesses, and presents recommendations on how to mitigate the negative effects of typical natural hazards.

This effort has drawn from the knowledge of local municipal officials and residents, and the recommendations presented are intended to be realistic and effective steps for mitigating natural hazards. Implementation of these actions will translate into savings – fewer lives lost, less property destroyed, and less disruption to essential services.

2.0 PLANNING PROCESS

This Plan is funded through a Fiscal Year 2013 Pre-Disaster Mitigation grant to CMRPC from the Federal Emergency Management Agency (FEMA) through the Massachusetts Emergency Management Agency (MEMA). Aside from Oxford, twelve other communities are participating in this round of planning: Blackstone, Douglas, Grafton, Holden, Hopedale, Mendon, Millville, Paxton, Princeton, Sutton, West Brookfield, and Westborough.

Figure 1



The planning process in each community was composed of two distinct but related phases – data collection and technical review, and public input and planning. Identification of natural hazards impacting participating communities was accomplished through review of available information from various sources. These included federal and state reports and datasets, existing plans, and in some cases engineering documents. An assessment of risks and vulnerabilities was performed primarily using geographic information systems (GIS) to identify the infrastructure (critical facilities, public buildings, roads, homes, businesses, etc.) at the highest risk for being damaged by hazards, particularly flooding. Local knowledge as imparted by town officials, staff, emergency management volunteers and others was a critical element of this phase.

The second phase of the process was focused on outreach, public participation and input, and planning. This phase was critical to ensuring awareness of the planning process among a wide range of local officials, coordinating plan elements with other sectors of the community, and providing opportunities for public comment and input from a representative base of residents and other stakeholders in each community. Through this engagement, CMRPC was better able to gauge community priorities for mitigation and to understand local resources and existing policies and procedures. With this information in hand, the planning team was able to develop an informed and community-specific list of mitigation strategies for each participating town.

In Oxford, a planning team of local staff and volunteers led by Fire Chief Sheri Bemis met three times to discuss hazard areas, critical infrastructure and other assets, and plan priorities and strategies: December 29, 2014, January 14, 2015, and November 16, 2015. Participants included Sean Divoll and Stephen Esposito (Public Works), Judy Lochner (Conservation Agent and GIS), Anthony Saad (Police Department), Richard Donais (Facilities) and John Phillips (resident). Between meetings and during development of the draft and final plans, information and comments were shared among the local team and CMRPC. CMRPC held a public regional forum for the thirteen participating towns on November 5, 2015 to discuss the overall planning effort and to highlight best practices in mitigation efforts and policies for use by individual communities. Fire Chief Bemis represented Oxford at the forum. Also in late 2015, a public survey to gauge residents' concerns about (and experiences with) hazards was distributed on the Town's website. More than 90 residents participated, offering opinions on hazards and vulnerabilities, preferred means of emergency communication, and priorities and suggestions for future mitigation action. Survey responses were discussed by the planning team at its November 2015 meeting and informed development and prioritization of mitigation strategies.

As planning activities progressed, a public presentation was made by CMRPC at the June 7, 2016 meeting of the Oxford Board of Selectmen to provide a summary of key aspects of the draft Plan report then being finalized. The presentation was televised on the local cable access channel and the opportunity for public comment was emphasized. Materials and notes from the presentation and subsequent public discussion are included in the appendix. A full draft Plan was provided to the Town for distribution and made available online at CMRPC's website for public comment for two weeks starting on June 8, 2016; a revised draft Plan was provided to the Town and again posted online for comment on August 23, 2016. No substantive public comments were received. In addition, the final draft Plan was distributed to officials in all neighboring communities for review and input regarding shared hazards. Again, no comments were received.

The final draft Plan was submitted to MEMA for review on August 30, 2016 and was then relayed to FEMA for federal review. After receipt of FEMA's revisions on October 19, 2016, a presentation of the final plan was made by CMRPC at the November 15, 2016 meeting of the Board of Selectmen. At the meeting, the plan was formally adopted by vote of the Board.

See Appendix C for additional documentation of local stakeholder and public participation in the planning process.

3.0 REGIONAL AND COMMUNITY PROFILE

The Central Massachusetts Regional Planning Commission (CMPRC) region occupies roughly 1,000 square miles in the southern two-thirds of Worcester County, Massachusetts. The area surrounds the City of Worcester, which is the second-largest city in Massachusetts and New England, with a population of 182,511 as of the 2014 American Community Survey (five-year estimate). Nearly 563,000 people live in the CMRPC Region, of whom 13,772 reside in Oxford.

The CMRPC area is framed on the west by the Central Massachusetts uplands, on the south by Rhode Island and Connecticut, on the east by the Boston metropolitan area, and on the north by the Montachusett region in northern Worcester County. The forty-community region has been divided for planning purposes into six sub-regions, determined by shared characteristics and roadway corridors. Oxford is located in the Southwest sub-region consisting of seven towns lying within the Quinebaug and French (Shetucket) River valleys, including: Auburn, Charlton, Dudley, Oxford, Southbridge, Sturbridge, and Webster.

Massachusetts has a humid continental climate, with maritime influences increasing from northwest to southeast. The Oxford area, as represented by National Weather Service data collected from 2000 through 2016 in nearby Worcester, sees monthly mean temperatures ranging from 24.4 degrees in January to 71 in July. Precipitation is relatively high at 49.15 inches annually, including 78 inches of snowfall. With a temperate climate and a location some 40 miles from the Atlantic coast, Oxford and its neighboring communities are subject to a variety of severe weather, including hurricanes, nor'easters, thunderstorms, and blizzards. All of these are discussed more fully in Chapter 4.

The Town of Oxford, Massachusetts was incorporated in 1713. Oxford is located on I-395 11 miles south of the City of Worcester and is largely a bedroom community. Much of Oxford lies within the French River Basin, except for the extreme eastern edge, which lies in the Blackstone River Basin. Oxford is bordered by Dudley and Charlton on the west, Millbury and Sutton on the east, Douglas and Webster on the south, and Leicester and Auburn on the north.

Oxford has a total area of 26.6 square miles and a population of 13,772 (2014 American Community Survey). Oxford is a demographically stable community, with population growth slowing as buildable land has been built out following a 1990s surge. According to the Central Massachusetts Regional Planning Commission's (CMRPC) Long Range Transportation Plan, Mobility 2040, the Town of Oxford is expected to experience minimal population growth over the next 25 years.

The number of residents has grown from 12,588 in the 1990 US Census to 13,352 in 2000 to the currently (2014) estimated 13,772. Oxford is a largely white community, with some 95.4% of residents identifying within that group. Latinos or Hispanics of all races are the largest minority group, at 4.7%. The age breakdown is broadly similar to Massachusetts state splits, with children under 19 (26.7%) and seniors 65 or over (12%) close to the state rates of 24.4% and 14.4% respectively. Median age is 40.9, slightly above the state median of 39.3. At $70,106, median household annual income is somewhat above the state ($67,846) and Worcester County ($65,453) medians. Poverty is low at 5%, or less than half the state and county rates (both 11.6%). Housing costs are relatively low, with a median owner-occupied home valued at $229,400, compared to $329,900 for Massachusetts and $255,600 for the county. More than 75% of occupied homes are detached or semi-detached single family houses; the remainder is multi-unit structures. At 4.9%, vacancies are well below the state (9.9%) and county (8.5%) numbers. Most homes are relatively new, with only 20.9% built before 1940, compared to nearly 34% for Massachusetts and almost 31% for Worcester County.

4.0 NATURAL HAZARD IDENTIFICATION AND ANALYSIS

The following section includes a summary of disasters that have affected or could affect Oxford. Historical research, discussions with local officials and emergency management personnel, available hazard mapping and other weather-related databases were used to develop this list. The most significant identified hazards are the following:

- Flooding
- Severe Snowstorms / Ice storms/ Nor'easters
- Hurricanes
- Severe Thunderstorms / Wind / Tornadoes
- Wildfires / Brushfires
- Earthquakes
- Dam failure
- Drought
- Extreme Temperatures
- Other hazards

4.1 Overview of Hazards and Impacts

This section examines the hazards in the Massachusetts State Hazard Mitigation Plan which are identified as likely to affect Oxford. 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 Oxford are: Flooding, Severe snowstorms / Ice storms / Nor'easters, Hurricanes, Severe thunderstorms / Wind / Tornadoes, Wildfire / Brushfire, Earthquakes, Dam failure, and Drought. Many of these hazards result in similar impacts to a community. For example, hurricanes, tornadoes 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 1

Percentage of Town Impacted by Natural Hazard	
Land Area Affected by Occurrence	**Percentage of Town Impacted**
Large	More than 50% of the town affected
Medium	10 to 50% of the town affected
Small	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 2

Frequency of Occurrence and Annual Probability of Given Natural Hazard	
Frequency of Occurrence	**Probability of Future Events**
Very High	70-100% probability in the next year
High	40-70% probability in the next year
Moderate	10-40% probability in the next year
Low	1-10% probability in the next year
Very Low	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 above. Impacts are classified according to the following scale:

Table 3

Impacts, Magnitude of Multiple Impacts of Given Natural Hazard	
Impacts	**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 on quality of life. Temporary shutdown of facilities.

Vulnerability

Based on the above metrics, a hazard index rating was determined for each hazard. The hazard index ratings are based on a scale of 1 through 5 as follows:

1 – Highest risk

2 – High risk
3 – Medium risk
4 – Low risk
5 – Lowest risk

The ranking is qualitative and is based, in part, on local knowledge of past experiences with each type of hazard. 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 4

Hazard Identification and Analysis Worksheet for Oxford				
Type of Hazard	**Location of Occurrence**	**Probability of Future Events**	**Impact**	**Hazard Risk Index Rating**
Flooding	Medium	Low	Minor	3
Severe Snowstorms / Ice Storms/ Nor'easter	Large	Very High	Limited	2
Severe Thunderstorms / Winds / Tornadoes	Small Small Small	Moderate Moderate Very Low	Minor Limited Limited	2 2 4
Hurricanes	Large	Low	Limited	3
Wildfire / Brushfire	Medium	Moderate	Minor	4
Earthquakes	Large	Very Low	Minor	5
Dam Failure	Small	Very Low	Limited	4
Drought	Large	Very Low	Minor	4
Extreme Temperatures	Large	Moderate	Limited	4

Source: based on Massachusetts State Hazard Mitigation Plan, 2013; modified to reflect conditions in Oxford

4.2 Flooding

Hazard Description

Flooding was the most prevalent natural hazard identified by local officials in Oxford. Flooding is generally caused by hurricanes, nor'easters, severe rainstorms, and thunderstorms. Global climate change has the potential to exacerbate these issues over time with the potential for more severe and frequent storm and rainfall events. There are several different types of flood hazards –

from stormwater inundation and poor drainage infrastructure to riverine flooding and storm surges to dam failures. The most extensive damage would result from dam failure. However, the most frequent flood threat is due to riverine and stormwater flooding.

Location

Flooding and flood-prone areas in Oxford are closely associated to the course of the French River and associated tributaries. According to a GIS analysis performed by CMRPC, there are 36 parcels in Oxford that are susceptible to 100-year floods, with 34 of them containing structures.

At this time the Town of Oxford has no repetitive loss structures as defined by FEMA's NFIP. As defined by the National Flood Insurance Program (NFIP), a repetitive loss property is any property which the NFIP has paid two or more flood claims of $1,000 or more in any given 10-year period since 1978. For more information on repetitive losses see https://www.fema.gov/repetitive-flood-claims-grant-program-fact-sheet.

Extent

The average annual precipitation for Oxford and surrounding areas in central Massachusetts has been 45 to 50 inches during the past several years.

Water levels in Oxford's rivers, streams, and wetlands rise and fall seasonally and during high rainfall events. High water levels are typical in spring, due to snowmelt and ground thaw. This is the period when flood hazards are normally expected. Low water levels occur in summer due to high evaporation and plant uptake (transpiration). At any time, heavy rainfall may create conditions that raise water levels in rivers and streams above bank full stage, which then overflow adjacent lands.

Based on past records and the knowledge and experience of members of the Oxford Hazard Mitigation team and residents, the extent of the impact of localized flooding would be minor.

Previous Occurrences

In addition to the floodplains mapped by FEMA for the 100-year and 500-year flood, Oxford often experiences minor flooding at isolated locations due to drainage problems, or problem culverts. The following specific flooding locations (mapped in Appendix A) were identified by the Oxford Hazard Mitigation Team:

- Main Street south of Pratt Ave.
- Sutton Ave. at Lind Street
- Main Street near State Street
- Sutton Ave & Turk Hollow Road
- Clara Barton Road near Main Street
- Old Webster Road at Country Lane
- Wellington Road
- Main St. @ Chestnut Hill Road
- Birchwood Terrace
- Beaver dams at Sutton Ave/Rt. 395 exit (MassDOT responsibility)

Additionally, the following locations experienced flooding due to inadequate culverts:

- Sacarrappa Road (Road is presently closed)
- Rawson Ave.
- Water Street between Cedar St. and Sibley Cir.
- Main St./Prince St./Holman St./Dana Rd.
- Hartwell Road
- Hall Road at stream crossing
- Main Street north of Clara Barton

Most of the flood hazard areas listed here were identified due to known past occurrence in the respective area. There are many areas with no record of previous flood incidents that could be affected in the future by heavy rain and runoff.

Probability of Future Events

Based upon previous data, there is low probability of localized flooding occurring in Oxford in the next year.

Impact

The Town faces a minor impact, with less than 10% of total town area likely to be affected by a flooding event.

Utilizing the GIS analysis noted above, the total value of the structures on the 34 parcels that are susceptible to a 100-year flood is approximately $14,149,600.

HAZUS- MH (multiple-hazards) is a computer program developed by FEMA to estimate losses due to a variety of natural hazards. The HAZUS software was used to model potential damages to the community from a 10,000 cubic feet per second (cfs) flood event, which would be greater than either a 100-year or 500-year flood event.

Table 5

Estimated Damages from Flood

	10,000 cfs flood event
Building Characteristics	
Estimated total number of buildings	5,032
Estimated total building replacement value (2010 $)	$ 1,642,000,000
Building Damages	
# of buildings sustaining minor damage (1-10%)	7
# of buildings sustaining moderate damage (11-40%)	46
# of buildings sustaining severe damage (41-50%)	2
# of buildings destroyed	1
Population Needs	
# of households displaced	214
# of people seeking public shelter	267
Debris	
Building debris generated (tons)	4,019
# of truckloads to clear building debris	161
Value of Damages	
Total property damage (buildings and content)	$ 50,650,000
Total losses due to business interruption	$ 100,000

Though there are no recorded instances of a flood event of this size, this model was included in order to present a reasonable "worst case scenario" that would help planners and emergency personnel evaluate the impacts of flooding that might be more likely in the future, as we enter into a period of more intense and frequent storms. For more information on the HAZUS-MH software, go to http://www.fema.gov/hazus-software.

Vulnerability

Based on this analysis, Oxford faces a hazard index rating of "3 - medium risk" from flooding.

The Nelson Street Well Station is located within the 100-year flood zone. Additionally, sections of evacuation routes including Routes 12 and 20 and also Critical Facilities, including the DPW Headquarters and Fire Station #2, are located in or adjacent to areas prone to local flooding.

Moreover, the local team identified 22 locations in Oxford susceptible to flooding, including those which are identified above under Previous Occurrences. If evacuation routes and critical facilities such as those listed above are flooded, emergency response and/or evacuations could be hampered.

4.3 Severe Snowstorms / Ice Storms / Nor'easters

Hazard Description

Severe winter storms can pose a significant risk to property and human life. Severe snowstorms and ice storms can involve rain, freezing rain, ice, snow, cold temperatures and wind. Heavy snowfall and extreme cold can immobilize an entire region. Even areas that normally experience mild winters can be hit with a major snowstorm or extreme cold. Winter storms can result in flooding, storm surge, closed highways, blocked roads, downed power lines and hypothermia. A northeast coastal storm, known as a nor'easter, is typically a large counter-clockwise wind circulation around a low-pressure center often resulting in heavy snow, high winds, and rain.

Location

The entire Town of Oxford is susceptible to severe snowstorms, which means the location of occurrence is "large." Because these storms occur regionally, they would impact the entire Town.

Extent

The Northeast Snowfall Impact Scale (NESIS) developed by Paul Kocin of The Weather Channel and Louis Uccellini of the National Weather Service (Kocin and Uccellini, 2004) characterizes and ranks high-impact Northeast snowstorms. These storms have large areas of 10-inch snowfall accumulations and greater. NESIS has five categories: Extreme, Crippling, Major, Significant, and Notable. The index differs from other meteorological indices in that it uses population information in addition to meteorological measurements. Thus NESIS gives an indication of a storm's societal impacts.

NESIS scores are a function of the area affected by the snowstorm, the amount of snow, and the number of people living in the path of the storm. The aerial distribution of snowfall and population information are combined in an equation that calculates a NESIS score which varies from around one for smaller storms to over ten for extreme storms. The raw score is then converted into one of the five NESIS categories. The largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers.

Table 6

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: http://www.ncdc.noaa.gov/snow-and-ice/rsi/nesis

Previous Occurrences

Based on data available from the National Oceanic and Atmospheric Administration, there are 58 high-impact snowstorms since 1958 that have affected the Northeast Corridor. Of these, approximately 30 storms resulted in snow falls in Oxford of at least 10 inches. These storms are listed in the table below:

Table 7

Winter Storms Producing over 10 Inches of Snow in Oxford, 1958-2015			
Date	**NESIS Value**	**NESIS Category**	**NESIS Classification**
2/8/2015	1.32	1	Notable
1/29/2015	5.42	3	Major
1/25/2015	2.62	2	Significant
3/4/2013	3.05	2	Significant
2/7/2013	4.35	3	Major
1/26/2011	2.17	1	Notable
1/9/2011	5.31	3	Major
12/24/2010	4.92	3	Major
2/23/2010	5.46	3	Major
12/18/2009	3.99	2	Significant
3/15/2007	2.54	2	Significant
2/12/2006	4.10	3	Major
1/21/2005	6.80	4	Crippling

Winter Storms Producing over 10 Inches of Snow in Oxford, 1958-2015			
Date	**NESIS Value**	**NESIS Category**	**NESIS Classification**
2/15/2003	7.50	4	Crippling
3/31/1997	2.29	1	Notable
2/8/1994	5.39	3	Major
3/12/1993	13.2	5	Extreme
2/10/1983	6.25	4	Crippling
4/6/1982	3.35	2	Significant
2/5/1978	5.78	3	Major
1/19/1978	6.53	4	Crippling
2/18/1972	4.77	3	Major
2/22/1969	4.29	3	Major
2/8/1969	3.51	2	Significant
2/5/1967	3.50	2	Significant
2/2/1961	7.06	4	Crippling
1/18/1961	4.04	3	Major
12/11/1960	4.53	3	Major
3/2/1960	8.77	4	Crippling
2/14/1958	6.25	4	Crippling

Source: http://www.ncdc.noaa.gov/snow-and-ice/rsi/nesis

Probability of Future Events

Based upon the availability of records for Worcester County, the likelihood that a severe snow storm will affect Oxford is “very high” (greater than 70 percent in any given year).

Research on climate change indicates that there is great potential for stronger, more frequent storms as the global temperature increases. The Massachusetts State Climate Change Adaptation Report has additional information about the impact of climate change and can be accessed at http://www.mass.gov/eea/air-water-climate-change/climate-change/.

Impact

The Town faces a "limited" impact or less than 10 percent of total property damaged, from snowstorms.

The weight from multiple snowfall events can test the load ratings of building roofs and potentially cause significant damage. Multiple freeze-thaw cycles can also create large amounts of ice and make for even heavier roof loads.

Other impacts from snowstorms and ice storms include:

- 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

Vulnerability

Based on the above assessment, Oxford has a hazard index rating of "2 — high risk" from snowstorms and ice storms.

Utilizing the Town's median home value of $229,400 (American Community Survey, 2014 5-year estimate), combined with the total value of all property, $1,273,705,685 (Massachusetts Department of Revenue, 2016), and an estimated 5 percent of damage to 10 percent of residential structures, approximately $ 6,368,528 worth of damage could occur from a severe snowstorm. This is a rough estimate and likely reflects a worst-case scenario. The cost of repairing or replacing the roads, bridges, utilities, and contents of structures is not included in this estimate.

4.4 Hurricanes

Hazard Description

Hurricanes are classified as cyclones and defined as any closed circulation developing around a low-pressure center in which the winds rotate counter-clockwise in the Northern Hemisphere (or clockwise in the Southern Hemisphere) and whose diameter averages 10 to 30 miles across. The primary damaging forces associated with these storms are high-level sustained winds and heavy precipitation. Hurricanes are violent rainstorms with strong winds that can reach speeds of up to 200 miles per hour and which generate large amounts of precipitation. Hurricanes generally occur between June and November and can result in flooding and wind damage to structures and above-ground utilities.

Location

Because of the hazard's regional nature, all of Oxford is at risk from hurricanes, meaning the location of occurrence is "large." Ridgetops are more susceptible to wind damage. Areas susceptible to flooding are also likely to be affected by heavy rainfall.

Extent

As an incipient hurricane develops, barometric pressure (measured in millibars or inches) at its center falls and winds increase. If the atmospheric and oceanic conditions are favorable, it can intensify into a tropical depression. When maximum sustained winds reach or exceed 39 miles per hour, the system is designated a tropical storm, given a name, and is closely monitored by the National Hurricane Center in Miami, Florida. When sustained winds reach or exceed 74 miles per hour the storm is deemed a hurricane. Hurricane intensity is further classified by the Saffir-Simpson Hurricane Wind Scale, which rates hurricane wind intensity on a scale of 1 to 5, with 5 being the most intense.

Table 8

Saffir-Simpson Scale	
Category	**Maximum Sustained Wind Speed (MPH)**
1	74–95
2	96–110
3	111–129
4	130–156
5	157 +

Source: National Hurricane Center, 2012

Previous Occurrences

Hurricanes that have affected the region in which Oxford is located are shown in the following table:

Table 9

Major Hurricanes and Tropical Storms Affecting the region		
Hurricane/Storm Name	**Year**	**Saffir/Simpson Category (when reached MA)**
Great Hurricane of 1938	1938	3
Great Atlantic Hurricane	1944	1
Hurricane Dog	1950	Unclear
Carol	1954	3
Edna	1954	1
Diane	1955	Tropical Storm
Donna	1960	Unclear, 1 or 2
Belle	1976	Minor Storm
Gloria	1985	1
Bob	1991	2
Floyd	1999	Tropical Storm
Irene	2011	Tropical Storm
Sandy	2012	"Super Storm"

Source: National Oceanic and Atmospheric Administration

Probability of Future Events

Oxford's location in central Massachusetts approximately 55 miles inland reduces the risk of extremely high winds that are associated with hurricanes, although it can still experience some high wind events. Based upon past occurrences, it is reasonable to say that there is a "low" probability (1 percent to 10 percent in any given year) of hurricanes in Oxford. Climate change is projected to result in more severe weather, including increased occurrence of hurricanes and tropical storms. Because of this, the occurrence of hurricanes will increase in the future.

Impact

A description of the damages that could occur due to a hurricane is described by the Saffir-Simpson scale, as shown below:

Table 10

Hurricane Damage Classifications			
Storm Category	**Damage Level**	**Description of Damages**	**Wind Speed (MPH)**
1	MINIMAL Very dangerous winds will produce some damage	No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Also, some coastal flooding and minor pier damage. An example of a Category 1 hurricane is Hurricane Dolly (2008).	74-95
2	MODERATE Extremely dangerous winds will cause extensive damage	Some roofing material, door, and window damage. Considerable damage to vegetation, mobile homes, etc. Flooding damages piers and small craft in unprotected moorings may break their moorings. An example of a Category 2 hurricane is Hurricane Francis in 2004.	96-110
3	EXTENSIVE Devastating damage will occur	Some structural damage to small residences and utility buildings, with a minor amount of curtain wall failures. Mobile homes are destroyed. Flooding near the coast destroys smaller structures, with larger structures damaged by floating debris. Terrain may be flooded well inland. An example of a Category 3 hurricane is Hurricane Ivan (2004).	111-129
4	EXTREME Catastrophic damage will occur	More extensive curtain wall failures with some complete roof structure failure on small residences. Major erosion of beach areas. Terrain may be flooded well inland. An example of a Category 4 hurricane is Hurricane Charley (2004).	130-156
5	CATASTROPHIC Catastrophic damage will occur	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Flooding causes major damage to lower floors of all structures near the shoreline. Massive evacuation of residential areas may be required. An example of a Category 5 hurricane is Hurricane Andrew (1992).	157+

The Town faces a "limited" impact from hurricanes, with 10 percent or less of Oxford affected.

Vulnerability

Based on the above analysis, Oxford has a hazard index rating of "3 – medium risk" from hurricanes.

HAZUS- MH (multiple-hazards) is a computer program developed by FEMA to estimate losses due to a variety of natural hazards. The HAZUS software was used to model potential damages to the community from a 100-year and 500-year hurricane event; storms that are 1% and .0.2% likely to happen in a given year, and roughly equivalent to a Category 2 and Category 4 hurricane. The damages caused by these hypothetical storms were modeled as if the storm track passed directly through the Town, bringing the strongest winds and greatest damage potential.

Table 11

Estimated Damages from Hurricanes

	100 Year	500 Year
Building Characteristics		
Estimated total number of buildings	5,032	
Estimated total building replacement value (2010 $)	$ 1,642,000,000	
Building Damages		
# of buildings sustaining minor damage	116	736
# of buildings sustaining moderate damage	10	119
# of buildings sustaining severe damage	0	6
# of buildings destroyed	0	2
Population Needs		
# of households displaced	2	28
# of people seeking public shelter	0	6
Debris		
Building debris generated (tons)	2,172	6,600
Tree debris generated (tons)	7,019	16,978
# of truckloads to clear building debris	17	90
Value of Damages (thousands of dollars)		
Total property damage (buildings and content)	$ 9,148.88	$33,282.34
Total losses due to business interruption	$ 292.69	$1,870.90

Though there are no recorded instances of a hurricane equivalent to a 500-year storm passing through Massachusetts, this model was included in order to present a reasonable "worst case scenario" that would help planners and emergency personnel evaluate the impacts of storms that might be more likely in the future, as we enter into a period of more intense and frequent storms. For more information on the HAZUS-MH software, go to http://www.fema.gov/hazus-software.

4.5 Severe Thunderstorms / Wind / Tornado

Hazard Description

A thunderstorm is a storm with lightning and thunder produced by a cumulonimbus cloud, usually producing gusty winds, heavy rain, and sometimes generating hail. Effective January 5, 2010, the NWS modified the hail size criterion to classify a thunderstorm as 'severe' when it produces damaging wind gusts in excess of 58 mph (50 knots), hail that is 1 inch in diameter or larger (quarter size), or a tornado (NWS, 2013).

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, etc. High winds can cause scattered power outages. High winds are also a hazard for the boating, shipping, and aviation industry sectors.

Tornadoes are swirling columns of air that typically form in the spring and summer during severe thunderstorm events. In a relatively short period of time and with little or no advance warning, a tornado can attain rotational wind speeds in excess of 250 miles per hour and can cause severe devastation along a path that ranges from a few dozen yards to over a mile in width. The path of a tornado may be hard to predict because they can stall or change direction abruptly. Within Massachusetts, tornadoes have occurred most frequently in the Connecticut River Valley and in western Worcester County, with Oxford some 20 miles east of the zone of most frequent past occurrence. High wind speeds, hail, and debris generated by tornadoes can result in loss of life, downed trees and power lines, and damage to structures and other personal property (cars, etc...).

Location

As per the Massachusetts Hazard Mitigation Plan, the entire Town is at risk of high winds, severe thunderstorms, and tornadoes. The plan identifies Oxford and its surrounding communities as having a moderate frequency of tornado occurrence within the Massachusetts context. However, the actual area affected by thunderstorms, wind, or tornadoes is “small,” with less than 10 percent of the Town generally affected.

Extent

An average thunderstorm is 15 miles across and lasts 30 minutes; severe thunderstorms can be much larger and longer. Southern New England typically experiences 10 to 15 days per year with severe thunderstorms. Thunderstorms can cause hail, wind, and flooding.

Tornadoes are measured using the enhanced F-Scale, shown with the following categories and corresponding descriptions of damage:

Table 12

Enhanced Fujita Scale Levels and Descriptions of Damage			
EF-Scale Number	**Intensity Phrase**	**3-Second Gust (MPH)**	**Type of Damage Done**
EF0	Gale	65–85	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages to sign boards.
EF1	Moderate	86–110	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
EF2	Significant	111–135	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
EF3	Severe	136–165	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
EF4	Devastating	166–200	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.

Table 13 - Extent Scale for Hail

CONVERTING TRADITIONAL HAIL SIZE DESCRIPTIONS

Traditional object-to-size conversion for assessment and translation of severe hail reports. We encourage *measurement*, not estimation, of hail size.

HAIL SIZE (in.)	OBJECT ANALOG REPORTED
.50	Marble, moth ball
.75	Penny
.88	Nickel
1.00	Quarter
1.25	Half dollar
1.50	Walnut, ping pong
1.75	Golf ball
2.00	Hen egg
2.50	Tennis ball
2.75	Baseball
3.00	Tea cup
4.00	Grapefruit
4.50	Softball

Previous Occurrences

Because thunderstorms and wind affect the town regularly on an annual basis, there are not significant records available for these events. As per the Massachusetts Hazard Mitigation Plan, there are approximately 10 to 30 days of thunderstorm activity in the state each year.

In Worcester County, there have been a number of F1 tornadoes occurring sporadically over the years. However, a data search for tornadoes rating 3 or above, or resulting in death/injury, or significant property damage, identifies the following events:

- In 1953, an F4 tornado struck Worcester. The event resulted in at least 90 fatalities, and more than 1,200 injured. There was extensive property damage. On the same date, an F3 tornado began in the Town of Sutton, immediately east of Oxford.
- In 1981 an F3 tornado struck, resulting in just 3 injuries and very little reported property damage.
- In June 2011, an F3 tornado struck Massachusetts.

Figure 2- Photo: MEMA 2011

Few deaths were reported, all in Hampden County. No deaths were reported in Worcester County.

Figure 3 - Above: NASA released this image of part of the 39-mile-long tornado track through south-central Mass. The image was captured June 5, 2011 by Landsat 5 satellite.

Probability of Future Events

One measure of tornado activity is the tornado index value. It is calculated based on historical tornado events data using USA.com algorithms. It is an indicator of the relative tornado activity level in a region. A higher tornado index value means a higher chance of tornado events. Index values for Oxford and its surroundings are shown below.

Table 14

Tornado Index Value	
Town of Oxford	109.15
Worcester County	120.35
Massachusetts	87.60
United States	136.45

Source: http://www.usa.com/massachusetts-state-natural-disasters-extremes.htm

Based upon the available historical record, as well as Oxford's location in a moderate-density cluster of tornado activity for Massachusetts, there is a "very low" probability (less than 1 percent chance in any given year) of a tornado affecting the town, and a moderate (10 percent to 40 percent chance in any given year) probability of a severe thunderstorm and/or high winds.

Impact

Overall, Oxford faces a "minor" impact from severe thunderstorms, and a "limited" impact from severe winds, or tornados, with 10 percent or less of the Town likely to be affected.

As indicated as part of the Enhanced Fujita Scale Levels for tornados, the following impacts can result from a tornado:

- EF0 - Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages to sign boards.

- EF1 - The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.

- EF2 - Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.

- EF3 - Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.

- EF4 - Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.

Vulnerability

Based on the above assessment, Oxford has a hazard index rating of "2- high risk" from severe thunderstorms and winds, and a "4 – low risk" from tornadoes.

The potential for locally catastrophic damage is a factor in any tornado, severe thunderstorm, or wind event. In Oxford, a tornado that hit residential areas would leave much more damage than a tornado with a travel path that ran along the town's uplands, where less settlement has occurred. Most buildings in the town have not been built to Zone 1, Design Wind Speed Codes. The first edition of the Massachusetts State Building Code went into effect on January 1, 1975, and 69.7% percent of the town's 5,170 occupied housing units was constructed in 1979 or earlier

(American Communities Survey, 2014 5-year estimate). Beyond private homes, some important Town facilities are vulnerable to strong winds and tornados. The Police Station lacks storm-resistant windows, and a tower at the Town Hall is believed to be structurally vulnerable. Utility lines throughout town are also vulnerable, particularly where trees have not been trimmed recently.

Utilizing the Town's median home value of $229,400 (American Communities Survey, 2014 5-year estimate), combined with the total value of all property, $1,273,705,685 (Massachusetts Dept. of Revenue, 2016), and an estimated 10 percent of damage to 5 percent of all structures, the estimated amount of damage from a tornado is $6,368,528. The cost of repairing or replacing the roads, bridges, utilities, and contents of structures is not included in this estimate.

4.6 Wildfires / Brush Fires

Hazard Description

Wildfires are typically larger fires, involving full-sized trees as well as meadows and scrublands. Brushfires are uncontrolled fires that occur in meadows and scrublands, but do not involve full-sized trees. Typical causes of brushfires and wildfires are lightning strikes, human carelessness, and arson.

FEMA has classifications for 3 different classes of wildfires:

- Surface fires are the most common type of wildfire, with the surface burning slowly along the floor of a forest, killing or damaging trees.
- Ground fires burn on or below the forest floor and are usually started by lightening
- Crown fires move quickly by jumping along the tops of trees. A crown fire may spread rapidly, especially under windy conditions.

Potential vulnerabilities to wildfires include damage to structures and other improvements, and impacts on natural resources. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly, and those with respiratory and cardiovascular diseases.

Location

Worcester County has approximately 645,000 acres of forested land, which accounts for 64% of total land area (Massachusetts Office of GIS, 2007). In Oxford, an estimated 59% of the land is forested. While Oxford is developed in a mostly low-density suburban pattern and few uninterrupted tracts of forest are present, the substantial tree coverage does present some risk for wildfires and brush fires. The total amount of town that could be affected by a wildfire is categorized as “small,” or less than 10 percent of the total area.

Extent

Wildfires can cause widespread damage. They can spread very rapidly, depending on local wind speeds and can be very difficult to get under control. Fires can last for several hours up to several days.

In Oxford approximately 59% percent of the town’s total land area is forested, and is therefore at risk of fire, but this forested area is generally scattered throughout the community, with developed areas, rivers and major transportation corridors (I-395 and I-90) breaking up the forest. In drought conditions, a brushfire or wildfire would be a matter of concern. As noted in the next section describing previous occurrences of wildfire, there have not been any major wildfires recorded in Oxford in recent decades. Based on historic data for 2001-2013, it is estimated that a brush fire might destroy 10 to 50 acres of forested area (Massachusetts Fire Incident Reporting System).

The overall extent of wildfires is shown in the table below:

Table 15 - Extent of Wildfires

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) Color Code: Green	Fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) Color Code: Blue	Fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.

Rating	Basic Description	Detailed Description
CLASS 3: High Danger (H) Color Code: Yellow	Fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) Color Code: Orange	Fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
CLASS 5: Extreme (E) Color Code: Red	Fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.

Previous Occurrences

Oxford has a mixed fire department with professional firefighters supported by on-call volunteers. There have not been any major forest fires in Oxford in recent decades. During the period 2001-2013, there were between 9 and 32 brush fires per year in town, with burned acreage ranging from 0 to nearly 14 per year. Almost 96 total acres burned over that 12-year period (Massachusetts Fire Incident Reporting System). Another locally notable brush fire occurred in 2014. The fire chief estimates that roughly 50% of brush fires are caused by railroad traffic along the CSX or Providence & Worcester lines. Oxford issues permits for controlled burning of yard waste. The map below illustrates statewide wildfires of all types from 2001-2009; during the period depicted, Oxford experienced fewer than 100 wildfires and less than 100 total acres burned.

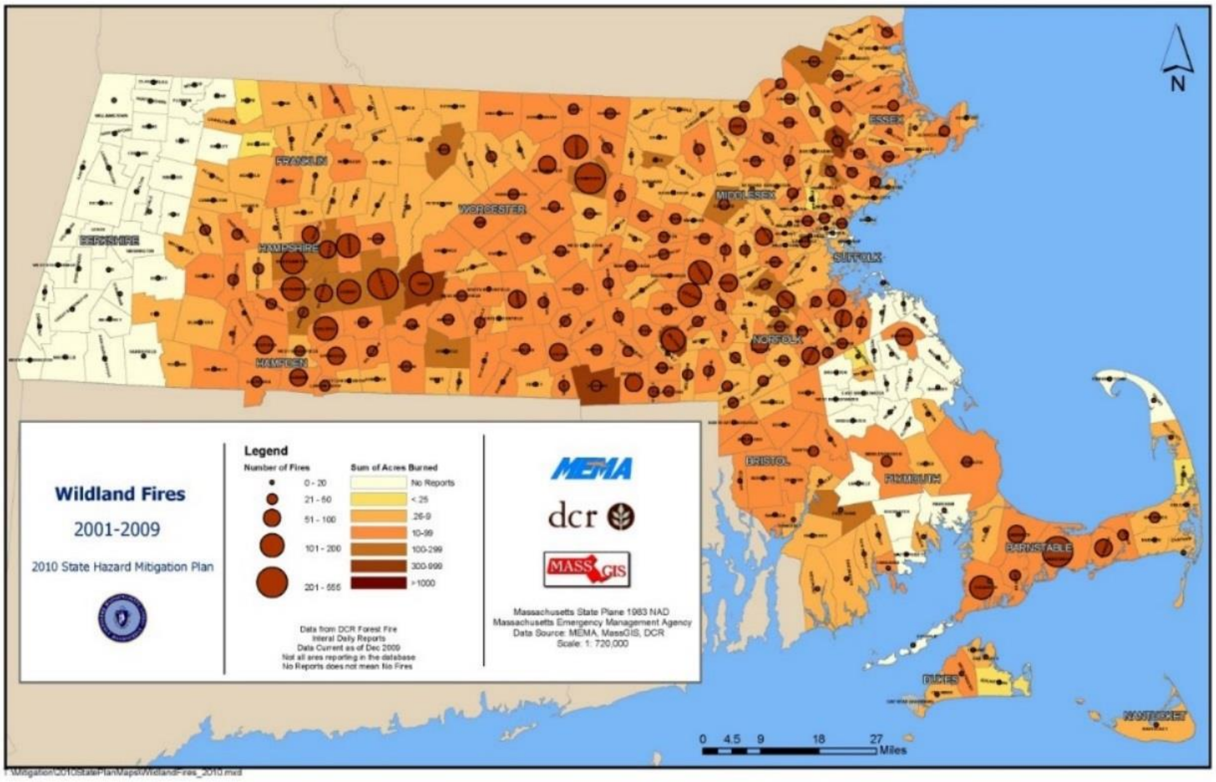


Figure 4 - Wildfires statewide from 2001-2009

Probability of Future Events

In accordance with the Massachusetts Hazard Mitigation Plan, the Oxford Hazard Mitigation Team found it is difficult to predict the likelihood of wildfires in a probabilistic manner because the number of variables involved. However, based on regular previous occurrences of minor brush fires, the planning team determined the probability of future damaging wildfire events to be “moderate” (10 percent to 40 percent probability in the next year).

Climate scenarios project summer temperature increases between 2º C and 5º C and precipitation decreases of up to 15 percent. Such conditions would exacerbate summer drought and further promote high-elevation wildfires, releasing stores of carbon and further contributing to the buildup of greenhouse gases. Forest response to increased atmospheric carbon dioxide—the so-called “fertilization effect”—could also contribute to more tree growth and thus more fuel for fires, but the effects of carbon dioxide on mature forests are still largely unknown.

Climate change is also predicted to bring increased wind damage from major storms, as well as new types of pests to the region. Both increased wind and the introduction of new pests could potentially create more debris in wooded areas and result in a larger risk of fires.

Impact

While a large wildfire could in theory damage much of the landmass of Oxford, most forested areas are sparsely developed, meaning that wildfire affected areas are not likely to cause damage to property. For this reason, the town faces a “minor” impact from wildfires, with little damage likely to occur.

Both wildfires and brush fires can consume homes, other buildings and/or agricultural resources. The impact of wildfires and brush fires are as follows:

- Impact to benefits that people receive from the environment, such as food/water and the regulation of floods and drought
- Impact on local heritage, through the destruction of natural features
- Impact to the economy, due to damage to property and income from land following a wildfire
- Impact through the destruction of people and property

Vulnerability

Based on the above assessment, Oxford has a hazard risk index of “4 – low risk” from wildfires.

Utilizing the Town’s median home value of $229,400 (American Communities Survey, 2014 5-year estimate), combined with the total value of all property, $1,273,705,685 (Massachusetts Dept. of Revenue, 2016), and an estimated 5 percent of damage to 1 percent of all structures, the estimated amount of damage from a wildfire is $636,853. The cost of repairing or replacing the roads, bridges, utilities, and contents of structures is not included in this estimate.

4.7 Earthquakes

Hazard Description

An earthquake is a sudden, rapid shaking of the ground that is caused by the breaking and shifting of rock beneath the Earth’s surface. Earthquakes can occur suddenly, without warning, at any time of the year. 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.

Location

Because of the regional nature of the hazard, the entire Town of Oxford is susceptible to earthquakes. This makes the location of occurrence "large," or over 50 percent of the total area.

Extent

The magnitude of an earthquake is measured using the Richter Scale, which measures the energy of an earthquake by determining the size of the greatest vibrations recorded on the seismogram. On this scale, one step up in magnitude (from 5.0 to 6.0, for example) increases the energy more than 30 times.

Table 16

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.

The intensity of an earthquake is measured using the Modified Mercalli Scale. This scale quantifies the effects of an earthquake on the Earth's surface, humans, objects of nature, and man-made structures on a scale of I through XII, with I denoting a weak earthquake and XII denoting an earthquake that causes almost complete destruction.

Table 17

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.	

Modified Mercalli Intensity Scale for and Effects			
Scale	**Intensity**	**Description of Effects**	**Corresponding Richter Scale Magnitude**
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 New England has not experienced a damaging earthquake since 1755, seismologists state that a serious earthquake occurrence is possible. There are five seismological faults in Massachusetts, but there is no discernible pattern of previous earthquakes along these fault lines. Earthquakes occur without warning and may be followed by aftershocks. Most older buildings and infrastructure were constructed without specific earthquake resistant design features.

The most recent notable (Magnitude or Intensity 4 or greater) earthquakes to affect Massachusetts since 1900 are shown in the table below:

Table 18

Notable Earthquakes in Massachusetts 1900 – 2007			
Location	**Date**	**Magnitude**	**MMI**
Nantucket, MA	October 25, 1965	4.7	5.0
Cape Anne, MA	January 7, 1925	4.0	5.0
Wareham, MA	April 25, 1924	4.0	5.0
Newbury, MA	June 10, 1951	4.0	5.0

Source: Northeast States Emergency Consortium website, *http://nesec.org/massachusetts-earthquakes/*

Additionally, a table showing historic incidences of earthquakes for the six New England states are shown in the table below:

Table 19

New England States Record of Historic Earthquakes		
State	**Years of Record**	**Number of Earthquakes**
Connecticut	1668 - 2007	137
Maine	1766 - 2007	544
Massachusetts	1668 - 2007	355
New Hampshire	1638 - 2007	360
Rhode Island	1776 - 2007	38
Vermont	1843 - 2007	73
New York	1840 - 2007	755
Total Number of Earthquakes within the New England states between 1638 and 1989 is 2262.		

Source: Northeast States Emergency Consortium website, *http://nesec.org/massachusetts-earthquakes/*

Probability of Future Events

One measure of earthquake activity is the Earthquake Index Value. It is calculated based on historical earthquake events data using USA.com algorithms. It is an indicator of the earthquake activity level in a region. A higher earthquake index value means a higher chance of earthquake events. Data was used for Worcester County to determine the Earthquake Index Value as shown in the table below:

Table 20

Earthquake Index for Worcester County	
Worcester County	0.34
Massachusetts	0.70
United States	1.81

Source: *USA.com*

The local Hazard Mitigation Team reports that no earthquakes have been felt in Oxford.
Based upon existing records, there is a "very low" frequency (less than 1 percent probability in any given year) of an earthquake in Oxford.

Impact

Massachusetts introduced earthquake design requirements into their 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 first edition of the Massachusetts State Building Code went into effect on January 1, 1975, and 69.7% percent of the town's 5,170 occupied housing units was constructed in 1979 or earlier (American Communities Survey, 2014 5-year estimate). The seismic standards were upgraded with the 1997 revision of the State Building Code. Despite the its older housing stock, Oxford faces a "minor" impact from earthquakes, with little damage likely to occur to the extreme rarity of damaging events.

Vulnerability

Based on the above analysis, Oxford has a hazard index rating of "5- lowest risk" from earthquakes. HAZUS- MH (multiple-hazards) is a computer program developed by FEMA to estimate losses due to a variety of natural hazards. The HAZUS earthquake module allows users to define an earthquake magnitude and model the potential damages caused by that earthquake as if its epicenter had been at the geographic center of the study area. For the purposes of this plan, a magnitude 5.0 earthquake was selected for analysis. Historically, major earthquakes are rare in New England, although a magnitude 5 event occurred in 1963.

Table 21 - Estimated Damages from an Earthquake

	Magnitude 5.0
Building Characteristics	
Estimated total number of buildings	5,032
Estimated total building replacement value (2010 $)	$ 1,642,000,000
Building Damages	
# of buildings sustaining slight damage	1,419
# of buildings sustaining moderate damage	670
# of buildings sustaining extensive damage	144
# of buildings completely damaged	27
Population Needs	
# of households displaced	134
# of people seeking public shelter	76

	Magnitude 5.0
Debris	
Building debris generated (tons)	30,000
# of truckloads to clear debris (@ 25 tons/truck)	1,160
Value of Damages (dollars)	
Total property damage	$165,510,000
Total losses due to business interruption	$17,820,000

For more information on the HAZUS-MH software, go to www.fema.gov/hazus-software.

In addition to the general impacts identified by HAZUS, the planning team noted that the Town Hall's historic brick clock tower may be vulnerable to a substantial earthquake.

4.8 Dam Failure

Hazard Description

Dams 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 failure is not a common occurrence, but dams do represent a potentially disastrous hazard. When a dam fails, the potential energy of the stored water behind the dam is released rapidly. Most dam failures occur when floodwaters above overtop and erode the material components of the dam. Often dam 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). To be regulated, these dams are in excess of 6 feet in height (regardless of storage capacity) and 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 Commonwealth of Massachusetts to dam owners, including the responsibility to conduct dam inspections.

Location

According to the Massachusetts Office of Dam Safety, there are 19 dams in Oxford, of which 2 are High Hazard and 9 are Significant Hazard. In addition to the 19 dams in town, the Buffumville Dam (High Hazard, MA00964, owned by the Army Corps of Engineers) in neighboring Charlton lies roughly a quarter-mile upgradient from a populated section of Oxford and the Significant Hazard Buffumville Pond Dam in Oxford. The names and hazard levels of dam structures within Oxford are:

Table 22

National ID	Dam Name	Owner Type	Hazard Potential	Notes
MA01954	Stone's Pond Dam	Private	N/A	
MA00669	Lowes Pond Dam	Private	Significant Hazard	
MA00992	Buffumville Pond Dam	Private	Significant Hazard	
MA03365	Texas Pond Outlet Dam	Private	N/A	
MA00671	Stumpy Pond Dam	Private	Significant Hazard	
MA01952	Lapa Farm Pond Dam	Private	N/A	
MA01955	Turner Pond	Private	N/A	
MA01948	Old Scythe Shop Pond Dam	Private	N/A	
MA01956	Clara Barton Pond Dam	Private Association or other non-profit	N/A	
MA00670	Robinson Pond Dam	Private	Significant Hazard	
MA01946	Bartlett Pond Dam	Private	Significant Hazard	
MA01947	Slaters Pond Dam	Town of Oxford	Significant Hazard	
MA00674	Hudson Pond Dam	Private	N/A	
MA01951	Cominsville Pond Dam	Private	N/A	
MA01005	Gordon Pond Dam	Private	Significant Hazard	
MA01950	Eames Pond Dam	Private	Significant Hazard	
MA00967	Hodges Village Dam	ACOE - U.S. Army Corps of Engineers	High Hazard	
MA01953	Mckinstry's Pond Dam	Town of Oxford	Significant Hazard	In poor condition. On State list of 100 critical dams.
MA00675	Chimney Pond Dam	Private	High Hazard	

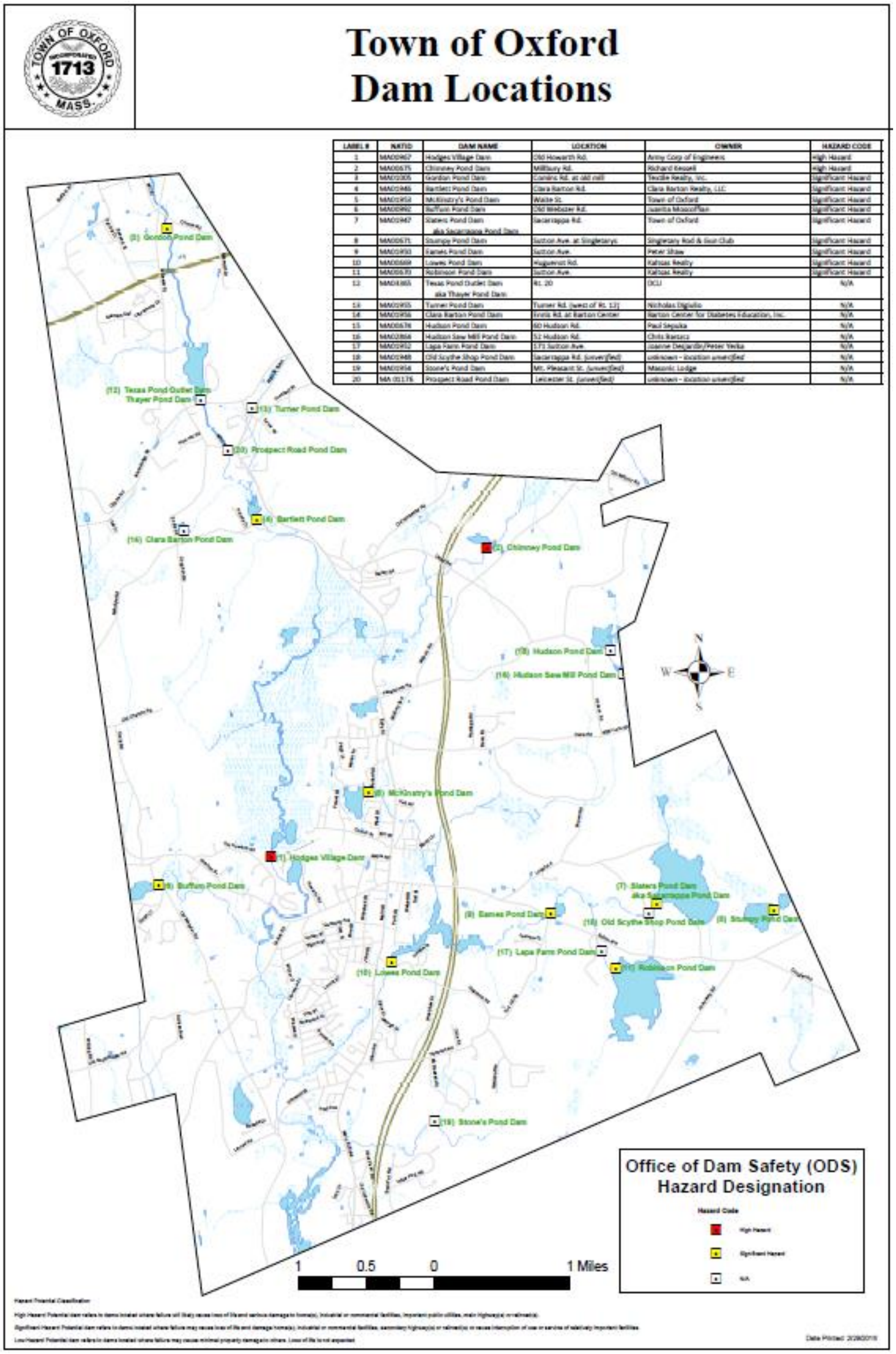


Figure 5 - Oxford Dam Locations

Inundation areas for these dams cover less than 10% of the town, or a “small” portion of its area.

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.

Previous Occurrences

To date, there have been no catastrophic dam failures in Oxford.

Probability of Future Events

While Oxford has a fairly high number of High and Significant Hazard dams, there are no reported previous dam failure events in the 150-plus years that dams have been present. Probability for future failure events is therefore “very low” with less than 1 percent chance of a dam bursting in any given year.

Impact

The Town faces a “limited” impact from failure of dams with, with 10 to 25 percent of the affected area likely to see damage.

It is not possible to estimate the property loss impacts of dam failure quantitatively given the large number of variables involved in failure events. Qualitatively, losses from failure of an individual dam could be significant but would be geographically limited to portions of the dam's inundation zone.

Vulnerability

In accordance with the Massachusetts Hazard Mitigation Plan, a quantitative vulnerability analysis could not be completed to estimate potential losses from a dam failure event. Based on a mostly qualitative assessment, Oxford has a hazard index rating of "4 – limited" from dam failure. Locally, there is specific concern about vulnerability from the Lowes Pond Dam (Significant Hazard), which lies roughly 300 yards upstream on Lowes Brook from Oxford's Fire Department and EMS headquarters. In addition, the poor structural condition of the McKinstry's Pond Dam (also Significant Hazard) threatens a number of residences in the northern part of the town center, as well as nearby Main Street (Route 12), a key evacuation route. Similarly, failure of the (High Hazard) Chimney Pond Dam would threaten on/off ramps for I-395 at Exit 5 (Depot Road). I-395 is an evacuation route.

4.9 Drought

Hazard Description

Drought is a normal, recurrent feature of climate. It occurs almost everywhere, although its features vary from region to region. In the most general sense, drought originates from a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector. Reduced crop, rangeland, and forest productivity; increased fire hazard; reduced water levels; increased livestock and wildlife mortality rates; and damage to wildlife and fish habitat are a few examples of the direct impacts of drought. Of course, these impacts can have far-reaching effects throughout the region and even the country.

Location

Because of this hazard's regional nature, a drought would likely impact the entire community, meaning the location of occurrence is "large" or over 50 percent of the town.

Extent

The severity of a drought would determine the scale of the event. Roughly 45% of Oxford residents and businesses are served by a private water system operated by the Aquarion Water Company. A few receive water from the public Cherry Valley and Rochdale Water District based in neighboring Leicester, while most others utilize individual private well water. The U.S. Drought Monitor also records information on historical drought occurrence. Unfortunately, data are only available at the state level. The U.S. Drought Monitor categorizes drought on a D0-D4 scale as shown below.

Table 23

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

Source: US Drought Monitor, http://droughtmonitor.unl.edu/.

Previous Occurrences

In Massachusetts, six major droughts have occurred statewide since 1930, though the Oxford area has been spared the most severe impacts in each case according to USGS Water Supply Paper for Massachusetts #2375. These historic major droughts range in severity and in length, lasting from three to eight years. In many of these droughts, water-supply systems around the state were found to be inadequate. Water was piped in to urban areas, and water-supply systems were modified to permit withdrawals at lower water levels. The following table displays peak drought severity since 2000, from the US Drought Monitor:

Table 24

Annual Drought Status	
Year	**Maximum Severity**
2000	No drought
2001	D2 conditions in 21% of the state
2002	D2 conditions in 100% of the state

Annual Drought Status	
Year	**Maximum Severity**
2003	No drought
2004	D0 conditions in 48% of the state
2005	D1 conditions in 7% of the state
2006	D0 conditions in 98% of the state
2007	D1 conditions in 71% of the state
2008	D0 conditions in 69% of the state
2009	D0 conditions in 45% of the state
2010	D1 conditions in 27% of the state
2011	D0 conditions in 0.01% of the state
2012	D2 conditions in 51% of the state
2013	D1 conditions in 60% of the state
2014	D1 conditions in 54% of the state
2015	D1 conditions in 58% of the state
2016 (to Aug. 23)	D3 conditions in 17% of the state

Source: US Drought Monitor

In Oxford, the last known drought event with substantial impacts occurred in 1999, when private wells serving several homes ran dry.

Probability of Future Events

In Oxford, as in the rest of the state, extreme and exceptional droughts occur at a "very low" probability (1 to 10 percent in the next year). Based on past events and current criteria outlined in the Massachusetts Drought Management Plan, it appears that central Massachusetts may be slightly more vulnerable than parts of eastern Massachusetts to severe drought conditions. However, many factors, such as water supply sources, population, economic factors (i.e., agriculture based economy), and infrastructure, may affect the severity and length of a drought event. When evaluating the region's risk for drought on a national level, utilizing a measure called the Palmer Drought Severity Index from the National Drought Mitigation Center at the University of Nebraska, Massachusetts is historically in the lowest percentile for severity and risk of drought.

As with all communities in normally precipitation-rich Massachusetts, Oxford is unlikely to be adversely affected by anything other than a major, extended drought. While such a drought would require water saving measures to be implemented, foreseeable damage to structures or loss of life resulting from the hazard would likely be very limited, with modest increased risk of damaging forest or brush fires.

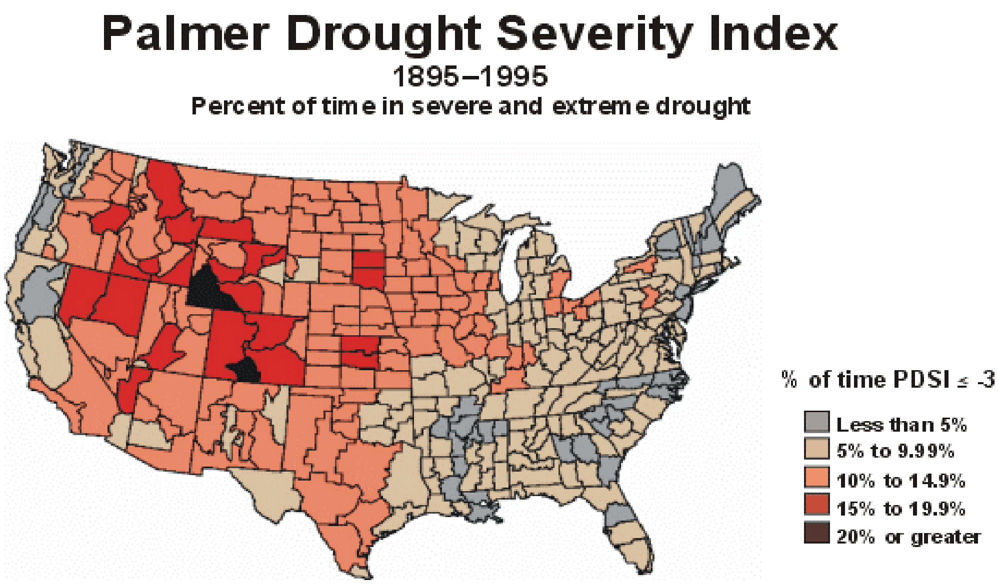


Figure 6

Impact

The impact of droughts is categorized by the U.S. Drought Monitor include:

- Slowing or loss of crops and pastures
- Water shortages or restrictions
- Minor to significant damage to crops, pastures;
- Low water levels in streams, reservoirs, or wells

Impacts in Oxford may vary among customers of the two water systems and private well users. In 1999, some residential wells ran dry, while the two larger systems comprising the Town's water service area were able to maintain service. So while the impact of a drought can be assessed as "minor" overall, with very little damage to people or property likely to occur, impacts may be higher in parts of town that are not located within the Town's water service area. Figure 7 below illustrates the geographic limits of the service area.

Vulnerability

Based on the above assessment, Oxford has a hazard index rating of "4 – low risk" from drought. Minimal or no loss of property, or damage to people or property is expected due to this hazard. Vulnerability is higher in areas outside the municipal water service area (see Figure 7).

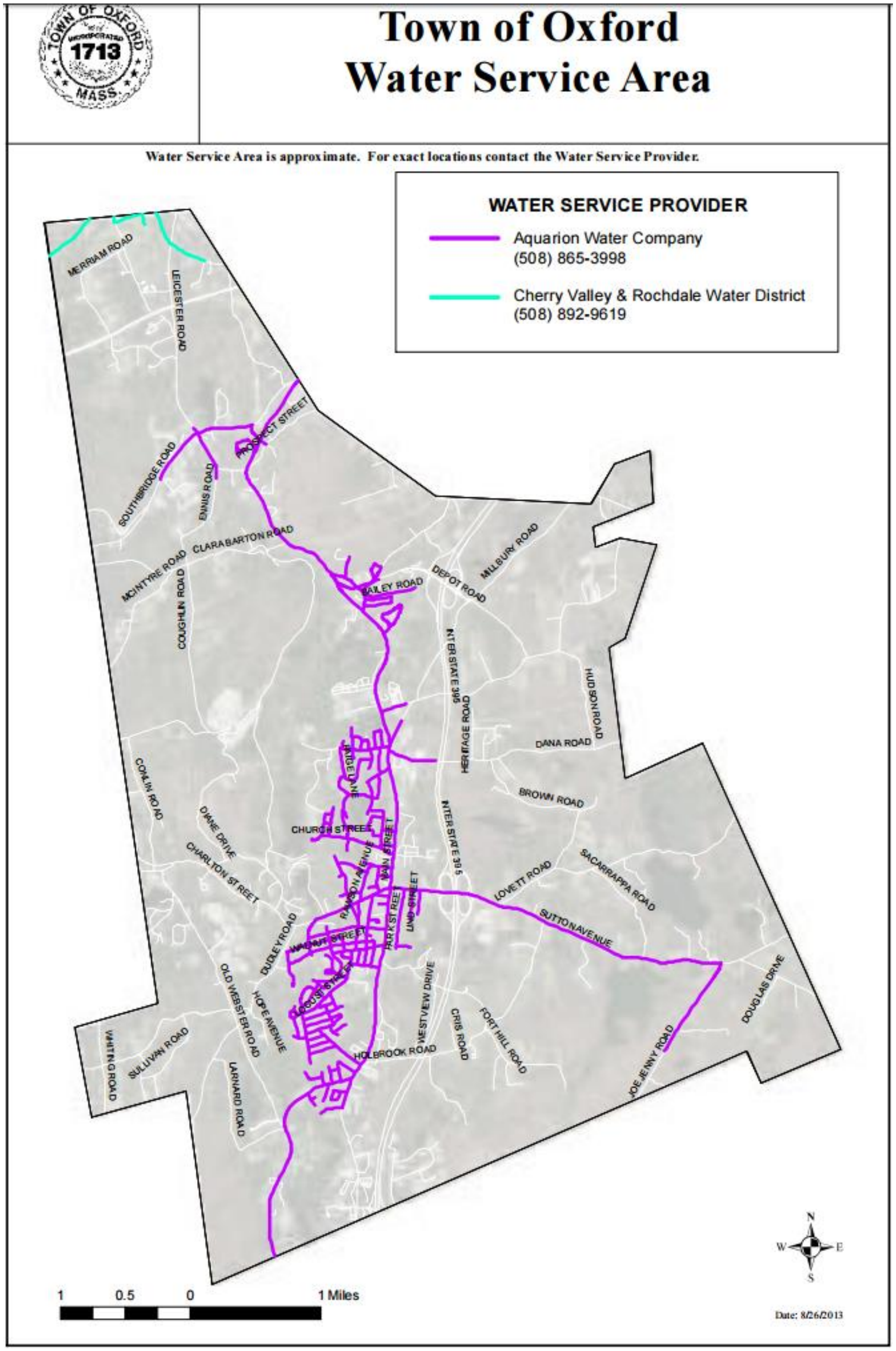

Town of Oxford
Water Service Area
Water Service Area is approximate. For exact locations contact the Water Service Provider.
WATER SERVICE PROVIDER
Aquarion Water Company
(508) 865-3998
Cherry Valley & Rochdale Water District
(508) 892-9619
1 0.5 0 1 Miles
Date: 8/26/2013

Figure 7

4.10 Extreme Temperatures

Hazard Description

As per the Massachusetts Hazard Mitigation Plan, 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. There is no universal definition for extreme temperatures, with the term relative to local weather conditions. For Massachusetts, extreme temperatures can be defined as those that are far outside the normal ranges. The average temperatures for Massachusetts are:

- Winter (Dec-Feb) Average = 27.51ºF
- Summer (Jun-Aug) Average = 68.15ºF

Criteria for issuing alerts for Massachusetts are provided on National Weather Service web pages at www.weather.gov/box/criteria.

Location

Extreme temperatures can be expected to be fairly uniform across Oxford during a given weather event, due to the town's lack of extreme elevations, urban areas, and coastal areas. Therefore this hazard is of "large" geographic coverage.

Extent

As per the Massachusetts Hazard Mitigation Plan, the extent (severity or magnitude) of extreme cold temperatures are generally measured through the Wind Chill Temperature Index. Wind Chill Temperature is the temperature that people and animals feel when outside and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. The chart shows three shaded areas of frostbite danger. Each shaded area shows how long a person can be exposed before frostbite develops. In Massachusetts, a wind chill warning is issued by the NWS Taunton Forecast Office when the Wind Chill Temperature Index, based on sustained wind, is –25ºF or lower for at least three hours.

Extreme temperatures would affect the whole community.

Wind Chills

Wind (mph)	Temperature (°F)																	
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Figure 8

For extremely hot temperatures, the heat index scale is used, which combines relative humidity with actual air temperature to determine the risk to humans. The NWS issues a Heat Advisory when the Heat Index is forecast to reach 100-104 degrees F for 2 or more hours. The NWS issues an Excessive Heat Warning if the Heat Index is forecast to reach 105+ degrees F for 2 or more hours. The following chart indicates the relationship between heat index and relative humidity:

Heat Index

Table 25

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Category	Heat Index	Health Hazards
Extreme Danger	130 °F – Higher	Heat Stroke or Sunstroke is likely with continued exposure.
Danger	105 °F – 129 °F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Extreme Caution	90 °F – 105 °F	Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.
Caution	80 °F – 90 °F	Fatigue possible with prolonged exposure and/or physical activity.

Previous Occurrences

The following are some of the lowest temperatures recorded in parts of Massachusetts for the period from 1895 to present (Source: NOAA, www.ncdc.noaa.gov.). Oxford's temperature range is essentially the same as in Worcester, located some 10 miles away and at a similar elevation.

- Blue Hills, MA: –21°F
- Boston, MA: –12°F
- Worcester, MA: –19°F

The following are some of the highest temperatures recorded for the period from 1895 to present (also NOAA):

- Blue Hills, MA: 101°F
- Boston, MA: 102°F
- Worcester, MA: 96°F

Probability of Future Events

The probability of future extreme heat and extreme cold is considered to be "moderate," or between 10 and 40 percent in the next year.

Impact

The impact of extreme heat or cold in Oxford is considered to be "limited," with no property damage and very limited effect on humans. Extreme temperatures are of some concern for the local Hazard Mitigation Team due to health threats to the very young and very old.

Vulnerability

Oxford's vulnerability from extreme heat and cold is considered to be, "4 - Low Risk."

4.11 Other Hazards

In addition to the hazards identified in previous sections, the Hazard Mitigation Team reviewed the other hazards listed in the Massachusetts Hazard Mitigation Plan: coastal hazards, atmospheric hazards, ice jams, coastal erosion, sea level rise, nor'easters, and tsunamis. It was determined that these hazards are either irrelevant to Oxford due to the town's location, or in the case of nor'easters, that the hazard is already included within another hazard described above (severe winter storms).

One other hazard that can affect Oxford is landslides. Landslides occur in all U.S. states and territories. In a landslide, masses of rock, earth, or debris move down a slope. Landslides may be small or large, slow or rapid. They are generally activated by:

- storms
- earthquakes
- volcanic eruptions
- fires
- alternate freezing or thawing
- steepening of slopes by natural erosion or by human modification

Debris and mud flows are rivers of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground, during heavy rainfall or rapid snowmelt, changing the earth into a flowing river of mud or "slurry." They can flow rapidly, striking with little or no warning at avalanche speeds. They also can travel several miles from their source, growing in size as they pick up trees, boulders, cars, and other materials.

There are no documented previous occurrences of significant landslides in Oxford. The town is relatively flat and most of its rivers are slow moving and frequently dammed, which can minimize landslide risk. Roadways are not generally built close to river channels, reducing undercutting risk from stormwater-induced bank erosion. High slope terrain (defined as 15 to 25% grade) cover 1,080 acres, or only 6.1% of the town; very high slopes (higher than 25% grade) cover 150 acres, or less than 1% of the town's area. Little development is present in these areas. Should a landslide occur in the future in Oxford, the type and degree of impacts would be highly localized. Vulnerabilities could include damage to structures, damage to transportation and other infrastructure, and localized road closures, though our data review and the local planning team noted no specific concerns. Injuries and casualties, while possible, would be unlikely given the low extent and impact of landslides in Oxford.

Oxford, like nearly all communities in the CMRPC region, is categorized in the Massachusetts Natural Hazard Mitigation Plan as a low incidence/low susceptibility area for landslide hazards based on review of past occurrences. Landslides are therefore considered low frequency events that may occur once in 50 to 100 years (a 1% to 2% chance of occurring per year).

4.12 Impacts of Climate Change on Hazards

Over the next several decades, climate change can be expected to exacerbate many of the hazards described previously in this chapter. This section identifies the impacts that a changing climate may have on Oxford's hazard risk profile going forward. Sources for this section include:

- Northeast Climate Impacts Assessment (NECIA) (2007)
- Massachusetts Climate Change Adaptation Report (2011)
- Massachusetts Multi-Hazard Mitigation Plan (2013)

Expected Changes

The NECIA and state Climate Change Adaptation Report offer Massachusetts state-level predictions for temperature and precipitation for upcoming decades, which show dramatic increases in both measures:

Table 26

Category	Current (1961-1990 avg.)	Predicted Change 2040-2069	Predicted Change 2070-2099
Average Annual Temperature (°F)	46°	50°to 51°	51° to 56°
Average Winter Temperature (°F)	23°	25.5° to 27°	31° to 35°
Average Summer Temperature (°F)	68°	69.5° to 71.5°	74° to 82°
Days over 90 °F	5 to 20 days	-	30 to 60 days
Days over 100 °F	0 to 2 days	-	3 to 28 days
Annual Precipitation	41 inches	43 to 44 inches	44 to 47 inches
Winter Precipitation	8 inches	8.5 to 9 inches	9 to 10.4 inches
Summer Precipitation	11 inches	10.9 to 10.7 inches	10.9 to 11 inches

Flooding

A warming climate is expected to lead to higher precipitation. The Massachusetts Multi-Hazard Mitigation Plan estimates that precipitation will increase 6 to 14% by mid-century, with an increased frequency of floods meeting current 10-year flood levels. Much of the winter precipitation increase is projected to be in the form of rain rather than snow, which may actually reduce peak spring flooding but could lead to more frequent winter runoff events. Overall, the frequency of flooding events and their impacts on people and property can be expected to increase over time, largely in locations that are already of flood concern. Public health may be impacted through increased mosquito populations, which depend on the availability of standing water.

Severe Snowstorms/Ice Storms/Nor'easters

The Massachusetts Multi-Hazard Mitigation Plan estimates that as the climate warms, winter snowfall will be reduced and will generally fall later in the winter season. The Climate Change Adaptation Report predicts that snowfall events will decline over time from around 5 per month during winter to 1 – 3, but that the frequency of the strongest winter storms may actually increase until winter average temperatures warm above the freezing point late in the century. Overall, the risk from winter storms to people and property can be expected to decline.

Hurricanes

The Massachusetts Multi-Hazard Mitigation Plan notes that there is still a great deal of uncertainty about the impacts of climate change on hurricanes and tropical storms, but that the limited evidence available indicates that stronger storms (Category 4 and 5) are becoming more frequent. Overall, the risk from hurricanes and their associated flooding can be expected to increase.

Severe Thunderstorms/Wind/Tornado

Evidence shows that severe weather including thunderstorms, damaging wind and tornados is already increasing as temperatures rise. The Massachusetts Multi-Hazard Mitigation Plan notes that smaller storm events are becoming less frequent, while more severe storms are becoming more common. Overall, the risk from severe storms can be expected to increase.

Wildfire/Brush Fire

The Massachusetts Multi-Hazard Mitigation Plan projects summer rainfall to decrease as much as 15% in the next decades. In combination with higher temperatures and winds, this drop in precipitation would contribute to additional fire risk. Forest response to increased atmospheric carbon dioxide – the so-called fertilization effect – could also contribute to more tree growth and thus provide more fuel for wildfires. Climate change may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods. Reduced stream flows and pond depths may also impact the number and quality of access points for rural firefighting, which is of particular concern to communities like Oxford where much of the town's area is not covered by shared water service. Overall, the risk from wildfires to people and property can be expected to increase.

Earthquake

Climate change is not expected to significantly impact the risk from earthquakes. The state Multi-Hazard Mitigation Plan notes that there may be additional earthquake risk in conjunction with other hazards such as higher rainfall (which can contribute to soil liquefaction during earthquakes), but that research is not yet mature. At this time, overall risk from earthquake to people and property can be expected to stay around the same as the current risk level.

Dam Failure

The Massachusetts Multi-Hazard Mitigation Plan does not note major concerns about catastrophic dam failure due to climate change. It does, however, mention that increased heavy rainfall events may lead to more frequent dam design failures, in which spillways overflow due to flow rates exceeding design capacity. This type of failure may have a secondary result of increased riverine flooding below dams. Overall, the risk from dam failure to people and property can be expected to stay around the same as the current risk level.

Drought

While the projections noted above show overall increases in precipitation going forward, summer rainfall is actually expected to decline slightly as the climate warms, raising the risk of seasonal droughts. According to the Massachusetts Multi-Hazard Mitigation Plan, droughts are expected to increase in frequency, severity and length. The Massachusetts Climate Change Adaptation Report finds that by the end of the century, under a high carbon emissions scenario, the occurrence of droughts lasting one to three months could go up by as much as 75% over existing conditions. Secondary to drought, wildfire risk can be expected to rise. Overall, the risk from drought to people and property can be expected to increase.

Extreme Temperatures

According to records of the US Historical Climatology Network, average temperatures have increased about 0.2 degrees C (0.5°F) per decade since 1970. These higher average temperatures have primarily been the result of warmer winters (December through March), during which there has been an increase of 1.3°F per decade since 1970. In addition to average temperature increases, the number of extremely hot and record heat days has also increased: the number of days with temperatures of 90°F and higher throughout the Northeast has doubled during the past 45 years. As noted in the table elsewhere in this section, the number of days exceeding 90 degrees is expected to surge several times over, presenting a health risk to young children, the elderly, and to persons with various health conditions. Overall, the risk from extreme temperatures to people and property can be expected to increase.

5.0 CRITICAL FACILITIES & VULNERABLE POPULATIONS

A Critical Facility is defined as a building, structure, or location which:

- Is vital to the hazard response effort.
- Maintains an existing level of protection from hazards for the community.
- Would create a secondary disaster if a hazard were to impact it.

5.1 Critical Facilities within Oxford

The Critical Facilities List for the Town of Oxford has been identified utilizing several sources, and the knowledge and expertise of the team:

- Oxford’s Comprehensive Emergency Management Plan
- MassGIS data
- Critical infrastructure mapping undertaken by CMRPC under contract with the Central Region Homeland Security Advisory Council, which is charged by the Executive Office

of Public Safety and Security to administer and coordinate the State Homeland Security Grant for central Massachusetts.

Oxford's Hazard Mitigation Team has broken up this list of facilities into three categories:

- Emergency Response Facilities needed in the event of a disaster
- Non-Emergency Response Facilities that have been identified by the Committee as non-essential. These are not required in an emergency response event, but are considered essential for the everyday operation of Oxford
- Dams
- Facilities/Populations that the Team wishes to protect in the event of a disaster

Critical infrastructure and facilities are mapped in Appendix A.

Category 1 – Emergency Response Facilities

The Town has identified the Emergency Response Facilities and Services as the highest priority in regards to protection from natural and man-made hazards.

1. **Emergency Operations Center/Police Station**
   Oxford Police Dept./EOC   503 Main Street

2. **Fire Station**
   Fire Station # 2   656 Main Street
   Fire Headquarters   181 Main Street

3. **Communications Facilities**
   Oxford Town Hall, 325 Main Street (repeater site)
   Public safety radio site (Crown Castle), 40 Federal Hill Road
   IPG Photonics Corporation, 50 Old Webster Road (repeater site)

4. **Highway Department**
   DPW Headquarters, 450 Main Street
   DPW Garage, 34 Charlton Street

5. **Primary Evacuation Routes**
   I-395
   Route 20
   Route 12 (Main St.)

Route 56
Sutton Ave.
Charlton St.
Depot Rd.
South St.

Category 2 – Non Emergency Response Facilities

The Town has identified these facilities as non-emergency facilities; however, they are considered essential for the everyday operation of Oxford.

1. **Water Supply**
   Oxford Wastewater Treatment Plant, Leicester Street
   #1 North Main Street Well Station, 579 Main Street
   #3 Nelson Street Well Station, 12 Nelson Street
   Pumping Station #1, 495 Main Street
   Pumping Station #2, Old Worcester Road
   Prospect Hill water tower (Prospect Hill)
   Sutton Avenue water tank, Sutton Avenue

2. **Town Facilities**
   Building Maintenance, 3 Barton Street
   Oxford Public Library/Shelter intake center, 339 Main Street

3. **Utilities**
   Mobil Oil Fuel Line (runs through town)
   Verizon Oxford Co. (MA862606), 8 Wheelock Avenue
   P & W Railroad (runs North and South through center of town)
   National Grid Pumping Station, Rocky Hill Road (behind schools)

Category 3 – Dams

The third category is a listing of dams in Oxford.

Table 27

National ID	Dam Name	Owner Type	Hazard Potential	Notes
MA01954	Stone's Pond Dam	Private	N/A	
MA00669	Lowes Pond Dam	Private	Significant Hazard	

National ID	Dam Name	Owner Type	Hazard Potential	Notes
MA00992	Buffumville Pond Dam	Private	Significant Hazard	
MA03365	Texas Pond Outlet Dam	Private	N/A	
MA00671	Stumpy Pond Dam	Private	Significant Hazard	
MA01952	Lapa Farm Pond Dam	Private	N/A	
MA01955	Turner Pond	Private	N/A	
MA01948	Old Scythe Shop Pond Dam	Private	N/A	
MA01956	Clara Barton Pond Dam	Private Association or other non-profit	N/A	
MA00670	Robinson Pond Dam	Private	Significant Hazard	
MA01946	Bartlett Pond Dam	Private	Significant Hazard	
MA01947	Slaters Pond Dam	Town of Oxford	Significant Hazard	
MA00674	Hudson Pond Dam	Private	N/A	
MA01951	Cominsville Pond Dam	Private	N/A	
MA01005	Gordon Pond Dam	Private	Significant Hazard	
MA01950	Eames Pond Dam	Private	Significant Hazard	
MA00967	Hodges Village Dam	ACOE - U.S. Army Corps of Engineers	High Hazard	
MA01953	Mckinstry's Pond Dam	Town of Oxford	Significant Hazard	In poor condition. On State list of 100 critical dams.
MA00675	Chimney Pond Dam	Private	High Hazard	

For additional information on dams and the dam failure hazard in Oxford, also see Chapter 4.

Category 4 – Facilities/Populations to Protect

1. **Special Needs Population/Elderly Housing/Assisted Living**
   Sandalwood Nursing Home, 3 Pine Street
   Colonial Valley Apts./ Elderly and handicapped housing, Liberty Lane
   Huguenot Arms Elderly Housing, 23 Wheelock Street

2. **Public Buildings/Areas**
   Oxford Community Center, 4 Maple Road
   Oxford Senior Center (warming & cooling center), 323 Main Street

3. **Schools/Daycare**
   (Please note: The EMD has a list of current daycare facilities but these can change locations and addresses frequently, so this list should be revisited periodically.)

Grace Church Preschool, 268 Main Street
Jack and Jill Preschool, 693 Main Street
Alfred M Chaffee School (shelter), 9 Clover Street
Clara Barton School (shelter), 30 Depot Rd
Oxford High School (shelter), 495 Main Street
Oxford Middle School (shelter), 497 Main Street

4. Historic Buildings/Sites

According to the Massachusetts Cultural Resources Information System (MACRIS) online database accessed in July 2016, there are 14 Areas, 330 Buildings, 5 Burial Grounds, 11 Objects, and 4 Structures listed for Oxford. The Local Team did not specifically identify any of these sites as Critical Facilities or Infrastructure.

5. Employment Centers

Based on data obtained from the Massachusetts Executive Office of Labor and Workforce Development (EOLWD), the following table shows the largest employers in Oxford:

Table 28

Largest Employers in Oxford - July 2016		
Company	**Location**	**No. of Employees**
IPG Photonics Corp	Old Webster Rd	1,000-4,999
Walmart Supercenter	Main St	250-499
Central Mass Auto Auction	Town Forest Rd	100-249
Home Depot	Sutton Ave	100-249
La Mountain Brothers Inc.	Federal Hill Rd	100-249
Market Basket	Sutton Ave	100-249
Sandalwood Care & Rehab Ctr.	Pine St	100-249
Schmidt Equipment Inc.	Southbridge Rd	100-249
Technetics Group	Old Webster Rd	100-249

Source: EOLWD website: http://lmi2.detma.org/lmi/Top_employer_list.asp?gstfips=25&areatype=05&gCountyCode=000485

6. Environmental Justice and Vulnerable Populations

The US Environmental Protection Agency defines Environmental Justice (EJ) as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Within the context of natural hazards and their mitigation, potential EJ concerns may arise from income-related factors, discrimination (overt or institutional), cultural isolation and barriers, language isolation, lack of transportation access, and disability (especially among the elderly).

In 2015, as part of its Mobility 2040 long range transportation plan, CMRPC identified disproportionate concentrations of EJ and other vulnerable populations at the US Census block group level throughout Central Massachusetts. Thresholds used in this identification process included various metrics from the 2010 Census and 2013 American Community Survey:

- Lower income households (median income below $50,259/year); or
- Minority residents (20.3% or more of population); or
- Hispanic or Latino residents (14.0% or more of population); or
- Language isolated households (9.45% or more of population); or
- Zero vehicle households (12.75% or more of population); or
- Households with persons 75+ years of age (18.8% or more of population); or

In Oxford, one block group in the southeastern portion of the town center was identified as an EJ area due to its relatively low household income. As of the 2014 American Community Survey, median household income in this neighborhood is now estimated at $62,861, compared to Oxford's town-wide median of $70,016 and Worcester County's median of $65,453. Because median income in this area is only slightly below regional and local norms and does not suggest a level of poverty that would impair household disaster preparations or response, no special action is recommended other than periodic monitoring of income statistics. The location of this EJ area is shown in Map 1 in Appendix A.

More information regarding the identification of Environmental Justice and Vulnerable populations in the Central Massachusetts region can be found online at http://www.cmrpc.org/mobility2040.

A complete listing of Critical Facilities and Infrastructure in Oxford are listed in Table 29 below:

Table 29

NAME & TYPE of FACILITY	ADDRESS	AFFECTED BY PAST EVENT?	DATE(S) AFFECTED BY PAST EVENT	IF AFFECTED BY PAST EVENT, PLEASE PROVIDE A DESCRIPTION	EMERGENCY GENERATOR?
EMERGENCY RESPONSE SERVICES					
Fire Station # 2	656 Main St.	Yes	ongoing	Roof issues many past snow and rain storms	Yes
Fire Headquarters	181 Main St.	Yes	2010	Flooding of basement.	Yes
Oxford Police Dept./EOC	503 Main St	No	N/A		Yes
Oxford Town Hall/repeater site	325 Main St.	No	N/A		Yes
Public safety radio site Crown Castle	40 Federal Hill Rd.	Yes	7/11, 9/11	Struck by lighting	Yes
IPG Photonics Corporation - Repeater site/Haz Mat	50 Old Webster Rd.	No	N/A		Yes
DPW Garage	34 Charlton St.	No	N/A		Yes
DPW Headquarters	450 Main St.	No	N/A		Yes
NON-EMERGENCY RESPONSE FACILITIES					
Mobil Oil Fuel Line	Runs through town	Yes	1980s	Large leak	?
#1 North Main Street Well Station	579 Main St.	No	N/A		?
#3 Nelson Street Well Station	12 Nelson St.	No	N/A		?
National Grid Pumping Station	Rocky Hill Rd (behind schools)	No	N/A		?
Pumping Station #1	495 Main St	No	N/A		Yes
Pumping Station #2	Old Worcester Rd.	No	N/A		Yes
Building Maintenance	3 Barton Street	No	N/A		No
Verizon Oxford Co. (MA862606)	8 Wheelock Ave	Yes	Storm Nemo	Long term power loss	Yes
Prospect Hill water tower	Prospect Hill	No	N/A		No
Sutton Ave water tank	Sutton Ave	No	N/A		No

NAME & TYPE of FACILITY	ADDRESS	AFFECTED BY PAST EVENT?	DATE(S) AFFECTED BY PAST EVENT	IF AFFECTED BY PAST EVENT, PLEASE PROVIDE A DESCRIPTION	EMERGENCY GENERATOR?
Oxford Public Library/Shelter intake center	339 Main St.	Yes	ongoing	Leaking roof after heavy rains	Yes
Oxford Wastewater Treatment Plant	Leicester Street	No	N/A		Yes
P & W Railroad	Runs North and South through center of town	No	N/A		No
DAMS					
Bartlett Pond Dam	North Water St.	No	N/A		No
Clara Barton Pond Dam	Clara Barton Rd.	No	N/A		No
Buffum Pond Dam	Old Webster Rd	No	N/A		No
Chimney Pond Dam	Millbury Rd	No	N/A		No
Comins Pond Dam	Comins Road	No	N/A		No
Eames Pond Dam	off Sutton Ave	No	N/A		No
Gordon Pond Dam	Comins Rd	No	N/A		No
Hodges Village Pond Dam	Old Howarth Rd.	No	N/A		No
Hudson Pond Dam	Hudson Rd	No	N/A		No
Hudson Saw Mill Pond Dam	Hudson Rd.	No	N/A		No
Lapa Farm Pond Dam	Sutton Ave	No	N/A		No
Lowes Pond Dam	off Huguenot Rd	No	N/A		No
Mckinstry's Pond Dam	Westgate Drive	No	N/A		No
Mill Pond Dam #1	Sutton Ave at line	No	N/A		No
Old Scythe Shop Pond Dam	Sacarrappa Rd	No	N/A		No
Prospect Road Pond Dam	120 Southbridge Rd	No	N/A		No
Robinson Pond Dam	off Sutton Ave.	No	N/A		No
Slaters Pond Dam	off Sacarrappa Rd.	No	N/A		No

NAME & TYPE of FACILITY	ADDRESS	AFFECT ED BY PAST EVENT?	DATE(S) AFFECTED BY PAST EVENT	IF AFFECTED BY PAST EVENT, PLEASE PROVIDE A DESCRIPTION	EMERGENCY GENERATOR?
Stone's Pond Dam	off Mount Pleasant Rd.	No	N/A		No
Stumpy Pond Dam	off Sutton Ave.	No	N/A		No
Texas Pond Outlet Dam	Rt. 20 Texas Pond	No	N/A		No
Turner Pond Dam	off Pine St.	No	N/A		No
FACILITIES/POPULATIONS TO PROTECT					
Sandalwood Nursing Home	3 Pine Street	Yes	Late 1990s	Partial roof collapse, Removal of 78 residents	Yes
Colonial Valley Apts./ Elderly and handicapped housing	Liberty Lane	Yes	Storm Nemo	Long term power loss	Yes
Alfred M Chaffee School/Shelter	9 Clover Street	Yes	Storm Nemo	Loss of power for long duration	Yes
Clara Barton School/Shelter	30 Depot Rd	No	N/A		Yes
Grace Church Preschool	268 Main Street	No	N/A		No
Huguenot Arms Elderly Housing	23 Wheelock St	No	N/A		No
Jack and Jill Preschool	693 Main Street	Yes	Storm Nemo	Roof damage	No
Oxford Community Center	4 Maple Road	No	N/A		Yes
Oxford High School/Shelter	495 Main Street	No	N/A		Yes
Oxford Middle School/Shelter	497 Main Street	No	N/A		Yes
Oxford Senior Center/warming /cooling center	323 Main Street	Yes	2010	Heavy rains, roof and floor damage	Yes

6.0 EXISTING PROTECTION

The Town of Oxford currently makes use of most available locally-controlled tools to mitigate the consequences of natural hazards: zoning regulations, planning, and physical improvements. The Town does not participate in any federal programs such as StormReady certification or Firewise community certification, but it does plan to research the utility of public awareness and education programs as a result of this planning process.

Oxford 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…. Oxford also has appropriate staff dedicated to hazard mitigation-related work for a community of its size, including a Town Manager, an Emergency Management Director, a professionally run Department of Public Works, a Facilities Director, and a Tree Warden. Oxford has several relevant plans in place, including a Comprehensive Emergency Management Plan, and it is working now to update its Master Plan. Not only does Oxford have these capabilities in place, but they are also deployed for hazard mitigation, as appropriate. The Town also has very committed and dedicated volunteers who serve on Boards, Commissions and Committees and in other volunteer positions. The Town collaborates closely with surrounding communities through its Regional Emergency Planning Committee (Tri-EPIC) and has opted in to fire protection mutual aid agreements through MEMA. Oxford is also an active member community of the Central Massachusetts Regional Planning Commission (CMRPC) and can take advantage of no cost local technical assistance as needed provided by the professional planning staff at CMRPC.

The table below describes existing mitigation protections in Oxford. It includes a brief description of each activity as well as a subjective evaluation of its effectiveness and of any need for modifications.

6.1 Existing Protection Matrix

Table 30

Existing Measure	Description	Action	Effectiveness & Recommendations
Participation in National Flood Insurance Program (NFIP)	Provides flood insurance for structures located in flood-prone areas. Also, communities participating in the NFIP have adopted and enforce ordinances, bylaws and regulations that meet or exceed FEMA requirements to reduce the risk of flooding.	Oxford monitors building activity within the flood plain to ensure compliance with provisions of state building code.	Effective There are no repetitive loss properties in Oxford. Oxford should seek to further limit development in the 100-year flood zones. It should work to score in the Community Rating System (CRS) under NFIP to enable its residents to obtain lower flood insurance rates. Oxford should educate its residents about NFIP.
Floodplain Zoning District bylaw in place	Requires all development to be in compliance with state building code requirements for construction in floodplains	Oxford has a Flood Plain District (Chapter VIII) in its Zoning Bylaw. This Chapter was last updated in May of 2011.	Very effective No changes recommended
Stormwater Management policy and regulations in place	Planning Boards or Conservation Commissions review projects for consistency with MA DEP standards. This helps ensure adequate on site retention and recharge.	Oxford enacted a Stormwater Management and Erosion Control Bylaw in January 2005, which is included as Chapter 65-67 in the Town's General Bylaws. Oxford also participates in the Central Mass Stormwater Coalition.	Very effective No changes recommended

Existing Measure	Description	Action	Effectiveness & Recommendations
Local Open Space and Recreation Plan	Local plan identifying significant natural resources and identifying mechanisms to ensure their protection. Following Mass. Department of Conservation and Recreation guidance for development of OSRPs, this document does not focus on specific hazards. Open Space Plans can provide many tools. Towns must commit to making the land acquisitions and regulatory changes, giving increased attention to preserving undeveloped flood-prone areas and associated lands	Oxford's Open Space and Recreation Plan was issued in March 2007.	Somewhat effective Plan is expired as of 2014. Oxford should prepare plan update as per Mass. DCR guidance. Where allowable, Oxford should use the update to integrate hazard mitigation activities and recommendations.
Combined Sewer Overflow (CSO) upgrade program	Upgrade of municipal sewer systems to reduce or eliminate CSO's, which compromise water quality and can increase flood risk during heavy storm events	Approximately 84% of the town is on private septic systems. Oxford has initiated a Comprehensive Wastewater Management Planning Process, which is s a 20-year sewer master plan to determine where there are needs for sewer and to determine the best way to meet the need.	Very effective No changes recommended

Existing Measure	Description	Action	Effectiveness & Recommendations
Local wetlands protection bylaw and regulations in place (Mass. Assoc. of Conservation Commissions, 2006 data)	Local bylaws building upon the State's Wetlands Protection Act and Regulations. These add regulatory oversight provisions for development within the jurisdictional buffer zone, adding increased attention to alteration of wetlands and the opportunity to preserve capacity and quality.	Oxford does not have a local town-wide wetland bylaw in place; however, the Town implemented the Robinson Pond Protection District to regulate development around that water body.	Very effective Oxford should examine enhanced development controls at other wetlands to sustain natural barriers to flooding
Drainage system maintenance and repair program	Plan to keep municipal drainage facilities (storm drains, culverts, etc.) in good order	Oxford performs street sweeping and catch basin cleaning from April to November.	Effective Oxford should examine a public education program for residents on storm drain clearance and other best practices
Tree Trimming	Plan to ensure routine maintenance of trees to reduce likelihood of vegetative debris in response to storm events	Oxford conducts roadside mowing from April-November to remove juvenile trees. Tree trimming (take-downs and clearing dead branches) takes place as needed.	Effective Oxford should work with its electrical utility to coordinate a more systematic tree trimming program

Existing Measure	Description	Action	Effectiveness & Recommendations
Culvert Maintenance and Replacement	Maintain existing culverts through regular maintenance and (in some cases) beaver controls; replace/expand culverts where needed to allow for adequate stormwater flow.	MassDOT is replacing a problem culvert at Clara Barton Road/Main Street. The Town has historically maintained and replaced other problem culverts when needed and as funding allows.	Somewhat effective Current efforts are piecemeal and are limited by lack of resources and systematic approach. Oxford should develop a prioritized inventory of problem culverts for use in seeking external financial support. Planning must comply with 2014 Mass. Wetlands Protection Act update; culverts may not be replaced in-kind.

7.0 MITIGATION STRATEGY

The Oxford hazard mitigation planning team developed a list of mitigation strategies (both new and previously identified by local officials) and prioritized them using the criteria described below. This list of factors is broadly derived from FEMA's STAPLE+E feasibility criteria.

7.1 Impact

The team's consideration of each strategy included an analysis of the mitigation impact each can provide, regardless of cost, political support, funding availability, and other constraints. The intent of this step is to separately evaluate the theoretical potential benefit of each strategy to answer the question: if cost were no object, what strategies have the most benefit? Factors considered in this analysis include the number of hazards each strategy helps mitigate (more hazards equals higher impact), the estimated benefit of the strategy in reducing loss of life and property (more benefit equals higher impact) based on the relevant hazard(s) as assessed in Chapter 4, and the geographic extent of each strategy's benefits (other factors being equal, a larger area equals higher impact).

- **High Impact** – actions that help mitigate several hazards, substantially reduce loss of life and property (including critical facilities and infrastructure), and/or aid a relatively large portion of the community
- **Medium Impact** – actions that help mitigate multiple hazards, somewhat reduce loss of life and property (including critical facilities and infrastructure), and/or aid a sizeable portion of the community
- **Low Impact** – actions that help mitigate a single hazard, lead to little or no reduction in loss of life and property (including critical facilities and infrastructure), and/or aid a highly localized area

7.2 Priority

Following the ranking of each strategy for its mitigation impact, real world considerations were brought back into the analysis to inform the priority ranking process. Factors considered in this step include costs and cost effectiveness (including eligibility and suitability for outside funding), timing, political and public support, and local administrative burden.

Costs and 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 clear and viable potential funding streams, such as FEMA's Hazard Mitigation Grant Program (HMGP), are also given higher priority.

Time required for completion - Projects that are faster to implement, either due to short work duration, current or near-term availability of funds, and/or ease of permitting or other regulatory procedures, are given higher priority.

Political and public support - Strategies that have demonstrated political and/or public support through positive involvement by the public or prioritization in previous regional and local plans and initiatives that were locally initiated or adopted are given higher priority.

Administrative burden – Strategies that are realistically within the administrative capacity of the town and its available support network (CMRPC, Tri-EPIC regional emergency planning, etc.) are prioritized. Considerations include grant application requirements, grant administrative requirements (including audit requirements), procurement, and staff time to oversee projects.

- **High Priority** – strategies that have obvious mitigation impacts that clearly justify their costs and to a large degree can be funded, can be completed in a timely fashion, can be administered effectively, and are locally supported
- **Medium Priority** – strategies that have some clear mitigation impacts that generally justify their costs and generally can be funded, can be completed in a timely fashion, can be administered effectively, and are locally supported
- **Low Priority** – strategies that have relatively low mitigation impacts that do not necessarily justify their costs and that may have difficulty being funded, completed in a timely fashion, administered effectively, and locally supported

7.3 Estimated Cost

Each implementation strategy is provided with a rough cost estimate based on available third-party or internal estimates and past experience with similar projects. Each includes hard costs (construction and materials), soft costs (engineering design, permitting, etc…), and where appropriate Town staff time (valued at appx. $25/hour for grant applications, administration, etc…). Projects that already have secured funding are noted. Detailed and current estimates were not generally available, so costs are summarized within the following ranges:

- **Low** – less than $50,000
- **Medium** – between $50,000 – $100,000
- **High** – over $100,000

Timeline

Each strategy is provided with an estimated length of time it will take for implementation. Where funding has been secured for a project, a specific future date is provided for when completion is expected. However, most projects do not currently have funding and thus it is difficult to know exactly when they will be completed. For these projects, an estimate is provided for the amount of time it will take to complete the project once funding becomes available. Strategies are grouped by 1-2 year timeframe, 3-5 year timeframe, 5+ year timeframe, and ongoing items.

Strategy Types

Mitigation strategies were broken into four broad categories to facilitate local implementation discussions, especially regarding budget considerations and roles/responsibilities:

Structure and Infrastructure Projects - Construct "bricks & mortar" infrastructure and building improvements in order to eliminate or reduce hazard threats, or to mitigate the impacts of hazards. Examples include drainage system improvement, dam repair, and generator installation. Structure and infrastructure improvements tend to have the greatest level of support at the local level, but are highly constrained by funding limits.

Preparedness, Coordination and Response Actions - Ensure that a framework exists to facilitate and coordinate the administration, enforcement and collaboration activities described in this plan. Integrate disaster prevention/mitigation and preparedness into every relevant aspect of town operations, including Police, Fire, EMD, EMS, DPW, Planning Board, Conservation Commission and Board of Selectmen; coordinate with neighboring communities where appropriate. Recommendations in this category tend toward standardizing and memorializing generally-practiced activities.

Education and Awareness Programs - Integrate education and outreach into the community to raise awareness of overall or hazard-specific risk and generate support for individual or community-wide efforts to reduce risk.

Awareness and education seek to affect broad patterns of behavior, essentially altering a culture. Awareness-building activity tends to have a fairly slow effect, although in the end it can provide extraordinary benefits with relatively little cash outlay.

Local Plans and Regulations - Review and propose updates to local bylaws, ordinances and regulations to protect vulnerable resources and prevent further risk to those resources. Formally adopt these updates into the local regulatory framework. Review the effectiveness of past mitigation projects, programs procedures and policies. Incorporate mitigation planning into master plans, open space plans, capital improvement plans, facility plans, etc…

Planning and regulatory activity tends to provide extraordinary benefits with relatively little cash outlay. However, in smaller communities where planning activities are largely the purview of volunteers, outside assistance from the state or regional levels may be required to maximize its benefits. Political support may be difficult to achieve for some planning and regulatory measures, especially those that place new constraints on land use.

In addition to describing action items in each of these categories, for each strategy we also identify what hazard(s) it is intended to address, as described in Chapter 4 of this plan. Each strategy also identifies the lead organization who serves as the primary point of contact for coordinating efforts associated with that item, and identifies potential funding sources for implementation. See Chapter 8 for more information on potential funding.

Town of Oxford
Mitigation Strategies

OVERALL GOAL: Facilitate activity within the Town of Oxford that reduces the loss, and risk of loss, to persons and property

	Action Plan/Descriptions	Hazards Addressed	Who agencies involved	Potential Funding Sources	Priority Political and economic viability: High/Med/Low	Impact Mitigation impact: High/Med/Low	Estimated Cost High/Med/Low	Timeline
A. Structure & Infrastructure Strategies								
	Drainage and culvert upgrades at Sacarrappa Road due to repeated flood incidents; adjacent to 100-year flood zone	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM), State Grants (Various)	Medium	Medium	High	1-2 Years
	Undersized drainage system replacement at Rawson Ave due to repeated flood incidents; adjacent to wetland	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM, TIP), State Grants (Various)	Medium	Medium	High	1-2 Years
	Identify/resolve issue causing flooding problem on MassDOT-responsible road at Main Street, south of Pratt Ave	FL, SS, ST, HU	MassDOT, DPW	State (MassDOT)	Low	Low	More information required	3-5 Years
	Address structural issues at Town-owned McKinstry's Pond Dam (Significant Hazard), in poor condition	DF	DPW	Local, State Grants (Dam & Seawall)	High	High	High	3-5 Years
	Multiple drainage issues need addressing on Water Street between Cedar St. and Sibley Cir, including, but not limited to culvert size and beaver dam	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM), State Grants (Various)	Medium	Medium	More information required	1-2 Years

	Action Plan/Descriptions	Hazards Addressed	Who agencies involved	Potential Funding Sources	Priority Political and economic viability: High/Med/Low	Impact Mitigation impact: High/Med/Low	Estimated Cost High/Med/Low	Timeline
	control. Within wetland, 100-year flood zone, 500-year flood zone							
	Address combination of undersized drain and hardened cement which has been poured into the system at Sutton Ave at Lind Street; adjacent to wetland	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM), State Grants (Various)	Low	Low	High	1-2 Years
	Undersized drain replacement at Sutton Ave between Lovett and Fort Hill Roads; adjacent to wetland and 100-year flood zone	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM), State Grants (Various)	Low	Low	High	1-2 Years
	Privately owned Lowes Pond Dam (Significant Hazard) needs repair near Main Street and State Street; dam area is just upstream from Fire/EMS station and within the 500-year and 100-year flood zones	DF	More information required	Private (dam owner)	Medium	High	More information required	3-5 Years
	Culverts at Main St./Prince St./Holman St./Dana Rd. under Main Street and parking lot need replacement; one residence with recurrent flooding	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM), State Grants (Various)	Medium	Medium	More information required	1-2 Years
	Area near Sutton Ave and Turk Hollow Rd is low lying; roadbed could be raised; area is	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM), State Grants	Low	Low	More information required	1-2 Years

	Action Plan/Descriptions	Hazards Addressed	Who agencies involved	Potential Funding Sources	Priority Political and economic viability: High/Med/Low	Impact Mitigation impact: High/Med/Low	Estimated Cost High/Med/Low	Timeline
	adjacent to wetland			(Various)				
	General drainage upgrades in area of Clara Barton Road near Main Street; adjacent to French River, wetland, and 100- and 500-year flood zones	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM), State Grants (Various)	Medium	Medium	More information required	1-2 Years
	Culvert upgrade/replacement at Hartwell Road; irregular reports of flooding in area; area within 500-year flood zone	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM), State Grants (Various)	Low	Low	High	1-2 Years
	Culvert upgrade/replacement at Hall Road at stream crossing; adjacent to wetland	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM), State Grants (Various)	Low	Low	High	1-2 Years
	676 Main Street area needs culvert replaced; near North Oxford Post Office and Fire Station #2; adjacent to wetland and 100- and 500-year flood zones	FL, SS, ST, HU	MassDOT	State (MassDOT)	High	High	More information required	1-2 Years
	Drainage and structural upgrades at Wellington Road; area within wetland and 500-year flood zone	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM), State Grants (Various)	Low	Low	More information required	1-2 Years
	Dam (Texas Pond Outlet Dam, N/A hazard tier) and/or roadway repair at Main St. (state route) at Chestnut Hill Rd; irregular flooding;	DF, FL, SS, ST, HU	MassDOT, Private dam owner	State (MassDOT), Private (dam owner)	Low	Low	More information required	3-5 Years

	Action Plan/Descriptions	Hazards Addressed	Who agencies involved	Potential Funding Sources	Priority Political and economic viability: High/Med/Low	Impact Mitigation impact: High/Med/Low	Estimated Cost High/Med/Low	Timeline
	adjacent to 500-year and 100-year flood zones							
	Drainage and structural upgrades at Birchwood Terrace; dead-end street floods regularly and is only access to 3-5 homes	FL, SS, ST, HU	DPW	Local, Federal Grants (HMGP/PDM), State Grants (Various)	Medium	Medium	More information required	1-2 Years
	Glass replacement and roof improvements at Police Station (EOC) to withstand hurricane force wind damage	ST, HU	Local Emergency Management	Local (funds already allocated)	High	High	Low	1-2 Years
	Structural repair to clock tower attached to Town Hall	ST, HU, EQ	Town Facilities Department	Local, State Grants (Various)	Low	Low	High	3-5 Years
	Tree trimming needed across the town to protect utility wires	SS, ST, HU	National Grid, Town, Private property owners	Utility (National Grid), Local, Private (property owners)	High	High	More information required	Ongoing
	Replace emergency generator and associated wiring at former school (4 Maple Road) to provide power to building and food storage and preparation areas for use as shelter	All	Local Emergency Management	Local, Federal Grants (HMGP/PDM), State Grants (Various)	High	High	High	1-2 Years
	Drainage improvements under P&W Railroad near Cudworth Road and the Whistle Stop; area is adjacent to wetland and 100- and 500-year flood zones	FL, SS, ST, HU	MassDOT, P&W Railroad	State (MassDOT), Private (P&W Railroad)	Low	Low	More information required	1-2 Years

	Action Plan/Descriptions	Hazards Addressed	Who agencies involved	Potential Funding Sources	Priority Political and economic viability: High/Med/Low	Impact Mitigation impact: High/Med/Low	Estimated Cost High/Med/Low	Timeline
	Drainage improvements at Route 12 (Main Street) under P&W Railroad (near Industrial Park West); area is within wetland and 100- and 500-year flood zones	FL, SS, ST, HU	MassDOT, P&W Railroad	State (MassDOT), Private (P&W Railroad)	Medium	Medium	More information required	3-5 Years
B. Preparedness, Coordination & Response Action Strategies								
	Continue to participate in National Flood Insurance Program (NFIP) (or other) training offered by the State and/or FEMA that addresses flood hazard planning and management	FL, SS, ST, HU	DPW, Local Emergency Management, Planning	Local	High	High	Low	Ongoing
	Investigate Community Rating System (CRS) benefits and requirements and decide whether to participate	FL, SS, ST, HU	DPW, Local Emergency Management, Planning	Local	Low	Low	Low	1-2 Years
	Road information coordination and planning for snow removal	SS	DPW; MassDOT; Mass State Police; CMRPC	Local, Federal Grants (HMGP/PDM), State Grants (Various), Private Contracts	High	High	Low	Ongoing
	Evacuation Plan updates	All	Local Emergency Management, DPW, CMRPC, MassDOT	Local, Federal Grants (Homeland Security via MEMA and CRHSAC)	High	High	Low	1-2 Years (update every 5 Years)
	Maintain fire access roads in isolated areas	DR, WF	Fire, DPW	Local; Federal Grants (AFG) for	High	High	Low	Ongoing

	Action Plan/Descriptions	Hazards Addressed	Who agencies involved	Potential Funding Sources	Priority Political and economic viability: High/Med/Low	Impact Mitigation impact: High/Med/Low	Estimated Cost High/Med/Low	Timeline
				equipment				
	Improve vegetation and debris management along P&W Railroad rights-of-way; recurrent brush fires reported near tracks	DR, WF	P&W Railroad, Fire, DPW	Private (P&W Railroad)	High	High	Low	Ongoing
C. Education & Awareness Strategies								
	Provide information to residents and businesses on water conservation through low-impact landscaping and other measures (to conserve water for firefighting)	DR, WF	DPW, Conservation, Aquarion Water, Cherry Valley & Rochdale Water District	Local, Private (water companies)	High	Medium	Low	Ongoing
D. Local Plan & Regulation Strategies								
	Review and update local plans and development review processes (planning, zoning, stormwater management, conservation, etc.) to ensure new construction will not be affected by hazards	All	All Town Departments	Local	Medium	High	Low	Ongoing
	Monitor implementation of Hazard Mitigation Plan	All	All Town Departments	Local	High	High	Low	Ongoing

'Hazards Addressed' abbreviations:

DF	Dam Failure	DR	Drought
EQ	Earthquake	FL	Flooding
HU	Hurricane	OT	Other
SS	Severe Snowstorm/Ice storm/Nor'easter	ST	Severe Thunderstorm/Wind/Tornado
WF	Wildfire/Brushfire	XT	Extreme Temperatures

8. PLAN ADOPTION, IMPLEMENTATION, AND MAINTENANCE

8.1 Plan Adoption

A public meeting was held on June 7, 2016 as part of the Board of Selectmen's meeting in order detail the planning process to date and to solicit comments and feedback from the public on the draft Oxford Hazard Mitigation Plan then being finalized. The draft plan was provided to the Town for distribution and posted on CMRPC's website from June 8 for public review and input. A revised final draft plan was posted online for comment on August 23, 2016. The Plan was then submitted to the Massachusetts Emergency Management Agency (MEMA) and the Federal Emergency Management Agency (FEMA) for their review. Upon receiving conditional approval of the plan by FEMA, the final plan was presented to the Oxford Board of Selectmen and adopted on November 15, 2016.

8.2 Plan Implementation

The implementation of this plan began upon its formal adoption by the Board of Selectmen and approval by MEMA and FEMA. Those Town departments and boards responsible for ensuring the development of policies, ordinance revisions, and programs as described in Sections 5 and 6 of this plan will be notified of their responsibilities immediately following approval. The Hazard Mitigation Team will oversee the implementation of the plan.

Incorporation with Other Planning Documents

Existing plans, studies, reports and municipal documents were incorporated throughout the planning process. This included a review and incorporation of significant information from the following key documents:

- ***Oxford Comprehensive Emergency Management Plan*** (particularly the Critical Infrastructure Section) – the Critical Infrastructure section was used to help identify infrastructure components in Town that have been identified as crucial to the function of the Town; this resource was also used to identify potentially vulnerable populations and potential emergency response shortcomings.

- ***Oxford Open Space and Recreation Plan* (2007) –** this Plan was used to identify the natural context within which mitigation planning would take place. This proved useful insofar as it identified water bodies, rivers, streams, infrastructure components (i.e. water and sewer, or the lack thereof), as well as population trends. This was incorporated to ensure that the Town's mitigation efforts would be sensitive to the surrounding environment. It should be noted that this plan has expired and needs to be updated.

- ***Oxford Zoning Bylaw*** –Zoning was used to gather identify those actions that the town is already taking that are reducing the potential impacts of a natural hazard (i.e. floodplain regulations) to avoid duplicating existing successful efforts.

- ***Oxford Master Plan*** – The Town is currently going through a Master Plan process, which is scheduled to be completed in the upcoming months. We encourage the Master Plan committee to include the recommendations provided by the Oxford Local Hazard Mitigation Team in this Plan be incorporated into the final Oxford Master Plan.

- ***Massachusetts State Hazard Mitigation Plan (2013)*** - This plan was used to ensure that the town's HMP was consistent with the State's Plan.

After this plan has been approved by both FEMA and the local government, links to the plan will be emailed to all Town staff, boards, and committees, with a reminder to review the plan periodically and work to incorporate its contents, especially the action plan, into other planning processes and documents. In addition, during annual monitoring meetings for the Hazard Mitigation Plan implementation process, the Hazard Mitigation Team will review whether any of these plans are in the process of being updated. If so, the Hazard Mitigation Team will remind people working on these plans, policies, etc., of the Hazard Mitigation plan, and urge them to incorporate the Hazard Mitigation plan into their efforts. The Hazard Mitigation Team will also review current Town programs and policies to ensure that they are consistent with the mitigation strategies described in this plan. The Hazard Mitigation Plan will also be incorporated into updates of the Town's Comprehensive Emergency Management Plan.

8.3 Plan Monitoring and Evaluation

The Town's Emergency Management Director will call meetings of all responsible parties to review plan progress as needed, based on occurrence of hazard events. The public will be notified of these meetings in advance through a posting of the agenda at Town Hall. Responsible parties identified for specific mitigation actions will be asked to submit their reports in advance of the meeting.

Meetings will involve evaluation and assessment of the plan, regarding its effectiveness at achieving the plan's goals and stated purpose. The following questions will serve as the criteria that is used to evaluate the plan:

Plan Mission and Goal

- Is the Plan's stated goal and mission still accurate and up to date, reflecting any changes to local hazard mitigation activities?

- Are there any changes or improvements that can be made to the goal and mission?

Hazard Identification and Risk Assessment

- Have there been any new occurrences of hazard events since the plan was last reviewed? If so, these hazards should be incorporated into the Hazard Identification and Risk Assessment.
- Have any new occurrences of hazards varied from previous occurrences in terms of their extent or impact? If so, the stated impact, extent, probability of future occurrence, or overall assessment of risk and vulnerability should be edited to reflect these changes.
- Is there any new data available from local, state, or Federal sources about the impact of previous hazard events, or any new data for the probability of future occurrences? If so, this information should be incorporated into the plan.

Existing Mitigation Strategies

- Are the current strategies effectively mitigating the effect of any recent hazard events?
- Has there been any damage to property since the plan was last reviewed?
- How could the existing mitigation strategies be improved upon to reduce the impact from recent occurrences of hazards? If there are improvements, these should be incorporated into the plan.

Proposed Mitigation Strategies

- What progress has been accomplished for each of the previously identified proposed mitigation strategies?
- How have any recently completed mitigation strategies affected the Town's vulnerability and impact from hazards that have occurred since the strategy was completed?
- Should the criteria for prioritizing the proposed mitigation strategies be altered in any way?
- Should the priority given to individual mitigation strategies be changed, based on any recent changes to financial and staffing resources, or recent hazard events?

Review of the Plan and Integration with Other Planning Documents

- Is the current process for reviewing the Hazard Mitigation Plan effective? Could it be improved?
- Are there any Town plans in the process of being updated that should have the content of this Hazard Mitigation Plan incorporated into them?
- How can the current Hazard Mitigation Plan be better integrated with other Town planning tools and operational procedures, including the zoning bylaw, the Comprehensive Emergency Management Plan, and the Capital Improvement Plan?

Following these discussions, it is anticipated that the planning team 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. The team will review and update the Hazard Mitigation Plan every five years.

Public participation will be a critical component of the Hazard Mitigation Plan maintenance process. The Hazard Mitigation Team will hold all meetings in accordance with Massachusetts open meeting laws and the public invited to attend. The public will be notified of any changes to the Plan via the meeting notices board at Town Hall, and copies of the revised Plan will be made available to the public at Town Hall.

8.4 Potential Federal and State Funding Sources

Federal Funding Sources

The FEMA web pages identify a number of funding opportunities. Please refer to https://www.fema.gov/grants. Some programs are described briefly below:

Hazard Mitigation Assistance

The HMA grant programs provide funding opportunities for pre- and post-disaster mitigation. While the statutory origins of the programs differ, all share the common goal of reducing the risk of loss of life and property due to Natural Hazards. Brief descriptions of the HMA grant programs can be found below. For more information on the individual programs, or to see information related to a specific Fiscal Year, please click on one of the program links.

Hazard Mitigation Grant Program (HMGP)

HMGP assists in implementing long-term hazard mitigation measures following Presidential disaster declarations. Funding is available to implement projects in accordance with State, Tribal, and local priorities. Please refer to: http://www.fema.gov/hazard-mitigation-grant-program for additional information.

HMGP funds may be used to fund projects that will reduce or eliminate the losses from future disasters. Projects must provide a long-term solution to a problem, for example, elevation of a home to reduce the risk of flood damages as opposed to buying sandbags and pumps to fight the flood. In addition, a project's potential savings must be more than the cost of implementing the project. Funds may be used to protect either public or private property or to purchase property that has been subjected to, or is in danger of, repetitive damage. Examples of projects include, but are not limited to:

- Acquisition of real property for willing sellers and demolition or relocation of buildings to convert the property to open space use

- Retrofitting structures and facilities to minimize damages from high winds, earthquake, flood, wildfire, or other natural hazards
- Elevation of flood prone structures
- Development and initial implementation of vegetative management programs
- Minor flood control projects that do not duplicate the flood prevention activities of other Federal agencies
- Localized flood control projects, such as certain ring levees and floodwall systems, that are designed specifically to protect critical facilities
- Post-disaster building code related activities that support building code officials during the reconstruction process

Pre-Disaster Mitigation Grant Program (PDM)

The PDM Program, authorized by Section 203 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, is designed to assist States, U.S. Territories, Federally-recognized tribes, and local communities in implementing a sustained pre-disaster natural hazard mitigation program. The goal is to reduce overall risk to the population and structures from future hazard events, while also reducing reliance on Federal funding in future disasters. This program awards planning and project grants and provides opportunities for raising public awareness about reducing future losses before disaster strikes. Please refer to http://www.fema.gov/pre-disaster-mitigation-grant-program for additional information.

Flood Mitigation Assistance (FMA)

Flood Mitigation Assistance (FMA) provides funds on an annual basis so that measures can be taken to reduce or eliminate risk of flood damage to buildings insured under the National Flood Insurance Program. Please refer to the FMA website: http://www.fema.gov/flood-mitigation-assistance-grant-program.

Three types of FMA grants are available to States and communities:

- **Planning Grants** to prepare Flood Mitigation Plans. Only NFIP-participating communities with approved Flood Mitigation Plans can apply for FMA Project grants
- **Project Grants** to implement measures to reduce flood losses, such as elevation, acquisition, or relocation of NFIP-insured structures. States are encouraged to prioritize FMA funds for applications that include repetitive loss properties; these include structures with 2 or more losses each with a claim of at least $1,000 within any ten-year period since 1978.
- **Technical Assistance Grants** for the State to help administer the FMA program and activities. Up to ten percent (10%) of Project grants may be awarded to States for Technical Assistance Grants

Repetitive Flood Claims (RFC)

The Repetitive Flood Claims (RFC) grant program was authorized by the Bunning-Bereuter-

Blumenauer Flood Insurance Reform Act of 2004 (P.L. 108–264), which amended the National Flood Insurance Act (NFIA) of 1968 (42 U.S.C. 4001, et al). Please refer to: https://www.fema.gov/repetitive-flood-claims-grant-program-fact-sheet

RFC provides funds on an annual basis to reduce the risk of flood damage to individual properties insured under the NFIP that have had one or more claim payments for flood damages. RFC provides up to 100% federal funding for projects in communities that meet the reduced capacity requirements.

Severe Repetitive Loss (SRL)

The Severe Repetitive Loss (SRL) grant program was authorized by the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004, which amended the National Flood Insurance Act of 1968 to provide funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss (SRL) structures insured under the National Flood Insurance Program (NFIP). Please refer to: https://www.fema.gov/media-library/resources-documents/collections/14

SRL provides funds on an annual basis to reduce the risk of flood damage to residential structures insured under the NFIP that are qualified as severe repetitive loss structures. SRL provides up to 90% federal funding for eligible projects.

Definition**:** The definition of severe repetitive loss as applied to this program was established in section 1361A of the National Flood Insurance Act, as amended (NFIA), 42 U.S.C. 4102a. An SRL property is defined as a residential property that is covered under an NFIP flood insurance policy and:

a) That has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or
b) For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

For both (a) and (b) above, at least two of the referenced claims must have occurred within any ten-year period, and must be greater than 10 days apart.

Purpose: To reduce or eliminate claims under the NFIP through project activities that will result in the greatest savings to the National Flood Insurance Fund (NFIF).

Federal / Non-Federal cost share: 75/25%; up to 90% Federal cost-share funding for projects approved in States, Territories, and Federally-recognized Indian tribes with FEMA-approved Standard or Enhanced Mitigation Plans or Indian tribal plans that include a strategy for mitigating existing and future SRL properties.

Disaster Assistance

Disaster assistance is money or direct assistance to individuals, families and businesses in an area whose property has been damaged or destroyed and whose losses are not covered by insurance. It is meant to help with critical expenses that cannot be covered in other ways. This assistance is not intended to restore damaged property to its condition before the disaster. While some housing assistance funds are available through our Individuals and Households Program, most disaster assistance from the Federal government is in the form of loans administered by the Small Business Administration.

<u>Disaster Assistance Available from FEMA</u>

In the event of a Declaration of Disaster, assistance from FEMA is grouped in 3 categories:

A. Housing Needs
B. Other than Housing Needs
C. Additional Services

A. Housing Needs

- **Temporary Housing** (a place to live for a limited period of time): Money is available to rent a different place to live, or a government provided housing unit when rental properties are not available.
- **Repair**: Money is available to homeowners to repair damage from the disaster to their primary residence that is not covered by insurance. The goal is to make the damaged home safe, sanitary, and functional.
- **Replacement**: Money is available to homeowners to replace their home destroyed in the disaster that is not covered by insurance. The goal is to help the homeowner with the cost of replacing their destroyed home.
- **Permanent Housing Construction**: Direct assistance or money for the construction of a home. This type of help occurs only in insular areas or remote locations specified by FEMA, where no other type of housing assistance is possible.

B. Other than Housing Needs

Money is available for necessary expenses and serious needs caused by the disaster, including:

- Disaster-related medical and dental costs.
- Disaster-related funeral and burial cost.
- Clothing; household items (room furnishings, appliances); tools (specialized or protective

clothing and equipment) required for your job; necessary educational materials (computers, school books, supplies)

- Fuels for primary heat source (heating oil, gas).
- Clean-up items (wet/dry vacuum, dehumidifier).
- Disaster damaged vehicle.
- Moving and storage expenses related to the disaster (moving and storing property to avoid additional disaster damage while disaster-related repairs are being made to the home).
- Other necessary expenses or serious needs as determined by FEMA.
- Other expenses that are authorized by law.

C. Additional Services

- Crisis Counseling
- Disaster Unemployment Assistance
- Legal Services
- Special Tax Considerations

Assistance to Firefighters Grants

The FEMA Assistance to Firefighters Grants (AFG) program provides funds to equip and train emergency personnel to recognized standards, enhance operations efficiencies, foster interoperability, and support community resilience. Under AFG, funds may be available for equipment, vehicles and/or training that can be used to mitigate and/or respond to wildfire-related hazards. AFG also has a Fire Prevention and Safety (FPS) component which funds public outreach programs and prevention activities, which can emphasize wildfire mitigation. Please refer to: https://www.fema.gov/welcome-assistance-firefighters-grant-program.

Disaster Loans Available from the Small Business Administration

The U.S. Small Business Administration (SBA) can make federally subsidized loans to repair or replace homes, personal property or businesses that sustained damages not covered by insurance. The Small Business Administration can provide three types of disaster loans to qualified homeowners and businesses:

- home disaster loans to homeowners and renters to repair or replace disaster- related damages to home or personal property (please refer to: https://www.sba.gov/loans-grants/see-what-sba-offers/sba-loan-programs/disaster-loans/types-disaster-loans/home-and-personal-property-loans)
- business physical disaster loans to business owners to repair or replace disaster- damaged property, including inventory, and supplies (please refer to: https://www.sba.gov/loans-grants/see-what-sba-offers/sba-loan-programs/disaster-loans/types-disaster-loans/business-physical-disaster-loans); and

- economic injury disaster loans, which provide capital to small businesses and to small agricultural cooperatives to assist them through the disaster recovery period (please refer to: https://www.sba.gov/loans-grants/see-what-sba-offers/sba-loan-programs/disaster-loans/types-disaster-loans/economic-injury-disaster-loans).

For many individuals the SBA disaster loan program is the primary form of disaster assistance.

Disaster Assistance from Other Organizations and Entities

DisasterAssistance.gov is a secure, user-friendly U.S. Government web portal that consolidates disaster assistance information in one place. If you need assistance following a presidentially declared disaster— which has been designated for individual assistance— you can now to go to DisasterAssistance.gov to register online. Local resource information to help keep citizens safe during an emergency is also available. Currently, 17 U.S. Government agencies, which sponsor almost 60 forms of assistance, contribute to the portal.

DisasterAssistance.gov speeds the application process by feeding common data to multiple online applications. Application information is shared only with those agencies you identify and is protected by the highest levels of security. DisasterAssistance.gov will continue to expand to include forms of assistance available at the federal, state, tribal, regional and local levels, with a projected completion date of 2014. Through www.DisasterAssistance.gov you have the ability to:

- Determine the number and forms of assistance you may be eligible to receive by answering a brief series of questions or start the individual assistance registration process immediately
- Apply for FEMA assistance and be referred to the Small Business Administration for loans through online applications
- Choose to have your Social Security benefits directed to a new address
- Access your federal student loan account information
- Receive referral information on forms of assistance that do not yet have online applications
- Access a call center in the event you do not have Internet access to ensure you can still register for assistance
- Check the progress and status of your applications online.
- Identify resources and services for individuals, families and businesses needing disaster assistance during all phases of an emergency situation
- Identify resources to help locate family members and pets
- Access assistance from the Department of State if you are affected by a disaster while traveling abroad
- Find information on disaster preparedness and response

Federal Funding Summary Table

The following is a summary of the programs which are the primary source for federal funding of hazard mitigation projects and activities in Massachusetts:

Table 31

Program	Type of Assistance	Availability	Managing Agency	Funding Source
National Flood Insurance Program (NFIP)	Pre-Disaster Insurance	Any time (pre & post disaster)	DCR Flood Hazard Management Program	Property Owner, FEMA
Community Rating System (CRS) (Part of the NFIP)	Flood Insurance Discounts	Any time (pre & post disaster)	DCR Flood Hazard Management Program	Property Owner
Flood Mitigation Assistance (FMA) Program	Cost share grants for pre- disaster planning & projects	Annual pre-disaster grant program	MEMA	75% FEMA/ 25% non- federal
Hazard Mitigation Grant Program (HMGP)	Post-disaster Cost-Share Grants	Post disaster program	MEMA	75% FEMA/ 25% non- federal
Pre-Disaster Mitigation Program	National, competitive grant program for projects & planning	Annual, pre-disaster mitigation program	MEMA	75% FEMA/ 25% non- federal
Severe Repetitive Loss	For SRL structures insured under the NFIP.	Annual	MEMA	Authorized up to $40 million for each fiscal year 2005 through 2009
Assistance to Firefighters Grants (AFG)	Training & equipment for wildfire-related hazards	Annual	FEMA	FEMA
Small Business Administration (SBA) Mitigation Loans	Pre- & Post- disaster loans to qualified applicants	Ongoing	MEMA	Small Business Administration
Public Assistance	Post-disaster aid to state & local governments	Post Disaster	MEMA	FEMA/ plus a non-federal share

For a list of additional potential funding sources, please refer also to Table 17-7 on Pages 545-8 of the 2013 State Hazard Mitigation Plan: http://www.mass.gov/eopss/docs/mema/resources/plans/state-hazard-mitigation-plan/massachusetts-state-hazard-mitigation-plan.pdf.

State Funding Sources

The Commonwealth of Massachusetts provides matching FEMA assistance. This means that, following Presidential disaster declarations, the state may contribute a portion of the 25% non-federal share for federal Infrastructure Support funds. Since 1991, the state has contributed nearly $20 million to match FEMA's funding following declared Presidential disasters. Other State funding sources include the following:

Special Appropriations and Legislative Earmarks

Although there is no separate state disaster relief fund in Massachusetts, the state legislature may enact special appropriations for those communities sustaining damages following a natural disaster that are not large enough for a Presidential disaster declaration. Since 1991, Massachusetts has issued 20 major disaster declarations. Additionally, individual legislators may seek specific project funding for projects through the legislative budgeting and appropriations process.

State Revolving Fund

This statewide loan program through the Executive Office of Environmental Affairs assists communities in funding local stormwater management projects which help to minimize and/or eliminate flooding in poor drainage areas.

Chapter 90 Funds

This statewide program reimburses communities for roadway projects, such as resurfacing and related work and other work incidental to the above such as preliminary engineering including State Aid/Consultant Design Agreements, right-of-way acquisition, shoulders, side road approaches, landscaping and tree planting, roadside drainage, structures (including bridges), sidewalks, traffic control and service facilities, street lighting (excluding operating costs), and for such other purposes as the Department may specifically authorize. Maintaining and upgrading critical infrastructure and evacuation routes is an important component of hazard mitigation.

Community Development Block Grant (CDBG)

CDBG remains the principal source of revenue for communities to use in identifying solutions to address physical, economic, and social deterioration in lower-income neighborhoods and communities. While primarily a housing and community development program administered through the Executive Office of Housing and Community Development (EOHCD), the program can also fund the rehabilitation of municipal buildings such as town halls, which in many cases, also serve as Emergency Operations Centers for their communities.

State Land Acquisition & Conservation Program

Through the Massachusetts Executive Office of Energy and Environmental Affairs, this annual program purchases private property for open space, wetland protection and floodplain preservation purposes. For instance, in 1998, the state set an ambitious goal of protecting 200,000 acres of open space in the Commonwealth by 2010. In August 2001, less than three years later, the state announced that the Commonwealth and its land protection partners had reached the halfway mark in achieving that goal - 100,000 acres. Updated information may be found on the website of the Executive Office of Energy and Environmental Affairs Open Space Protection program at http://www.mass.gov/envir/openspace/default.htm.

Dams & Levees Program

EEA funds projects for the repair and removal of dams, levees, seawalls, and other forms of inland and coastal flood control. In FY 2016, the maximum award for any one application was $1,000,000 for dams and levees and $3,000,000 for seawalls and other coastal foreshore protection. A minimum financial match of 25% of total funds requested is required. For additional information, please refer to http://www.mass.gov/eea/waste-mgnt-recycling/water-resources/preserving-water-resources/water-laws-and-policies/water-laws/draft-regs-re-dam-and-sea-wall-repair-or-removal-fund.html.

Major Flood Control Projects

The state provides half of the non-federal share of the costs of major flood control projects developed in conjunction with the U.S. Army Corps of Engineers. This program is managed by DCR.

Flood Control Dams

Natural Resource Conservation Service (NRCS), manages the Flood Control Dams Program, (PL566), which funds states in the operation and maintenance of the 25 PL566 flood control dams located on state property. This program also includes technical assistance and other smaller services from the NRCS and partners.

Flood Hazard Management Program Staff Funding

The state provides the 25% non-federal share for FEMA's funding under the Community Assistance Program - State Support Services Element (CAP-SSSE). CAP-SSSE funding, and the state match supports the Flood Hazard Management Program (FHMP) within the Department of Conservation and Recreation. The FHMP works with FEMA to coordinate the National Flood Insurance Program throughout Massachusetts, providing technical assistance to participating communities, professionals.

MassWorks Infrastructure Program

The MassWorks Infrastructure Program provides a one-stop shop for municipalities and other eligible public entities seeking public infrastructure funding to support economic development and job creation. Although not specific to natural hazards per se, these infrastructure enhancements under MassWorks could also address identified needs for hazard mitigation. The MassWorks Infrastructure Program is administered by the Executive Office of Housing and Economic Development, in cooperation with the Department of Transportation and Executive

Office for Administration & Finance. Please refer to http://www.mass.gov/hed/economic/eohed/pro/infrastructure/massworks/ for additional information.

Weatherization Assistance Program

The Weatherization Assistance Program is funded each year by the U.S. Department of Energy's Office of Energy Efficiency & Renewable. The extent of services to be provided depends on available funding. The program is intended to help low-income homeowners and renters lower their energy cost and reduce the potential impact from severe weather events. Weatherization service agencies throughout Massachusetts run the Weatherization Assistance Program. Please refer to http://energy.gov/eere/wipo/weatherization-assistance-program for additional information.

APPENDICES

A. Maps
B. Public Survey Results
C. Planning Team & Public Meetings
D. Certificate of Adoption
E. Glossary