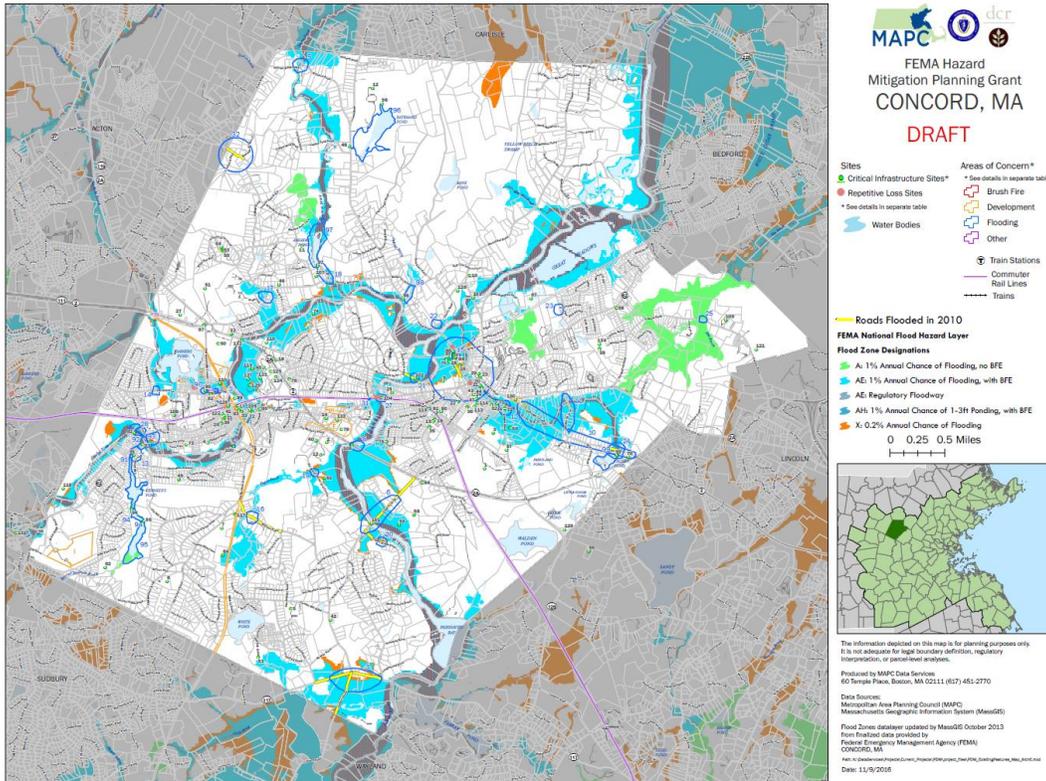


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TOWN OF CONCORD

HAZARD MITIGATION PLAN

2017 UPDATE



MAPC 50 YEARS
METROPOLITAN AREA PLANNING COUNCIL
SMART GROWTH AND REGIONAL COLLABORATION

Plan Update
Month, Day, 2017

**TOWN OF CONCORD HAZARD MITIGATION PLAN
2017 UPDATE**

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ACKNOWLEDGEMENTS AND CREDITS

This plan was prepared for the Town of Concord by the Metropolitan Area Planning Council (MAPC) under the direction of the Massachusetts Emergency Management Agency (MEMA) and the Massachusetts Department of Conservation and Recreation (DCR).

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Alan Cathcart	Public Works
David Wood	Municipal Light Plant
Mark Cotreau	Fire Department
Thomas Judge	Fire Department
Wanda Rupelt	Fire Department
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Kate Hodges	Assistant Town Manager
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Laurie Livoli	Building Commissioner
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I. EXECUTIVE SUMMARY

Hazard Mitigation planning is a proactive effort to identify actions that can be taken to reduce the dangers to life and property from natural hazard events. In the communities of the Boston region of Massachusetts, hazard mitigation planning tends to focus most on flooding, the most likely natural hazard to impact these communities. The Federal Disaster Mitigation Act of 2000 requires all municipalities that wish to be eligible to receive FEMA funding for hazard mitigation grants, to adopt a local multi-hazard mitigation plan and update this plan in five year intervals.

Planning Process

Planning for the Hazard Mitigation Plan update was led by the Concord Local Hazard Mitigation Planning Team, composed of staff from a number of different Town Departments. This team met on January 20, 2016, August 31, 2016, and January 23, 2017 and discussed where the impacts of natural hazards most affect the Town, goals for addressing these impacts, updates to the Town's existing mitigation measures and new or revised hazard mitigation measures that would benefit the Town.

Public participation in this planning process is important for improving awareness of the potential impacts of natural hazards and to build support for the actions the Town takes to mitigate them. The Town's Hazard Mitigation Planning Team hosted two public meetings, the first on November 15, 2016 and the second on May 8, 2017 and the draft plan update was posted on the Town's website for public review. Key town stakeholders and neighboring communities were notified and invited to review the draft plan and submit comments.

Risk Assessment

The Concord Hazard Mitigation Plan assesses the potential impacts to the Town from flooding, high winds, winter storms, brush fire, geologic hazards, extreme temperatures, and drought. These are shown on the map series (Appendix B).

The Concord Local Hazard Mitigation Planning Team identified 131 Critical Facilities. These are also shown on the map series and listed in Table 23, identifying which facilities are located within the mapped hazard zones.

A HAZUS-MH analysis provided estimates of damages from of a 1% and .2% chance hurricane (\$15 million to \$55 million) a 1% and .2% chance flood (\$53 million to \$71 million), as well as earthquakes of magnitudes 5 and 7 (\$473 million to \$3.3 billion).

Hazard Mitigation Goals

The Concord Local Hazard Mitigation Planning Team identified the following hazard mitigation goals for the Town:

Goal 1: Prevent and reduce the loss of life, injury, public health impacts and property damages resulting from all major natural hazards.

Goal 2: Identify and seek funding for measures to mitigate or eliminate each known significant flood hazard area.

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Goal 3: Integrate hazard mitigation planning as an integral factor in all relevant municipal departments, committees and boards.

Goal 4: Prevent and reduce the damage to public infrastructure resulting from all hazards.

Goal 5: Encourage the business community, major institutions and non-profits to work with the Town to develop, review and implement the hazard mitigation plan.

Goal 6: Work with surrounding communities, state, regional and federal agencies to ensure regional cooperation and solutions for hazards affecting multiple communities.

Goal 7: Ensure that future development meets federal, state and local standards for preventing and reducing the impacts of natural hazards.

Goal 8: Take maximum advantage of resources from FEMA and MEMA to educate Town staff and the public about hazard mitigation.

Goal 9: Consider the potential impacts of future climate change. Incorporate climate sustainability and resiliency in hazard mitigation planning.

Hazard Mitigation Strategy

The Concord Hazard Mitigation Planning Team identified a number of mitigation measures that would serve to reduce the Town’s vulnerability to natural hazard events. These include drainage improvements to Cambridge Turnpike, a town-wide tree inventory and management plan, drought management policies, on-going culvert replacement projects, and continuing open space purchases.

Overall, the hazard mitigation strategy recognizes that mitigating hazards for Concord will be an ongoing process as our understanding of natural hazards and the steps that can be taken to mitigate their damages changes over time. Global climate change and a variety of other factors impact the Town’s vulnerability and in the future, and local officials will need to work together across municipal lines and with state and federal agencies in order to understand and address these changes. The Hazard Mitigation Strategy will be incorporated into the Town’s other related plans and policies.

Plan Review and Update Process

The process for developing Concord’s Hazard Mitigation Plan 2017 Update is summarized in Table 1 below.

Table 1 Plan Review and Update Process

Chapter	Reviews and Updates
III – Public Participation	The Local Hazard Mitigation Planning Team placed an emphasis on public participation for the update of the Hazard Mitigation Plan,

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	discussing strategies to enhance participation opportunities at the first local committee meeting. During plan development, the plan was discussed at two public meetings hosted by the Emergency Management Team. The plan was also available on the Town’s website for public comment.
IV – Risk Assessment	MAPC gathered the most recently available hazard and land use data and met with Town staff to identify changes in local hazard areas and development trends. Town staff reviewed critical infrastructure with MAPC staff in order to create an up-to-date list. MAPC also used the most recently available version of HAZUS and assessed the potential impacts of flooding using the latest data.
V - Goals	The Hazard Mitigation Goals were reviewed and endorsed by the Concord Local Hazard Mitigation Planning Team.
VI – Existing Mitigation Measures	The list of existing mitigation measures was updated to reflect current mitigation activities in the Town.
VII & VIII – Hazard Mitigation Strategy	Mitigation measures from the 2010 plan were reviewed and assessed as to whether they were completed, in-progress, or deferred. The Local Hazard Mitigation Planning Team determined whether to carry forward measures into the 2017 Plan Update or modify or delete them. The Plan Update’s hazard mitigation strategy reflects both new measures and measures carried forward from the 2010 plan. The Local Hazard Mitigation Team prioritized all of these measures based on current conditions.
IX – Plan Adoption & Maintenance	This section of the plan was updated with a new on-going plan implementation review and five year update process that will assist the Town in incorporating hazard mitigation issues into other Town planning and regulatory review processes and better prepare the Town for the next comprehensive plan update.

As indicated in Table 28, Concord made good progress implementing mitigation measures identified in the 2010 Hazard Mitigation Plan. Several projects have been completed, including upgrades to the Pine Street and Flints Bridges, preservation of two 80-acre open space parcels, revisions to the town’s stormwater management regulations and updating the Hazardous Materials Response Plan. Other projects were partially completed, including design and financing for the Cambridge Turnpike drainage improvement project, creating a back-up emergency operations center, and identifying an alternate shelter location. These mitigation measures will be continued in this 2017 Plan Update.

Projects that were not completed will also be continued into this plan update including, improvements to the Main Street Bridge, and creating back-up capacity for the Lowell Road sewer pump station. On-going projects include open space purchases and culvert replacement projects.

Moving forward into the next five year plan implementation period there will be many more opportunities to incorporate hazard mitigation into the Town’s decision making processes.

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Though not formally done in the 2010 Plan, the Town will document any actions taken within this iteration of the Hazard Mitigation Plan on challenges met and actions successfully adopted as part of the ongoing plan maintenance to be conducted by the Concord Hazard Mitigation Implementation Team, as described in Section IX, Plan Adoption and Maintenance.

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II. INTRODUCTION

Planning Requirements under the Federal Disaster Mitigation Act

The Federal Disaster Mitigation Act, passed in 2000, requires that after November 1 2004, all municipalities that wish to continue to be eligible to receive FEMA funding for hazard mitigation grants, must adopt a local multi-hazard mitigation plan and update this plan in five year intervals. This planning requirement does not affect disaster assistance funding.

Federal hazard mitigation planning and grant programs are administered by the Federal Emergency Management Agency (FEMA) in collaboration with the states. These programs are administered in Massachusetts by the Massachusetts Emergency Management Agency (MEMA) in partnership with the Department of Conservation and Recreation (DCR).

Massachusetts has taken a regional approach and has encouraged the regional planning agencies to apply for grants to prepare plans for groups of their member communities. The Town of Concord contracted with the Metropolitan Area Planning Council (MAPC), to assist the Town in updating its local Hazard Mitigation Plan, which was first adopted in 2010 as a multijurisdictional plan. The local Hazard Mitigation Plan update produced under this contract is designed to individually meet the requirements of the Disaster Mitigation Act for each community while listing regional concerns and hazards that impact the Town or City creating the plan.

What is a Hazard Mitigation Plan?

Natural hazard mitigation planning is the process of determining how to systematically reduce or eliminate the loss of life and property damage resulting from natural hazards such as floods, earthquakes, and hurricanes. Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries, and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, programs, projects, and other activities.

Previous Federal/State Disasters

The Town of Concord has experienced 17 natural hazards that triggered federal or state disaster declarations since 1991. These are listed in Table 2 below. The majority of these events involved flooding, while six were due to hurricanes or nor'easters, and six were due to severe winter weather.

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Table 2 Previous Federal/State Disaster Declarations

DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
Hurricane Bob (August 1991)	FEMA Public Assistance Project Grants	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (16 projects)
No-Name Storm (October 1991)	FEMA Public Assistance Project Grants	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk
	FEMA Individual Household Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (10 projects)
March Blizzard (March 1993)	FEMA Public Assistance Project Grants	All 14 Counties
January Blizzard (January 1996)	FEMA Public Assistance Project Grants	All 14 Counties
October Flood (October 1996)	FEMA Public Assistance Project Grants	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
	FEMA Individual Household Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
	Hazard Mitigation Grant Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk (36 projects)
1997	Community Development Block Grant-HUD	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
June Flood (June 1998)	FEMA Individual Household Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (19 projects)

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DISASTER NAME (DATE OF EVENT)	TYPE OF ASSISTANCE	DECLARED AREAS
(1998)	Community Development Block Grant-HUD	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
March Flood (March 2001)	FEMA Individual Household Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (16 projects)
February Snowstorm (Feb 17-18, 2003)	FEMA Public Assistance Project Grants	All 14 Counties
January Blizzard (January 22-23, 2005)	FEMA Public Assistance Project Grants	All 14 Counties
Hurricane Katrina (August 29, 2005)	FEMA Public Assistance Project Grants	All 14 Counties
May Rainstorm/Flood (May 12-23, 2006)	Hazard Mitigation Grant Program	Statewide
April Nor'easter (April 15-27, 2007)	Hazard Mitigation Grant Program	Statewide
Flooding (March, 2010)	FEMA Public Assistance FEMA Individuals and Households Program SBA Loan	Bristol, Essex, Middlesex, Suffolk, Norfolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Statewide
Tropical Storm Irene (August 27-28, 2011)	FEMA Public Assistance	Statewide
Hurricane Sandy (October 27-30, 2012)	FEMA Public Assistance	Statewide
Severe snowstorm and Flooding (February 8-09, 2013)	FEMA Public Assistance; Hazard Mitigation Grant Program	Statewide
Blizzard of 2015 (January 26-28, 2015)	FEMA Public Assistance; Hazard Mitigation Grant Program	Statewide

Source: database provided by MEMA

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FEMA Funded Mitigation Projects

Town of Concord has received funding from FEMA for three mitigation projects under the Hazard Mitigation Grant Program (HMGP). These projects totaled \$841,600, with \$631,247 covered by FEMA grants and \$210,413 by local funding. The projects are summarized in Table 3 below.

Table 3 FEMA-Funded Mitigation Projects

Grant	Project Title	Scope of Work	Total Cost	Federal Funding	Local Funding
1994-01	Culvert replacement at Fitchburg Turnpike	Upgrade of undersized culvert	\$92,960	\$69,720	\$23,240
1895-25	Spencer Brook culvert replacement at Westford Rd.	Upgrade of 36 pipe culvert with upgraded box bottom culvert	\$73,700	\$55,277	\$18,423
4028-02	Culvert replacement and drainage improvements at Lowell Rd.	Replacement of stone culvert with concrete box culvert. Replacement of closed drainage system with open. New piping and drainage structures.	\$675,000	\$506,250	\$168,750

(Source: database provided by MEMA)

Community Profile

Concord is located in Middlesex County and is bordered by Maynard and Acton to the west, Carlisle to the north, Bedford and Lincoln to the east and southeast, and Sudbury to the south. Concord is 15 miles south of Lowell, 18 miles north of Boston, 34 miles northeast of Worcester. The Fitchburg line of the commuter rail runs through Concord, with two stations – Concord and West Concord. State roadways include Routes 2, 2A, 62, 117, 119 and 126.

The town is governed by a five-member Select Board and a Town Manager. The town operates under the open town meeting format. The Town Manager, appointed by the Select Board, carries out the day-to-day governing functions of the town.

Named in 1635, Concord is an historic town on the western axis of suburban Boston. Concord is home to a number of regional, state and national assets: Minute Man National Historic Park, Walden Pond, and the Great Meadows National Wildlife Refuge. The Concord, Assabet and Sudbury Rivers all converge in Concord. The Northeastern Correctional Center and MCI-Concord are located in Concord. Concord is also home to a number of historic resources, including nine well-preserved colonial houses with many of them on or near Concord Green and witnesses of the famous Battle of Concord.

Skyrocketing land prices in the real estate boom of the 1980's resulted from Concord's proximity to Boston and the 128 technical/industrial corridor, coupled with a vigorous regional economy. Considerable concern is felt by Concord residents about the pressures on the town from its significant tourist industry and suburban development.

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There are slightly fewer than 11,807 jobs in Concord. A part of Hanscom Air Field is located in eastern Concord. Emerson Hospital, a regional medical facility, is located in Concord. According to the hospital's website, the facility has 179 beds and provides service to 25 communities.

According to the 2010 Census, 17,668 people live in Concord. Of the town's just over 7,000 housing units, 28% were built before 1940. Due to the two prison facilities located in town, a large percentage (9.6%) of the population lives in group quarters

The Town of Concord has several unique characteristics to keep in mind while planning for natural hazards:

- A defining characteristic of the town is that three major rivers, the Assabet, Sudbury, and Concord, converge in the town and are associated with a large amount of floodplain.
- Another defining characteristic of the town is the tree-lined streets. Although these trees are vulnerable to high winds and ice storms, they are a tradeoff the town is willing to have.
- The town is home to over 50 registered farms with animals such as horses that need to be considered in evacuation plans.
- The town has very proactive municipal officials that frequently share information and coordinate on a regular basis.
- Concord is home to historic structures and sites that are irreplaceable and bring economic value to the town.
- Concord contains several major roadways that provide emergency routes for evacuation and for routes to medical facilities, such as Emerson Hospital.
- Concord has numerous bridge crossings and dams that could be at risk in the event of flooding.
- Concord would be a good candidate for flood-related grants due to the potential impact to property, transportation emergency routes, economic/historic resources, and the ability to solve the flooding problems through structural measures such as culvert upgrades, dam and bridge upgrades or flood proofing. The cost-benefit analysis would likely be in the town's favor.
- Much of the critical infrastructure in the town is located in clusters, often near areas of floodplain. These facilities are therefore at higher risk during natural hazards.

The Town of Concord maintains a website at www.concordma.gov

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Table 4 Concord Characteristics

Population = 17,668

- 4.2% are under age 5
- 22.6% are under age 18
- 19% are over age 65
- 2.5% speak English less than “very well” (over age 5)
- 6.4% of households have no vehicle
- 7.9% have a disability
- 9.6% live in group quarters

Number of Housing Units = 7,260

- 22.6% are renter-occupied housing units
- 27.5% of housing units were built before 1940

Source: U.S. Census, 2010 and American Community Survey 2014.

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III. PLANNING PROCESS AND PUBLIC PARTICIPATION

MAPC employs a six step planning process based on FEMA’s hazard mitigation planning guidance focusing on local needs and priorities but maintaining a regional perspective matched to the scale and nature of natural hazard events. Public participation is a central component of this process, providing critical information about the local occurrence of hazards while also serving as a means to build a base of support for hazard mitigation activities. MAPC supports participation by the general public and other plan stakeholders through Local Hazard Mitigation Planning Teams, two public meetings hosted by the local Hazard Mitigation Team, posting of the plan to the Town’s website, and invitations sent to neighboring communities, Town boards and commissions, the local chamber of commerce, and other local or regional entities to review the plan and provide comment.

Planning Process Summary

The seven-step planning process outlined below is based on the guidance provided by FEMA in the Local Multi-Hazard Mitigation Planning Guidance. Public participation is a central element of this process, which attempts to focus on local problem areas and identify needed mitigation measures based on where gaps occur in the existing mitigation efforts of the municipality. By working on municipal hazard mitigation plans in groups of neighboring cities and towns, MAPC is able to identify regional opportunities for collaboration and facilitate communication between communities. In plan updates, the process described below allows staff to bring the most recent hazard information into the plan, including new hazard occurrence data, changes to a municipality’s existing mitigation measures, and progress made on actions identified in previous plans.



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- Map the Hazards – MAPC relies on data from a number of different federal, state, and local sources in order to map the areas with the potential to experience natural hazards. This mapping represents a multi-hazard assessment of the municipality and is used as a set of base maps for the remainder of the planning process. A particularly important source of information is the knowledge drawn from local municipal staff on where natural hazard impacts have occurred. These maps can be found in Appendix B.

- Assess the Risks & Potential Damages – Working with local staff, critical facilities, infrastructure, vulnerable populations, and other features are mapped and contrasted with the hazard data from the first step to identify those that might represent particular vulnerabilities to these hazards. Land use data and development trends are also incorporated into this analysis. In addition, MAPC develops estimates of the potential impacts of certain hazard events on the community. MAPC drew on the following resources to complete the plan:
 - Town of Concord, Annual Report 2015
 - Town of Concord, General Bylaws
 - Town of Concord, Zoning Bylaw, amended through 4/2010
 - Town of Concord Comprehensive Plan 2005 – 2020
 - Town of Concord Open Space Plan 2015
 - Town of Concord Water Quality Report 2011
 - FEMA, FIRM, Letter of Map Revision, 2015
 - Metropolitan Area Planning Council, GIS Lab, Regional Plans and Data.
 - Environment America Research and Policy Center, *When It Rains It Pours – Global Warming and the Increase in Extreme Precipitation*, July 2012
 - FEMA, Flood Risk Report, Concord River Watershed, 2/27/2013
 - FEMA, Flood Insurance Rate Maps for Middlesex County, MA, 2014
 - FEMA, Local Mitigation Plan Review Guide; October 1, 2011.
 - MA Emergency Management Agency, *State Hazard Mitigation Plan*, 2013
 - MA Geographic Information System, *McConnell Land Use Statistics*, 2005
 - MA Office of Dam Safety, *Inventory of Massachusetts Dams*
 - Metropolitan Area Planning Council, *Geographic Information Systems Lab*
 - New England Seismic Network, *Weston Observatory*
 - Northeast States Emergency Consortium website
 - NOAA, *National Climatic Data Center website*
 - Union of Concerned Scientists, *Confronting Climate Change in the U.S. Northeast*, 2007
 - U. S. Census, 2010, and American Community Survey, 2013
 - USGS, *National Water Information Center, website*

- Review Existing Mitigation – Municipalities in the Boston Metropolitan Region have an active history in hazard mitigation as most have adopted flood plain zoning districts, wetlands protection programs, and other measures as well as enforcing the State building code, which has strong provisions related to hazard resistant building requirements. All current municipal mitigation measures must be documented.

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- **Develop Mitigation Strategies** – MAPC works with the local municipal staff to identify new mitigation measures, utilizing information gathered from the hazard identification, vulnerability assessments, and the community’s existing mitigation efforts to determine where additional work is necessary to reduce the potential damages from hazard events. Additional information on the development of hazard mitigation strategies can be found in Chapter VII.

- **Plan Approval & Adoption** – Once a final draft of the plan is complete it is sent to MEMA for the state level review and, following that, to FEMA for approval. Typically, once FEMA has approved the plan the agency issues a conditional approval (Approval Pending Adoption), with the condition being adoption of the plan by the municipality. More information on plan adoption can be found in Chapter IX and documentation of plan adoption can be found in Appendix D.

- **Implement & Update the Plan** – Implementation is the final and most important part of any planning process. Hazard Mitigation Plans must also be updated on a five year basis making preparation for the next plan update an important on-going activity. Chapter IX includes more detailed information on plan implementation.

2010 Plan Implementation and Maintenance

The 2010 Town of Concord Hazard Mitigation Plan contained a risk assessment of identified hazards for the Town and mitigation measures to address the risk and vulnerability from these hazards. Since approval of the plan by FEMA and local adoption, progress has been made on implementation of the measures. The Town has advanced a number of projects for implementation, including drainage improvements to Cambridge Turnpike, a town-wide tree inventory and management plan, drought management policies, on-going culvert replacement projects, and continuing open space purchases.

The Local Multiple Hazard Community Planning Team

MAPC worked with the local community representatives to organize a Local Hazard Mitigation Planning Team for Concord. MAPC briefed the local representatives as to the desired composition of that team as well as the need for public participation in the local planning process.

The Local Hazard Mitigation Planning Team is central to the planning process as it is the primary body tasked with developing a mitigation strategy for the community. The local team was tasked with working with MAPC to set plan goals, provide information on the hazards that impact the town, existing mitigation measures, and helping to develop new mitigation measures for this plan update. The Local Hazard Mitigation Planning Team membership can be found in Table 5 below.

The Concord Planning Board, as well as the Concord Conservation Commission, are the primary entities responsible for regulating development in town. Feedback from the Planning Board and the Conservation Commission was assured through the participation of the Director of Planning and Land Management and the Director of Natural Resources, as well as the Assistant Town Manager. The Planning Board hosted the first public meeting. In addition, MAPC, the State-designated regional planning authority for Concord, works with all agencies that regulate

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development in the region, including the listed municipal entities and state agencies, such as the MassDOT.

The Local Hazard Mitigation Planning Team met on: January 20, 2016, August 31, 2016, and January 23, 2017. The purpose of the first meeting was to introduce the Hazard Mitigation planning program goals and requirements. The second meeting included review and updates to the hazard mitigation goals, and gathering information on local hazard mitigation issues and sites or areas related to these. The third meeting focused on verifying information gathered by MAPC staff and discussion of existing mitigation practices, the status of mitigation measures identified in the 2010 hazard mitigation plan, and potential new or revised mitigation measures.

The agendas for these meetings are included in Appendix A.

Table 5 Membership of the Concord Hazard Mitigation Planning Team	
Name	Representing
Rich Reine	Public Works
Dan Rowley	Public Works
Alan Cathcart	Public Works
Rod Robinson	Public Works
David Wood	Municipal Light Plant
Mark Cotreau	Fire Department
Thomas Judge	Fire Department
Wanda Rupelt	Fire Department
Joseph O'Connor	Police
Kate Hodges	Assistant Town Manager
Delia Kaye	Natural Resources
Marcia Rasmussen	Planning and Land Management
Susan Rask	Public Health
Laurie Livoli	Building Commissioner
Mark Howell	IT
Russ Gaulin	GIS

Public Meetings

Public participation in the hazard mitigation planning process is important, both for plan development and for later implementation of the plan. Residents, business owners, and other community members are an excellent source for information on the historic and potential impacts of natural hazard events and particular vulnerabilities the community may face from these hazards. Their participation in this planning process also builds understanding of the concept of hazard mitigation, potentially creating support for mitigation actions taken in the future to implement the plan. To gather this information and educate residents on hazard mitigation, the Town hosted two public meetings, one during the planning process and one after a complete draft plan was available for review.

Natural hazard mitigation plans unfortunately rarely attract much public involvement in the Boston region, unless there has been a recent hazard event. One of the best strategies for overcoming this challenge is to include discussion of the hazard mitigation plan on the agenda of an existing

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Local Stakeholder Involvement

The local Hazard Mitigation Planning Team was encouraged to reach out to local stakeholders that might have an interest in the Hazard Mitigation Plan including neighboring communities, agencies, businesses, nonprofits, and other interested parties. Notice was sent to the following organizations and neighboring municipalities inviting them to review the Hazard Mitigation Plan and submit comments to the Town:

Town of Acton
Town of Carlisle
Town of Bedford
Town of Lincoln
Town of Sudbury
Town of Maynard
Town of Wayland
Great Meadows National Wildlife Refuge (US Fish and Wildlife)
Walden Pond State Reservation (MA DCR)
Emerson Hospital
Walden Street School
Army Corps of Engineers Regional Headquarters
Concord Chamber of Commerce
Concord Academy
Fenn School
Middlesex School
Nashoba Brooks School
Concord Public Schools
Concord Housing Authority
Concord Museum
DeCordova Museum
NE Deaconess Newbury Court
Concord Business Partnership
Concord Park Assisted Living

See Appendix C for public meeting notices.

Town Web Site

The draft Concord Hazard Mitigation Plan 2017 Update was posted on the Town's website for the second public meeting. Members of the public could access the draft document and submit comments or questions to the Town. [ADD SUMMARY OF COMMENTS RECEIVED, OR NONE]

Continuing Public Participation

Following the adoption of the plan update, the planning team will continue to provide residents, businesses, and other stakeholders the opportunity to learn about the hazard mitigation planning process and to contribute information that will update the town's understanding of local hazards. As updates and a review of the plan are conducted by the Hazard Mitigation Implementation Team, these will be placed on the Town's web site, and any meetings of the Hazard Mitigation

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Implementation Team will be publicly noticed in accordance with town and state open meeting laws.

Planning Timeline

January 20, 2016	Meeting of the Concord Hazard Mitigation Team
August 31, 2016	Meeting of the Concord Hazard Mitigation Team
November 16, 2016	First Public Meeting with the Concord Planning Board
January 23, 2016	Meeting of the Concord Hazard Mitigation Team
May 8, 2017	Second Public Meeting with the Select Board
	Draft Plan Update submitted to MEMA

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IV. RISK ASSESSMENT

The risk assessment analyzes the potential natural hazards that could occur within the Town of Concord as well as the relationship between those hazards and current land uses, potential future development, and critical infrastructure. This section also includes a vulnerability assessment that estimates the potential damages that could result from certain large scale natural hazard events.

Update Process

In order to update Concord’s risk assessment, MAPC gathered the most recently available hazard and land use data and met with Town staff to identify changes in local hazard areas and development trends. MAPC also used FEMA’s damage estimation software, HAZUS (described below).

Overview of Hazards and Impacts

The Massachusetts Hazard Mitigation Plan provides an in-depth overview of natural hazards in Massachusetts. Previous state and federal disaster declarations since 1991 are summarized in Table 2. Table 7 below summarizes the hazard risks for Concord. This evaluation takes into account the frequency of the hazard, historical records, and variations in land use. This analysis is based on the vulnerability assessment in the Massachusetts State Hazard Mitigation Plan. The statewide assessment was modified to reflect local conditions in Concord using the definitions for hazard frequency and severity listed below. Based on this, the Town developed locally-specific rankings for the frequency and severity of each category of natural hazard in Concord.

Table 7 Hazard Risks Summary

Hazard	Frequency		Severity	
	Massachusetts	Concord	Massachusetts	Concord
Flooding	High	High	Serious	Serious
Dam failures	Very Low	Very Low	Extensive	Extensive
Coastal Hazards	High	N/A	Serious	N/A
Hurricane/Trop Storm	Medium	Medium	Serious	Serious
Tornadoes	Medium	Medium	Serious	Serious
Thunderstorms	High	High	Minor	Minor
Nor’easter	High	High	Minor	Minor
Winter-Blizzard/Snow	High	High	Minor	Minor
Winter-Ice Storms	Medium	Medium	Minor	Minor
Earthquakes	Very Low	Very Low	Serious	Serious
Landslides	Low	Very Low	Minor	Minor
Brush fires	Medium	Low	Minor	Minor
Extreme Temperatures	Medium	Medium	Minor	Minor
Drought	Low	Low	Minor	Minor

Source, Massachusetts State Hazard Mitigation Plan, 2013, modified for Concord

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Definitions used in the Commonwealth of Massachusetts State Hazard Mitigation Plan

Frequency

Very low frequency: events that occur less frequently than once in 100 years (less than 1% per year)

Low frequency: events that occur from once in 50 years to once in 100 years (1% to 2% per year);

Medium frequency: events that occur from once in 5 years to once in 50 years (2% to 20% per year);

High frequency: events that occur more frequently than once in 5 years (Greater than 20% per year).

Severity

Minor: Limited and scattered property damage; limited damage to public infrastructure and essential services not interrupted; limited injuries or fatalities.

Serious: Scattered major property damage; some minor infrastructure damage; essential services are briefly interrupted; some injuries and/or fatalities.

Extensive: Widespread major property damage; major public infrastructure damage (up to several days for repairs); essential services are interrupted from several hours to several days; many injuries and/or fatalities.

Catastrophic: Property and public infrastructure destroyed; essential services stopped; numerous injuries and fatalities.

It should be noted that several of the hazards listed in the 2013 Massachusetts State Hazard Mitigation plan are not applicable to the Town of Concord. Being an inland community not located on the coast, Coastal Hazards, Storm Surge, and Tsunamis are not applicable in this local Hazard Mitigation Plan. In addition, due to the low density suburban/rural development pattern in Concord, Major Urban Fires are also not applicable to this town.

Flood Related Hazards

Flooding was the most prevalent natural hazard identified by local officials in Concord. Flooding can occur during hurricanes, nor'easters, severe rainstorms and thunderstorms. Global climate change has the potential to exacerbate these issues over time with the potential for changing rainfall patterns leading to heavier storms.

Regionally Significant Floods

There have been a number of major floods that have affected the Metro Boston region over the last fifty years. Significant historic flood events in Concord have included:

- The Blizzard of 1978
- January 1979
- April 1987
- October 1991
- October 1996
- June 1998
- March 2001
- April 2004
- May 2006
- April 2007
- March 2010

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Local data for previous flooding occurrences are not collected by the Town of Concord. The best available local data is for Middlesex County through the National Climatic Data Center (see Table 8). Middlesex County, which includes the Town of Concord, experienced 60 flood events from 1996 –2016. No deaths or injuries were reported and the total reported property damage in the county was \$40.9 million dollars. Of that total, \$35.2 million is attributed to the two major events of March 2010.

Table 8 Middlesex County Flood Events, 1996-2016

Date	Type	Deaths	Injuries	Property Damage
1/29/1996	Flood	0	0	0
4/17/1996	Flood	0	0	0
9/18/1996	Flood	0	0	0
10/21/1996	Flood	0	0	0
10/22/1996	Flood	0	0	0
3/10/1998	Flood	0	0	0
3/11/1998	Flood	0	0	0
5/12/1998	Flood	0	0	0
6/14/1998	Flood	0	0	0
6/15/1998	Flood	0	0	0
6/17/1998	Flood	0	0	0
4/22/2000	Flood	0	0	0
4/23/2000	Flood	0	0	0
3/22/2001	Flood	0	0	0
3/23/2001	Flood	0	0	0
3/31/2001	Flood	0	0	0
4/1/2001	Flood	0	0	0
4/2/2004	Flood	0	0	0
4/15/2004	Flood	0	0	0
3/29/2005	Flood	0	0	0
10/15/2005	Flood	0	0	100000
10/15/2005	Flood	0	0	100000
10/15/2005	Flood	0	0	125000
5/13/2006	Flood	0	0	5000000
7/11/2006	Flood	0	0	2000
10/28/2006	Flood	0	0	5000
4/16/2007	Flood	0	0	25000
2/13/2008	Flood	0	0	0
5/27/2008	Flood	0	0	3000
6/24/2008	Flood	0	0	10000
6/29/2008	Flood	0	0	5000
8/10/2008	Flood	0	0	15000
8/10/2008	Flood	0	0	40000
9/6/2008	Flood	0	0	15000
12/12/2008	Flood	0	0	20000
3/14/2010	Flood	0	0	26430000
3/29/2010	Flood	0	0	8810000
4/1/2010	Flood	0	0	0
8/28/2011	Flood	0	0	5000
10/14/2011	Flood	0	0	0
6/8/2012	Flood	0	0	0
6/23/2012	Flood	0	0	15000
7/18/2012	Flood	0	0	5000
10/29/2012	Flood	0	0	0

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6/7/2013	Flood	0	0	0
7/1/2013	Flood	0	0	0
7/23/2013	Flood	0	0	0
9/1/2013	Flood	0	0	10000
3/30/2014	Flood	0	0	35000
7/27/2014	Flood	0	0	0
8/31/2014	Flood	0	0	0
10/22/2014	Flood	0	0	20000
10/23/2014	Flood	0	0	0
12/9/2014	Flood	0	0	5000
12/9/2014	Flood	0	0	30000
5/31/2015	Flood	0	0	0
8/4/2015	Flood	0	0	0
8/15/2015	Flood	0	0	50000
8/15/2015	Flood	0	0	75000
9/30/2015	Flood	0	0	0

Source: NOAA, National Climatic Data Center

Overview of Town-Wide Flooding

Three major rivers converge in Concord – the Assabet, the Sudbury, and the Concord River. As a result, the town is home to a significant amount of flood plain. In addition to the three major rivers, Concord’s waterways also consist of tributary streams, low-lying wetland areas, and ponds formed naturally and from man-made dams.

Flooding occurs in Concord on a routine basis, ranging from minor nuisance roadway flooding, to basement flooding, to roadway closures, and to bridge scouring. The causes can be due to proximity to floodplain, improperly functioning drainage systems, beaver activity, and dam breaches. More detail on specific flooding regions within the town is provided in the site-specific flooding section below.

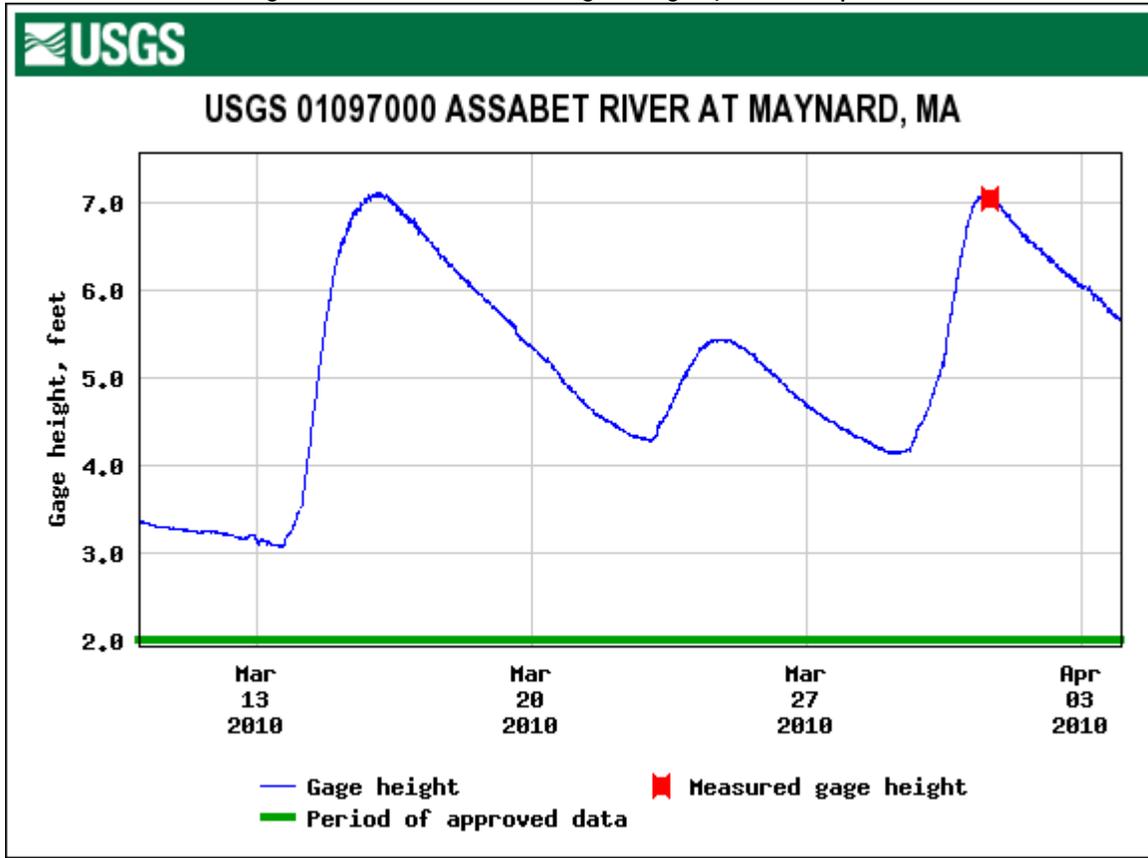
In the event of a large storm event, the greatest concerns are property damage, blockages of roadways or bridges vital for emergency response, and breaching of dams. Not only is Concord home to many regional entities of significance (see section on Regional Issues), but it also has historic sites that are irreplaceable and must be protected.

The most severe flooding since the previous plan occurred during March 2010, when a total of 14.83 inches of rainfall accumulation was recorded by the National Weather Service (NWS). The weather pattern that consisted of early springtime prevailing westerly winds that moved three successive storms, combined with tropical moisture from the Gulf of Mexico, across New England. Torrential rainfall caused March 2010 to be the wettest month on record.

One indication of the extent of flooding is the gage height at the nearest USGS streamflow gauging station, which is on the Assabet River in neighboring Maynard. The USGS gage height, shown in Figure 1, was nearly just over 7 feet on March 16 and again on March 31, 2010. Typical gage height in March tends to range between 2 and 3 feet. The Town of Concord recorded the location of street flooding from the 2010 storms; they are shown on Maps 3 and 8.

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Figure 1 Assabet River Gage Heights, March-April 2010



Potential Flood Hazard Areas

Information on potential flood hazard areas was taken from two sources. The first was the National Flood Insurance Rate Maps. The FIRM flood zones are shown on Map 3 in Appendix B and their definitions are listed below. Mapped flood plains are located along the Assabet, Concord and Sudbury Rivers, as well as the Spencer, Fort Pond and Dugan Brooks.

In addition, information on areas subject to flooding was provided by local officials. The Locally Identified Areas of Flooding described below were identified by Town staff as areas where flooding is known to occur. All of these areas do not necessarily coincide with the flood zones from the FIRM maps. Some may be areas that flood due to inadequate drainage systems or other local conditions rather than location within a flood zone. The numbers correspond to the numbers on Map 8, "Local Hazard Areas."

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Flood Insurance Rate Map Zone Definitions

Zone A (1% annual chance) - Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs (base flood elevations) or depths are shown within this zone. Mandatory flood insurance purchase requirements apply.

Zone AE and A1-A30 (1% annual chance) - Zones AE and A1-A30 are the flood insurance rate zones that correspond to the 100-year floodplains that are determined in the FIS by detailed methods. In most instances, BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.

Zones X500 (.2% annual chance) - Zone X500 is the flood insurance rate zone that correspond to the 500-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs (base flood elevations) or depths are shown within this zone.

Zone VE (1% annual chance) - Zone VE is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.

Westvale Meadows Condominiums (1)

The Westvale Condos are located downstream of several dams along the Assabet River and have experienced flooding of the property, but not of the buildings. If the dams were to breach, the buildings would likely be impacted.

Pine Street Bridge (2)

The Pine Street Bridge over the Assabet River has been closed in the past due to flooding (approximately once every 5 years). If any upstream dams were to give way, the impacts to this bridge would be of concern. Tree stumps in the river wear on the bridge and the banks are eroded.

Commonwealth Avenue at Warner's Pond (3)

This site at Commonwealth Avenue up to Maple Court has experienced flooding caused by Warner's Pond.

Pedestrian Bridge at Warner's Pond (4)

This pedestrian bridge behind the Warner's Pond dam connecting Winthrop to Commonwealth Avenue is old and of concern due to scouring. This issue should improve upon completion of the Warner's Pond Dam upgrades.

Spencer Brook Bridge (5)

The bridge over Spencer Brook has experienced flooding due to upstream beaver dams.

Sudbury Road – Heath's Bridge (6)

Heath's Bridge over the Sudbury River has caused water backing up to houses, but so far it has not impacted the structures. The town has had to redirect traffic in the Sudbury and Oxbow Drive areas. This site does have potential for property damage, but this has not yet occurred. The flooding occurs during the wet season or during a major storm such as a hurricane.

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Fitchburg Turnpike (7)

The Fitchburg Turnpike area in southern concord has experienced road closures 3 to 4 times per year for the past several years. This area is located within floodplain.

Route 2 Bridge over Sudbury River (8)

The Route 2 bridge over the Sudbury River has not experienced impacts from flooding, however, the town has noted this as an area of concern due to its important status as a main arterial route.

Concord Center (9)

The Concord Center Area is located within the floodplain where the Assabet, Sudbury and Concord Rivers converge, as well as the culverted Mill Brook enters the Concord River. Mill Brook runs under the buildings, many of which are historic. This area floods around once every 10 years. Basements have been impacted, access has been restricted, roads have closed, and floor drains have backed up. A collapse of the culverted brook could greatly impact buildings, which is of great concern to the town.

Cambridge Turnpike (10)

The Cambridge Turnpike experiences flooding every year over approximately a 2-mile stretch. It had two road closures in 2006 due to rising water levels. The water damages the road bed and the town has spent money to keep repairing the bed, which is constructed on peat moss. Beaver dams in the area also worsen the flooding.

Hawthorne Lane (11)

Hawthorne Lane is located in floodplain and seasonally floods, causing road closures and impacts to basements. One potential solution may be for residents to flood proof their homes.

Police/Fire Station (12)

Mill Brook behind the Fire and Police Stations has caused some flooding on the property but not at the buildings.

Harrington Avenue (13)

Harrington Avenue, near Kennedy's dam, has been identified by the town as a historical flooding site.

Laws Brook Road (14)

This site has been identified by the town as a historical flooding area.

Lowell Road Sewer Pump Station (15)

This wastewater pump station is located within floodplain and may be susceptible to infiltrating flows during large storm events, thus requiring a greater pump capacity to maintain wastewater services to important sections of the town.

Williams Road Site (16)

This site has been identified by the town as a historical flooding area.

Barretts Mill Road (17)

This site has been identified by the town as a historical flooding area.

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Barretts Mill Road east of Strawberry Hill Road (18)

This site, near Barrett's Mill Road Dam, has been identified by the town as a historical flooding area.

Old Road to Nine Acres Corner (19)

This site has been identified by the town as a historical flooding area.

Heaths Bridge Road (20)

This site has been identified by the town as a historical flooding area.

Nashawtuc Road – Nashawtuc Bridge (21)

This town-owned bridge is an area of concern due to the failure of its sidewalls and the large debris dams that form during a flood.

Liberty Street (22)

This site has been identified by the town as a historical flooding area.

Peters Spring Road (23)

This site has been identified by the town as a historical flooding area.

Crosby Pond (24)

Crosby Pond and dam, located adjacent the Cambridge Turnpike, have flooded and exacerbated the flooding at Cambridge Turnpike. In addition, beaver activity has worsened the situation. The dam is in poor condition due to infiltration through the earthen dam, and trees growing in the embankment.

Virginia Road (25)

This site has been identified by the town as a historical flooding area.

Main Street Bridge between Elm and Wood (27)

This bridge is a concern due to its weight restrictions and inability to carry loads from Emergency Response Vehicles (see further discussion under "Other Hazards").

Damon Mill Properties (28)

These office buildings are subject to flooding below Damondale dam.

Main St. MBTA underpass (31)

This is an area subject to heavy rain flash flooding, as water is trapped between the bridge walls.

Strawberry Hill Road near Pope Road (32)

This area adjacent to wetlands, flooded in the March 2010 rainstorm.

Repetitive Loss Structures

As defined by the National Flood Insurance Program (NFIP), a repetitive loss property is any property for which the NFIP has paid two or more flood claims of \$1,000 or more in any given 10-year period since 1978. There are five (5) repetitive loss properties in Concord; two of these are a single family residence and three are non-residential properties located within the Concord

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River watershed. These properties are shown on the maps in Appendix A. These repetitive loss properties had a total of eighteen (18) losses between 1979 and 2010, totaling \$241,058 in damages. For more information on repetitive losses see

https://www.fema.gov/txt/rebuild/repetitive_loss_faqs.txt and <https://www.fema.gov/repetitive-flood-claims-grant-program-fact-sheet>.

Table 9 summarizes the number and type of repetitive loss structures located within Concord and the number of losses and total claims associated with them.

Table 9 Summary of Repetitive Losses and Claims

	Single Family Residential	Other Residential	Non-Residential	Total
Number of Properties	2	0	3	5
Number of Losses	5	0	13	18
Total Claims	\$59,547	0	\$181,511	\$241,058

Source: Department of Conservation and Recreation, FEMA Repetitive Loss data

Based on the record of previous occurrences flooding events in Concord are a High frequency event as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur more frequently than once in five years, or a greater than 20% chance per year.

Dams and Dam Failure

Dam failure can occur as a result of structural failure, independent of a hazard event, or as the result of the impacts of a hazard event such as flooding associated with storms or an earthquake. In the event of a dam failure, the energy of the water stored behind even a small dam can cause loss of life and property damage if there are people or buildings downstream. The number of fatalities from a dam failure depends on the amount of warning provided to the population and the number of people in the area in the path of the dam's floodwaters.

Dam failure is a highly infrequent occurrence but a severe incident could result in loss of lives and significant property damage. Since 1984, three dams have failed in or very near to Massachusetts, one of which resulted in a death. There have been no recorded dam breaches in Concord.

According to data provided by the Massachusetts Department of Conservation and Recreation and town staff, the following dams are located in Concord. The numbers following the dam names correspond to the Critical Infrastructure ID provided on maps 1-8 in Appendix A.

Warner's Pond Dam (90)

Warner's Pond Dam, located in West Concord tributary to the Assabet River, is town-owned and has caused flooding of downstream properties in the past. Upstream issues in neighboring towns

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have led to siltation and filling of the pond. This dam has been repaired following local studies that determined the dam was in poor condition. Work includes spillway reconstruction, sluiceway reconstruction, slope stabilization, channel improvements, water level control improvements and permanent access improvements.

Kennedy Pond Dam (91)

This dam is privately-owned and is on Kennedy Pond, tributary to the Assabet River.

Damondale Dam (92)

This dam is located on the Assabet River and is privately owned.

Harrington Ave Dam (Town-owned) (93)

This is a town-owned dam near where Kennedy Pond joins the Assabet River.

Lower Musquetaquid Pond Dam (94)

This is a private dam located at the Sportsman Club on Musquetaquid Pond.

Upper Musquetaquid Pond Dam (95)

This is a private dam located at the Sportsman Club on Musquetaquid Pond.

Batemans Pond Dam (96)

This is a privately-owned dam located on Bateman's Pond at Dakin Brook.

Barretts Mill Road Dam (97)

This dam is privately-owned and located on Angiers Pond along Spencer Brook.

Dakin Brook Dam (98)

This is a town-owned dam located on Dakin Brook near Lowell Road, tributary to the Assabet River.

Crosby Pond Dam (99)

Crosby Pond and dam, located adjacent the Cambridge Turnpike, have flooded and exacerbated the flooding at Cambridge Turnpike. In addition, beaver activity has worsened the situation. The lengthy dam is privately-owned and is in poor condition due to infiltration through the earthen dam, and trees growing in the embankment. Repairs are ongoing under the oversight of the DCR Office of Dam Safety.

DCR defines dam hazard classifications as follows:

High: Dams located where failure or mis-operation will likely cause loss of life and serious damage to homes(s), industrial or commercial facilities, important public utilities, main highways(s) or railroad(s).

Significant: Dams located where failure or mis-operation may cause loss of life and damage home(s), industrial or commercial facilities, secondary highway(s) or railroad(s) or cause interruption of use or service of relatively important facilities.

Low: Dams located where failure or mis-operation may cause minimal property damage to others. Loss of life is not expected.

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Wind Related Hazards

Wind-related hazards include hurricanes, tropical storms, and tornadoes as well as high winds during Nor’easters and thunderstorms. As with many communities, falling trees that result in downed power lines and power outages are an issue in Concord. Information on wind related hazards can be found on Map 5 in Appendix B

Hurricanes and Tropical Storms

A hurricane is a violent wind and rainstorm with wind speeds of 74-200 miles per hour. A hurricane is strongest as it travels over the ocean and is particularly destructive to coastal property as the storm hits the land. The Town's entire area is vulnerable to hurricanes. Hurricanes occur between June and November. A tropical storm has similar characteristics, but wind speeds are below 74 miles per hour.

Since 1900, 39 tropical storms have impacted New England (NESEC). Massachusetts has experienced approximately 32 tropical storms, nine Category 1 hurricanes, five Category 2 hurricanes and one Category 3 hurricane. A hurricane or storm track is the line that delineates the path of the eye of a hurricane or tropical storm.

As shown in Map 5 in Appendix A, the following storm tracked through Concord:

- Tropical Storm in 1996

In addition, Concord experiences the impacts of hurricanes and tropical storms regardless of whether the storm track passes directly through the Town, and numerous hurricanes have affected the communities of eastern Massachusetts (see Table 10) The hazard mapping indicates that the 100 year wind speed in Concord is 110 miles per hour (see Appendix B).

Table 10 Hurricane Records for Massachusetts, 1938 - 2016

Hurricane Event	Date
Great New England Hurricane*	September 21, 1938
Great Atlantic Hurricane*	September 14-15, 1944
Hurricane Doug	September 11-12, 1950
Hurricane Carol*	August 31, 1954
Hurricane Edna*	September 11, 1954
Hurricane Diane	August 17-19, 1955
Hurricane Donna	September 12, 1960
Hurricane Gloria	September 27, 1985
Hurricane Bob	August 19, 1991
Hurricane Earl	September 4, 2010
Tropical Storm Irene	August 28, 2011
Hurricane Sandy	October 29-30, 2012

*Category 3. Source: National Oceanic and Atmospheric Administration

Hurricane intensity is measured according to the Saffir/Simpson scale, which categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure, and storm surge

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potential. These are combined to estimate potential damage. The following gives an overview of the wind speeds, surges, and range of damage caused by different hurricane categories:

Scale No. (Category)	Winds(mph) Storm	Surge (ft)	Potential Damage
1	74 – 95	4 - 5	Minimal
2	96 – 110	6 - 8	Moderate
3	111 – 130	9 - 12	Extensive
4	131 – 155	13 - 18	Extreme
5	> 155	>18	Catastrophic

Source: NOAA

Hurricanes typically have regional impacts beyond their immediate tracks. Falling trees and branches are a significant problem because they can result in power outages when they fall on power lines or block traffic and emergency routes. Hurricanes are a town-wide hazard in Concord. Potential hurricane damages to Concord have been estimated using HAZUS-MH. Total damages are estimated at \$15 million for a Category 2 hurricane and \$55 Million for a Category 4 hurricane. Other potential impacts are detailed in Table 24.

Based on records of previous occurrences, hurricanes in Concord are a Medium frequency event as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard occurs from once in 5 years to once in 50 years, or a 2% to 20% chance per year.

Tornados

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. These events are spawned by thunderstorms and occasionally by hurricanes, and may occur singularly or in multiples. They develop when cool air overrides a layer of warm air, causing the warm air to rise rapidly. Most vortices remain suspended in the atmosphere. Should they touch down, they become a force of destruction. Some ingredients for tornado formation include:

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

Tornado damage severity is measured by the Fujita Tornado Scale, in which wind speed is not measured directly but rather estimated from the amount of damage. As of February 01, 2007, the National Weather Service began rating tornados using the Enhanced Fujita-scale (EF-scale), which allows surveyors to create more precise assessments of tornado severity. The EF-scale is summarized below:

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Fujita Scale			Derived		Operational EF Scale	
F Number	Fastest ¼ mile (mph)	3-second gust (mph)	EF Number	3-second gust (mph)	EF Number	3-second gusts (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over -200

Source: Massachusetts State Hazard Mitigation Plan, 2013

The frequency of tornadoes in eastern Massachusetts is low; on average, there are six tornadoes that touchdown somewhere in the Northeast region every year. The strongest tornado in Massachusetts history was the Worcester Tornado in 1953 (NESEC).

The most recent tornado events in Massachusetts were in Springfield in 2011 and in Revere in 2014. The Springfield tornado caused significant damage and resulted in 4 deaths in June of 2011. The Revere tornado touched down in Chelsea just south of Route 16 and moved north into Revere's business district along Broadway and ended near the intersection of Routes 1 and 60. The path was approximately two miles long and 3/8 mile wide, with wind speeds up to 120 miles per hour. Approximately 65 homes had substantial damages and 13 homes and businesses were uninhabitable.

There have been no recorded tornadoes in the Town of Concord. Since 1955 there have been 16 tornadoes in surrounding Middlesex County recorded by the Tornado History Project. Two of these were F3 tornados, and four were F2. These 17 tornadoes resulted in a total of one fatality and six injuries and \$38.8 million in damages, as summarized in Table 11.

Table 11 Tornado Records for Middlesex County 1955-2016

Date	Fujita	Fatalities	Injuries	Width	Length	Damage
10/24/1955	1	0	0	10	0.1	\$500-\$5000
6/19/1957	1	0	0	17	1	\$5K-\$50K
6/19/1957	1	0	0	100	0.5	\$50-\$500
7/11/1958	2	0	0	17	1.5	\$50K-\$500K
8/25/1958	2	0	0	50	1	\$500-\$5000
7/3/1961	0	0	0	10	0.5	\$5K-\$50K
7/18/1963	1	0	0	50	1	\$5K-\$50K
8/28/1965	2	0	0	10	2	\$50K-\$500K
7/11/1970	1	0	0	50	0.1	\$5K-\$50K
10/3/1970	3	1	0	60	35.4	\$50K-\$500K
7/1/1971	1	0	1	10	25.2	\$5K-\$50K
11/7/1971	1	0	0	10	0.1	\$50-\$500
7/21/1972	2	0	4	37	7.6	\$500K-\$5M
9/29/1974	3	0	1	33	0.1	\$50K-\$500K

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Date	Fujita	Fatalities	Injuries	Width	Length	Damage
7/18/1983	0	0	0	20	0.4	\$50-\$500
9/27/1985	1	0	0	40	0.1	\$50-\$500
8/7/1986	1	0	0	73	4	\$50K-\$500K

Source: The Tornado History Project

Buildings constructed prior to current building codes may be more vulnerable to damages caused by tornadoes. Evacuation of impacted areas may be required on short notice. Sheltering and mass feeding efforts may be required along with debris clearance, search and rescue, and emergency fire and medical services. Key routes may be blocked by downed trees and other debris, and widespread power outages are also typically associated with tornadoes.

Although tornadoes are a potential town-wide hazard in Concord, tornado impacts are relatively localized compared to severe storms and hurricanes. Damages from any tornado in Concord would greatly depend on the track of the tornado. Generally Concord Center and West Concord Center, are more densely developed and would likely be subject to more damage in the event of a tornado.

Based on the record of previous occurrences since 1950, Tornado events in Concord are a Medium frequency event as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur from once in 5 years to once in 50 years, or a 2% to 20% chance per year.

Nor'easters

A northeast coastal storm, known as a nor'easter, is typically a large counter-clockwise wind circulation around a low-pressure center. Featuring strong northeasterly winds blowing in from the ocean over coastal areas, nor'easters are relatively common in the winter months in New England occurring one to two times a year. The storm radius of a nor'easter can be as much as 1,000 miles and these storms feature sustained winds of 10 to 40 mph with gusts of up to 70 mph. These storms are accompanied by heavy rains or snows, depending on temperatures.

Previous occurrences of Nor'easters include the following which are listed in the Massachusetts State Hazard Mitigation Plan 2013:

February 1978	Blizzard of 1978
October 1991	Severe Coastal Storm ("Perfect Storm")
December 1992	Great Nor'easter of 1992
January 2005	Blizzard/Noreaster
October 2005	Coastal Storm/Nor'easter
April 2007	Severe Storms, Inland & Coastal Flooding/Nor'easter
January 2011	Winter Storm/Nor'easter
October 2011	Severe Storm/Nor'easter
Blizzard of 2013	Februray 2013
Blizzard of 2015	January 2015

Many of the historic flood events identified in the previous section were precipitated by nor'easters, including the "Perfect Storm" event in 1991. More recently, blizzards in December

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2010, October 2011, February 2013, and January 2015 were large nor'easters that caused significant snowfall amounts.

Concord is vulnerable to both the wind and precipitation that accompanies nor'easters. High winds can cause damage to structures, fallen trees, and downed power lines leading to power outages. Intense rainfall can overwhelm drainage systems causing localized flooding of rivers and streams as well as urban stormwater ponding and localized flooding. Fallen tree limbs as well as heavy snow accumulation and intense rainfall can impede local transportation corridors, and block access for emergency vehicles.

The entire Town of Concord could be at risk from the wind, rain or snow impacts from a nor'easter, depending on the track and radius of the storm, but due to its inland location the town is not subject to coastal hazards.

Based on the record of previous occurrences, nor'easters in Concord are high frequency events as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur more frequently than once in 5 years (greater than 20% per year).

Severe Thunderstorms

While less severe than the other types of storms discussed, thunderstorms can lead to localized damage and represent a hazard risk for communities. A thunderstorm typically features lightning, strong winds, and rain and/or hail. Thunderstorms sometime give rise to tornados. On average, these storms are only around 15 miles in diameter and last for about 30 minutes. A severe thunderstorm can include winds of close to 60 mph and rain sufficient to produce flooding. The town's entire area is potentially subject to severe thunderstorms.

The best available data on previous occurrences of thunderstorms in Concord is for Middlesex County through the National Climatic Data Center (NCDC). Between the years 2006 and 2016 NCDC records show 71 thunderstorm events in Middlesex County (Table 12). These storms resulted in a total of \$1,617,000 in property damages. There were no injuries or deaths reported.

Table 12 Middlesex County Thunderstorm Events, 2006-2016

Date	Type	Magnitude	Deaths	Injuries	Damage
4/1/2006	Thunderstorm Wind	50	0	0	8000
5/21/2006	Thunderstorm Wind	61	0	0	75000
5/21/2006	Thunderstorm Wind	61	0	0	20000
6/23/2006	Thunderstorm Wind	50	0	0	30000
7/11/2006	Thunderstorm Wind	50	0	0	10000
7/21/2006	Thunderstorm Wind	50	0	0	35000
7/28/2006	Thunderstorm Wind	50	0	0	15000
8/2/2006	Thunderstorm Wind	50	0	0	15000
5/16/2007	Thunderstorm Wind	50	0	0	0
6/27/2007	Thunderstorm Wind	50	0	0	0
7/6/2007	Thunderstorm Wind	50	0	0	0
7/9/2007	Thunderstorm Wind	50	0	0	0

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7/15/2007	Thunderstorm Wind	50	0	0	0
7/28/2007	Thunderstorm Wind	50	0	0	0
7/29/2007	Thunderstorm Wind	50	0	0	0
8/17/2007	Thunderstorm Wind	50	0	0	0
9/8/2007	Thunderstorm Wind	50	0	0	25000
5/27/2008	Thunderstorm Wind	50	0	0	8000
6/10/2008	Thunderstorm Wind	50	0	0	20000
6/23/2008	Thunderstorm Wind	50	0	0	5000
6/24/2008	Thunderstorm Wind	50	0	0	5000
6/27/2008	Thunderstorm Wind	50	0	0	5000
6/29/2008	Thunderstorm Wind	50	0	0	10000
7/1/2008	Thunderstorm Wind	50	0	0	20000
7/2/2008	Thunderstorm Wind	50	0	0	5000
7/3/2008	Thunderstorm Wind	50	0	0	15000
7/19/2008	Thunderstorm Wind	50	0	0	8000
7/20/2008	Thunderstorm Wind	50	0	0	5000
7/27/2008	Thunderstorm Wind	50	0	0	5000
8/3/2008	Thunderstorm Wind	50	0	0	5000
8/7/2008	Thunderstorm Wind	50	0	0	5000
9/9/2008	Thunderstorm Wind	50	0	0	8000
5/9/2009	Thunderstorm Wind	50	0	0	2000
5/24/2009	Thunderstorm Wind	50	0	0	15000
7/7/2009	Thunderstorm Wind	50	0	0	1000
7/8/2009	Thunderstorm Wind	50	0	0	20000
7/26/2009	Thunderstorm Wind	50	0	0	15000
7/31/2009	Thunderstorm Wind	50	0	0	30000
5/4/2010	Thunderstorm Wind	50	0	0	30000
6/1/2010	Thunderstorm Wind	50	0	0	5000
6/3/2010	Thunderstorm Wind	50	0	0	20000
6/5/2010	Thunderstorm Wind	50	0	0	40000
6/6/2010	Thunderstorm Wind	50	0	0	100000
6/24/2010	Thunderstorm Wind	50	0	0	30000
7/12/2010	Thunderstorm Wind	50	0	0	50000
7/19/2010	Thunderstorm Wind	50	0	0	25000
6/1/2011	Thunderstorm Wind	50	0	0	5000
6/9/2011	Thunderstorm Wind	50	0	0	15000
8/2/2011	Thunderstorm Wind	50	0	0	1000
8/19/2011	Thunderstorm Wind	50	0	0	15000
6/8/2012	Thunderstorm Wind	50	0	0	25000
6/23/2012	Thunderstorm Wind	45	0	0	5000
7/4/2012	Thunderstorm Wind	50	0	0	10000
7/18/2012	Thunderstorm Wind	70	0	0	350000
9/7/2012	Thunderstorm Wind	50	0	0	10000

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9/8/2012	Thunderstorm Wind	40	0	0	3000
6/17/2013	Thunderstorm Wind	50	0	0	25000
6/18/2013	Thunderstorm Wind	45	0	0	10000
6/24/2013	Thunderstorm Wind	45	0	0	3000
7/23/2013	Thunderstorm Wind	50	0	0	20000
7/29/2013	Thunderstorm Wind	50	0	0	5000
7/3/2014	Thunderstorm Wind	50	0	0	75000
7/7/2014	Thunderstorm Wind	87	0	0	100000
7/15/2014	Thunderstorm Wind	50	0	0	25000
7/28/2014	Thunderstorm Wind	50	0	0	50000
9/6/2014	Thunderstorm Wind	50	0	0	15000
5/28/2015	Thunderstorm Wind	45	0	0	5000
8/4/2015	Thunderstorm Wind	50	0	0	40000
8/15/2015	Thunderstorm Wind	50	0	0	25000
2/25/2016	Thunderstorm Wind	50	0	0	30000
3/17/2016	Thunderstorm Wind	45	0	0	5000

Source: NOAA, National Climatic Data Center Magnitude refers to maximum wind speed.

Severe thunderstorms are a town-wide hazard for Concord. The town's vulnerability to severe thunderstorms is similar to that of Nor'easters. High winds can cause falling trees and power outages, as well as obstruction of key routes and emergency access. Heavy precipitation may also cause localized flooding, both riverine and urban drainage related.

Based on the record of previous occurrences, severe thunderstorms in Concord are high frequency events as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur more frequently than once in 5 years (greater than 20% per year).

Coastal Hazards and Tsunamis

Coastal Hazards are included in the Massachusetts State Hazard Mitigation Plan 2013, however the Town of Concord is not a coastal community subject to these hazards, thus coastal hazards and Tsunamis are not included in this local plan update.

Winter Storms

Winter storms, including heavy snow, blizzards, and ice storms, are the most common and most familiar of the region's hazards that affect large geographic areas. The majority of blizzards and ice storms in the region cause more inconvenience than they do serious property damage, injuries, or deaths. However, periodically, a storm will occur which is a true disaster, and necessitates intense large-scale emergency response.

Heavy Snow and Blizzards

A blizzard is a winter snow storm with sustained or frequent wind gusts to 35 mph or more, accompanied by falling or blowing snow reducing visibility to or below ¼ mile. These conditions must be the predominant condition over a 3 hour period. Extremely cold temperatures are often

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associated with blizzard conditions, but are not a formal part of the definition. The hazard created by the combination of snow, wind and low visibility significantly increases, however, with temperatures below 20 degrees.

Winter storms are a combination hazard because they often involve wind, ice and heavy snow fall. The National Weather Service defines “heavy snow fall” as an event generating at least 4 inches of snowfall within a 12 hour period. Winter Storms are often associated with a Nor’easter event, a large counter-clockwise wind circulation around a low-pressure center often resulting in heavy snow, high winds, and rain.

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. 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 largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers. The NESIS categories are summarized below:

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: Massachusetts State Hazard Mitigation Plan, 2013

The most significant winter storm in recent history was the “Blizzard of 1978,” which resulted in over 3 feet of snowfall and multiple day closures of roadways, businesses, and schools. In Concord blizzards and severe winter storms have occurred in the following years:

Table 13 Severe Winter Storm Records for Massachusetts

Blizzard of 1978	February 1978
Blizzard	March 1993
Blizzard	January 1996
Severe Snow Storm	March 2001
Severe Snow Storm	December 2003
Severe Snow Storm	January 2004
Severe Snow Storm	January 2005
Severe Snow Storm	April, 2007
Severe Snow Storm	December 2010
Severe Snow Storm	January 2011
Blizzard of 2013	February 2013
Blizzard of 2015	January 2015

Source: National Oceanic and Atmospheric Administration

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The Town of Concord does not keep local records of winter storms. Data for Middlesex County, which includes Concord, is the best available data to help understand previous occurrences and impacts of heavy snow events. According to National Climate Data Center (NCDC) records, from 1996 to 2016 Middlesex County experienced 85 heavy snowfall events, resulting in no deaths, no injuries, and \$4.5 million dollars in property damage. See Table 14 for and heavy snow events and impacts in Middlesex County.

Table 14 Heavy Snow events and Impacts in Middlesex County 1996 –2016

Date	Type	Deaths	Injuries	Property Damage
1/2/1996	Heavy Snow	0	0	0
1/7/1996	Heavy Snow	0	0	1400000
1/7/1996	Heavy Snow	0	0	1500000
1/10/1996	Heavy Snow	0	0	0
1/12/1996	Heavy Snow	0	0	0
2/2/1996	Heavy Snow	0	0	0
2/16/1996	Heavy Snow	0	0	0
3/2/1996	Heavy Snow	0	0	0
3/7/1996	Heavy Snow	0	0	0
4/7/1996	Heavy Snow	0	0	0
4/9/1996	Heavy Snow	0	0	0
12/6/1996	Heavy Snow	0	0	0
12/7/1996	Heavy Snow	0	0	1360000
3/31/1997	Heavy Snow	0	0	0
4/1/1997	Heavy Snow	0	0	0
11/14/1997	Heavy Snow	0	0	0
12/23/1997	Heavy Snow	0	0	0
1/15/1998	Heavy Snow	0	0	0
1/23/1998	Heavy Snow	0	0	0
1/14/1999	Heavy Snow	0	0	0
2/25/1999	Heavy Snow	0	0	0
3/6/1999	Heavy Snow	0	0	0
3/15/1999	Heavy Snow	0	0	0
1/13/2000	Heavy Snow	0	0	0
1/25/2000	Heavy Snow	0	0	0
2/18/2000	Heavy Snow	0	0	0
12/30/2000	Heavy Snow	0	0	0
1/20/2001	Heavy Snow	0	0	0
2/5/2001	Heavy Snow	0	0	0
3/5/2001	Heavy Snow	0	0	0
3/9/2001	Heavy Snow	0	0	0
3/30/2001	Heavy Snow	0	0	0
12/8/2001	Heavy Snow	0	0	0
3/20/2002	Heavy Snow	0	0	0
3/16/2004	Heavy Snow	0	0	0
2/24/2005	Heavy Snow	0	0	0
12/13/2007	Heavy Snow	0	0	0
12/16/2007	Heavy Snow	0	0	0
12/19/2007	Heavy Snow	0	0	0
1/14/2008	Heavy Snow	0	0	28000
1/14/2008	Heavy Snow	0	0	20000
1/14/2008	Heavy Snow	0	0	20000
2/22/2008	Heavy Snow	0	0	0

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3/1/2008	Heavy Snow	0	0	0
12/19/2008	Heavy Snow	0	0	0
12/20/2008	Heavy Snow	0	0	8000
12/21/2008	Heavy Snow	0	0	0
12/31/2008	Heavy Snow	0	0	0
1/10/2009	Heavy Snow	0	0	0
1/11/2009	Heavy Snow	0	0	0
1/18/2009	Heavy Snow	0	0	0
3/1/2009	Heavy Snow	0	0	0
3/2/2009	Heavy Snow	0	0	0
12/9/2009	Heavy Snow	0	0	15000
12/9/2009	Heavy Snow	0	0	500
12/19/2009	Heavy Snow	0	0	0
12/20/2009	Heavy Snow	0	0	0
1/18/2010	Heavy Snow	0	0	0
2/16/2010	Heavy Snow	0	0	15000
2/23/2010	Heavy Snow	0	0	8000
1/12/2011	Heavy Snow	0	0	0
1/26/2011	Heavy Snow	0	0	0
10/29/2011	Heavy Snow	0	0	30000
12/29/2012	Heavy Snow	0	0	0
2/8/2013	Heavy Snow	0	0	0
2/8/2013	Heavy Snow	0	0	0
2/23/2013	Heavy Snow	0	0	0
3/7/2013	Heavy Snow	0	0	0
3/18/2013	Heavy Snow	0	0	0
12/14/2013	Heavy Snow	0	0	0
12/17/2013	Heavy Snow	0	0	0
1/2/2014	Heavy Snow	0	0	0
1/18/2014	Heavy Snow	0	0	0
2/5/2014	Heavy Snow	0	0	0
2/13/2014	Heavy Snow	0	0	0
2/18/2014	Heavy Snow	0	0	0
11/26/2014	Heavy Snow	0	0	10000
1/24/2015	Heavy Snow	0	0	0
1/26/2015	Heavy Snow	0	0	0
2/2/2015	Heavy Snow	0	0	0
2/8/2015	Heavy Snow	0	0	0
2/14/2015	Heavy Snow	0	0	0
2/5/2016	Heavy Snow	0	0	70000
2/5/2016	Heavy Snow	0	0	5000
3/21/2016	Heavy Snow	0	0	0

Source: NOAA, National Climatic Data Center

Blizzards are considered to be high frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan, 2013. This hazard occurs more than once in five years, with a greater than 20 percent chance of occurring each year.

Ice Storms

The ice storm category covers a range of different weather phenomena that collectively involve rain or snow being converted to ice in the lower atmosphere leading to potentially hazardous conditions on the ground. Hail size typically refers to the diameter of the hailstones. Warnings

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and reports may report hail size through comparisons with real-world objects that correspond to certain diameters:

Description	Diameter (inches)
Pea	0.25
Marble or Mothball	0.50
Penny or Dime	0.75
Nickel	0.88
Quarter	1.00
Half Dollar	1.25
Walnut or Ping Pong Ball	1.50
Golf ball	1.75
Hen's Egg	2.00
Tennis Ball	2.50
Baseball	2.75
Tea Cup	3.00
Grapefruit	4.00
Softball	4.50

While ice pellets and sleet are examples of these, the greatest hazard is created by freezing rain conditions, which is rain that freezes on contact with hard surfaces leading to a layer of ice on roads, walkways, trees, and other surfaces. The conditions created by freezing rain can make driving particularly dangerous and emergency response more difficult. The weight of ice on tree branches can also lead to falling branches damaging electric lines.

Town-specific data for previous hail occurrences are not collected by the Town of Concord. The best available local data is for Middlesex County through the National Climatic Data Center (see Table 15). Middlesex County, which includes the Town of Concord, experienced 45 events from 2000-2014.

Table 15 Middlesex County Hail Events, 2000-2015

Date	Event	Magnitude	Deaths	Injuries	Damage
7/18/2000	Hail	1	0	0	0
6/20/2001	Hail	1.75	0	0	0
7/12/2001	Hail	1.5	0	0	0
5/27/2002	Hail	0.75	0	0	0
6/2/2002	Hail	0.75	0	0	0
8/13/2003	Hail	0.75	0	0	0
7/2/2004	Hail	0.75	0	0	0
8/20/2004	Hail	0.88	0	0	0
5/21/2006	Hail	0.75	0	0	0
5/21/2006	Hail	0.75	0	0	0
7/11/2006	Hail	1	0	0	0
7/28/2006	Hail	0.75	0	0	0

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6/5/2007	Hail	1.25	0	0	0
6/22/2007	Hail	0.75	0	0	0
7/9/2007	Hail	1	0	0	0
7/28/2007	Hail	0.88	0	0	0
6/23/2008	Hail	0.75	0	0	0
6/24/2008	Hail	0.75	0	0	0
7/1/2008	Hail	0.88	0	0	0
7/2/2008	Hail	0.75	0	0	0
8/3/2008	Hail	0.75	0	0	0
8/7/2008	Hail	1	0	0	0
8/10/2008	Hail	0.75	0	0	0
5/24/2009	Hail	1	0	0	0
6/27/2009	Hail	0.88	0	0	0
6/27/2009	Hail	0.75	0	0	0
7/7/2009	Hail	0.75	0	0	0
7/8/2009	Hail	1.75	0	0	0
5/4/2010	Hail	0.75	0	0	0
5/7/2011	Hail	0.75	0	0	0
6/1/2011	Hail	0.75	0	0	0
8/2/2011	Hail	0.75	0	0	0
8/19/2011	Hail	0.75	0	0	0
3/13/2012	Hail	1.25	0	0	0
3/14/2012	Hail	1	0	0	0
6/23/2012	Hail	0.75	0	0	0
7/18/2012	Hail	1	0	0	0
10/30/2012	Hail	1	0	0	0
6/17/2013	Hail	0.75	0	0	0
5/25/2014	Hail	0.75	0	0	0
7/3/2014	Hail	1	0	0	0
8/7/2014	Hail	0.75	0	0	0
9/6/2014	Hail	0.88	0	0	0
8/4/2015	Hail	1	0	0	0
8/15/2015	Hail	0.75	0	0	0

Source: NOAA, National Climatic Data Center Magnitude refers to diameter of hail stones in inches.

Ice storms are considered to be medium frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan, 2013. This hazard occurs once in 5 years to once in 50 years, with 2% to 20% chance of occurring each year.

The impacts of winter storms are often related to the weight of snow and ice, which can cause roof collapses and also causes tree limbs to fall which can in turn cause property damage and potential injuries.

Winter storms are a potential town-wide hazard in Concord. The average annual snowfall for Concord is 48 - 72 inches (see Map 6 in Appendix B). The Town's vulnerability is primarily

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related to restrictions to travel on roadways, temporary road closures, school closures, and potential restrictions on emergency vehicle access. The Town works to clear roads and carries out general snow removal operations, and bans on-street parking during snow removal to ensure that streets can be plowed and public safety vehicle access is maximized. Commuter rail operations may also be impacted, as they were in the 2015 blizzard which caused the closure of the MBTA system for one day and limited services on several transit lines for several weeks. Another winter storm vulnerability is power outages due to fallen trees and utility lines.

Geologic Hazards

Geologic hazards include earthquakes and landslides. Although new construction under the most recent building codes generally will be built to seismic standards, there are still many structures which pre-date the most recent building code. Information on geologic hazards in Concord can be found on Map 4 in Appendix B.

Earthquakes

Damage in an earthquake stems from ground motion, surface faulting, and ground failure in which weak or unstable soils, such as those composed primarily of saturated sand or silts, liquefy. The effects of an earthquake are mitigated by distance and ground materials between the epicenter and a given location. An earthquake in New England affects a much wider area than a similar earthquake in California due to New England's solid bedrock geology (NESEC).

Seismologists use a Magnitude scale (Richter Scale) to express the seismic energy released by each earthquake. The typical effects of earthquakes in various ranges are summarized below.

Richter Magnitudes	Earthquake Effects
Less than 3.5	Generally not felt, but recorded
3.5- 5.4	Often felt, but rarely causes damage
Under 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 km. across where people live.
7.0- 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or greater	Great earthquake. Can cause serious damage in areas several hundred meters across.

Source: Nevada Seismological Library (NSL), 2005

According to the State Hazard Mitigation Plan, New England experiences an average of five earthquakes per year. From 1668 to 2007, 355 earthquakes were recorded in Massachusetts (NESEC). Most have originated from the La Malbaie fault in Quebec or from the Cape Anne fault located off the coast of Rockport. The region has experienced larger earthquakes, including a magnitude 5.0 earthquake in 1727 and a 6.0 earthquake that struck in 1755 off the coast of Cape Anne. More recently, a pair of damaging earthquakes occurred near Ossipee, NH in 1940, and a 4.0 earthquake centered in Hollis, Maine in October 2012 was felt in the Boston area. Historical records of some of the more significant earthquakes in the region are shown in Table 16.

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Table 16 Historical Earthquakes in Massachusetts or Surrounding Area

Location	Date	Magnitude
MA - Cape Ann	11/10/1727	5
MA - Cape Ann	12/29/1727	NA
MA - Cape Ann	2/10/1728	NA
MA - Cape Ann	3/30/1729	NA
MA - Cape Ann	12/9/1729	NA
MA - Cape Ann	2/20/1730	NA
MA - Cape Ann	3/9/1730	NA
MA - Boston	6/24/1741	NA
MA - Cape Ann	6/14/1744	4.7
MA - Salem	7/1/1744	NA
MA - Off Cape Ann	11/18/1755	6
MA - Off Cape Cod	11/23/1755	NA
MA - Boston	3/12/1761	4.6
MA - Off Cape Cod	2/2/1766	NA
MA - Offshore	1/2/1785	5.4
MA - Wareham/Taunton	12/25/1800	NA
MA - Woburn	10/5/1817	4.3
MA - Marblehead	8/25/1846	4.3
MA - Brewster	8/8/1847	4.2
MA - Boxford	5/12/1880	NA
MA - Newbury	11/7/1907	NA
MA - Wareham	4/25/1924	NA
MA - Cape Ann	1/7/1925	4
MA - Nantucket	10/25/1965	NA
MA - Boston	12/27/74	2.3
VA - Mineral	8/23/11	5.8
MA - Nantucket	4/12/12	4.5
ME - Hollis	10/17/12	4.0

Source: Boston HIRA

One measure of earthquake risk is ground motion, which is measured as maximum peak horizontal acceleration, expressed as a percentage of gravity (1 g). The range of peak ground acceleration in Massachusetts is from 10g to 20g, with a 2% probability of exceedance in 50 years. Concord is in the middle part of the range for Massachusetts, at 14g to 16g, making it a relatively moderate area of earthquake risk within the state, although the state as a whole is considered to have a low risk of earthquakes compared to the rest of the country. There have been no recorded earthquake epicenters within Concord.

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.

Earthquakes are a hazard with multiple impacts beyond the obvious building collapse. Buildings may suffer structural damage which may or may not be readily apparent. Earthquakes can cause major damage to roadways, making emergency response difficult. Water lines and gas lines can break, causing flooding and fires. Another potential vulnerability is equipment within

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structures. For example, a hospital may be structurally engineered to withstand an earthquake, but if the equipment inside the building is not properly secured, the operations at the hospital could be severely impacted during an earthquake. Earthquakes can also trigger landslides.

Earthquakes are a potential town-wide hazard in Concord, The Town has many older buildings that pre-date current building code which could be vulnerable in the event of a severe earthquake. Potential earthquake damages to Concord have been estimated using HAZUS-MH. Total building damages are estimated at \$473 million for a 5.0 magnitude earthquake and \$3.3 billion for a 7.0 magnitude earthquake. Other potential impacts are detailed in Table 25.

According to the Boston College Weston Observatory, in most parts of New England, there is a one in ten chance that a potentially damaging earthquake will occur in a 50 year time period. The Massachusetts State Hazard Mitigation Plan classifies earthquakes as Very Low frequency events that occur less frequently than once in 100 years, or a less than 1% per year.

Landslides

According to the USGS, “The term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors.” Among the contributing factors are: erosion by rivers or ocean waves over steepened slopes; rock and soil slopes weakened through saturation by snowmelt or heavy rains; earthquakes create stresses that make weak slopes fail; and excess weight from accumulation of rain or snow, and stockpiling of rock or ore, from waste piles, or from man-made structures.

Landslides can result from human activities that destabilize an area or can occur as a secondary impact from another natural hazard such as flooding. In addition to structural damage to buildings and the blockage of transportation corridors, landslides can lead to sedimentation of water bodies. Typically, a landslide occurs when the condition of a slope changes from stable to unstable. Natural precipitation such as heavy snow accumulation, torrential rain and run-off may saturate soil creating instability enough to contribute to a landslide. The lack of vegetation and root structure that stabilizes soil can destabilize hilly terrain.

There is no universally accepted measure of landslide extent but it has been represented as a measure of the destructiveness. The table below summarizes the estimated intensity for a range of landslides. For a given landslide volume, fast moving rock falls have the highest intensity while slow moving landslides have the lowest intensity.

Estimated Volume (m ³)	Expected Landslide Velocity		
	Fast moving landslide (Rock fall)	Rapid moving landslide (Debris flow)	Slow moving landslide (Slide)
<0.001	Slight intensity		
<0.5	Medium intensity		
>0.5	High intensity		
<500	High intensity	Slight intensity	
500-10,000	High intensity	Medium intensity	Slight intensity
10,000 – 50,000	Very high intensity	High intensity	Medium intensity
>500,000		Very high intensity	High intensity
>>500,000			Very high intensity

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Source: *A Geomorphological Approach to the Estimation of Landslide Hazards and Risks in Umbria, Central Italy*, M. Cardinali et al, 2002

Roughly the western half of Concord is classified as having a low risk for landslides, while the eastern half is classified as moderate risk (see Map 4, Appendix B). The town does not have records of any damages caused by landslides in Concord.

Should a landslide occur in the future, the type and degree of impacts would be highly localized, and the town's vulnerabilities could include damage to structures, damage to transportation and other infrastructure, and localized road closures. Potential damages would depend on the extent of impact, based on how many properties were affected. Given the relatively high assessed value of property in Concord, damages affecting a single residence could exceed \$500,000, and damages affecting several homes or business properties could theoretically total several million dollars. However, there are no data available on landslide damages in Concord, as there are no records of any damages caused by landslides in the town. Injuries and casualties, while possible, would be unlikely given the low extent and impact of landslides in Concord.

Based on past occurrences and the Massachusetts Hazard Mitigation Plan, landslides are of Low frequency, events that can occur once in 50 to 100 years (a 1% to 2% chance of occurring each year).

Fire Related Hazards

A brush fire is an uncontrolled fire occurring in a forested or grassland area. In the Boston Metro region these fires rarely grow to the size of a wildfire as seen more typically in the western U.S. As their name implies, these fires typically burn no more than the underbrush of a forested area. There are three different classes of wild fires:

- Surface fires are the most common type and burn along the floor of a forest, moving slowly and killing or damaging trees;
- Ground fires are usually started by lightning and burn on or below the forest floor;
- Crown fires spread rapidly by wind, jumping along the tops of trees.

Wildfire season can begin in March and usually ends in late November. The majority of wildfires typically occur in April and May, when most vegetation is void of any appreciable moisture, making them highly flammable. Once "green-up" takes place in late May to early June, the fire danger usually is reduced somewhat.

A wildfire differs greatly from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to unexpectedly change direction, and its ability to jump gaps such as roads, rivers and fire breaks.

These fires can present a hazard where there is the potential for them to spread into developed or inhabited areas, particularly residential areas where sufficient fuel materials might exist to allow the fire the spread into homes. Protecting structures from fire poses special problems, and can stretch firefighting resources to the limit.

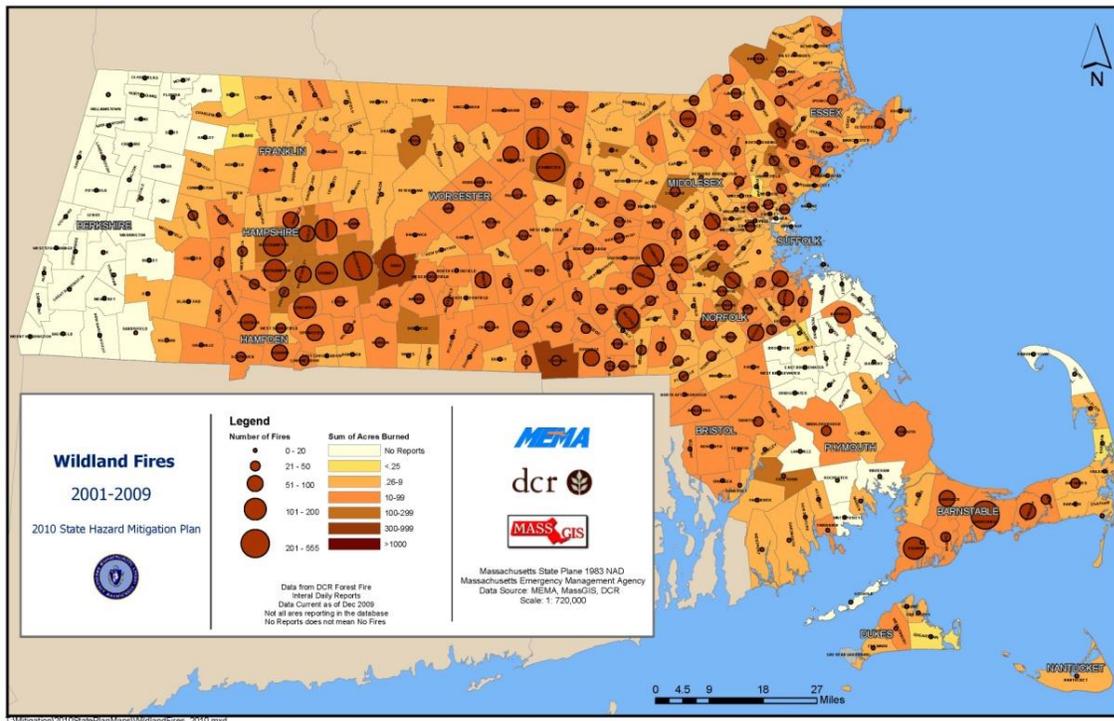
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If heavy rains follow a fire, other natural disasters can occur, including landslides, mudflows, and floods. If the wild fire destroys the ground cover, then erosion becomes one of several potential problems.

The Concord Fire Department responds to a handful of brush fires annually, but they do not result in major property damage or deaths. The most common cause of these fires is due to human carelessness. The brush fires are typically not concentrated in certain locations, but are distributed throughout the town.

Wildfires in Massachusetts are measured by the number of fires and the sum of acres burned. The most recent data available for wildfires in Massachusetts, shown in Figure 2 below, indicates that the wildfire extent in Concord consists of less than 9 acres burned, with 21 to 50 recordable fires from 2001 to 2009.

Figure 2 Massachusetts Wildfires 2001-2009



Source: Massachusetts State Hazard Mitigation Plan

Potential vulnerabilities to wildfires include damage to structures and other improvements, and impacts on natural resources such as town conservation land. 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.

Based on past occurrences and the Massachusetts Hazard Mitigation Plan 2013, brushfires are of Medium frequency, events that occur from once in 5 years to once in 50 years (2% to 20% probability per year).

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Extreme Temperatures

Extreme temperatures occur when either high temperature or low temperatures relative to average local temperatures occur. These can occur for brief periods of time and be acute, or they can occur over long periods of time when there is a prolonged period of excessively hot or cold weather.

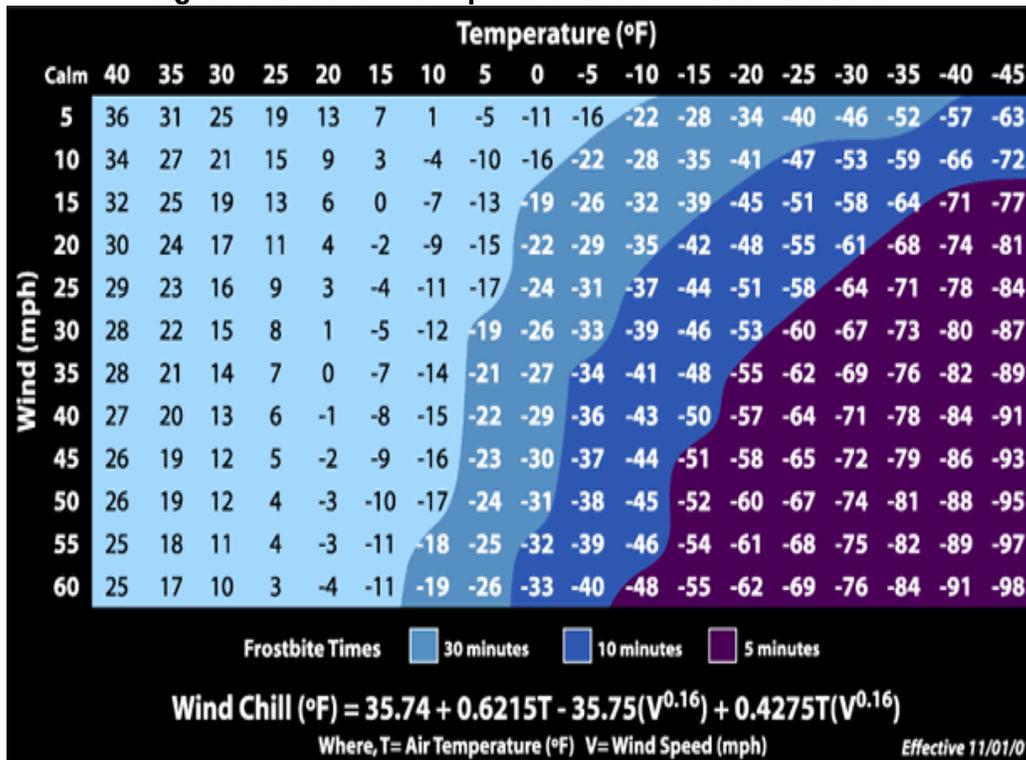
Concord has four well-defined seasons. The seasons have several defining factors, with temperature one of the most significant. Extreme temperatures can be defined as those, which are far outside of the normal seasonal ranges for Massachusetts. The average temperatures for Massachusetts are: winter (Dec-Feb) Average = 31.8°F and summer (Jun-Aug) Average = 71°F. Extreme temperatures are a town-wide hazard.

Extreme Cold

For extreme cold, temperature is typically measured using Wind Chill Temperature Index, which is provided by the National Weather Service (NWS). The latest version of the index was implemented in 2001 and it meant to show how cold conditions feel on unexposed skin. The index is provided in Figure 3 below.

Extreme cold is relative to the normal climatic lows in a region. Temperatures that drop decidedly below normal and wind speeds that increase can cause harmful wind-chill factors. The wind chill is the apparent temperature felt on exposed skin due to the combination of air temperature and wind speed.

Figure 3 Wind Chill Temperature Index and Frostbit Risk



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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.

The Town of Concord does not collect data for previous occurrences of extreme cold. The best available local data are for Middlesex County, through the National Climatic Data Center (NCDC). There are three extreme cold events on record which caused no deaths, injuries, or property damage. (see Table 17).

Table 17 Middlesex County Extreme Cold and Wind Chill Occurrences

Date	Deaths	Injuries	Damage
2/15/2015	0	0	0
2/16/2015	0	0	0
2/14/2016	0	0	0

Source: NOAA, National Climatic Data Center

Extreme Heat

While a heat wave for Massachusetts is defined as three or more consecutive days above 90°F, another measure used for identifying extreme heat events is through a Heat Advisory from the NWS. These advisories are issued when the heat index (Figure 4) is forecast to exceed 100

Figure 4 Heat Index Chart

		Temperature (°F)															
		80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
Relative Humidity (%)	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.													

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degree Fahrenheit (F) for 2 or more hours; an excessive heat advisory is issued if forecast predicts the temperature to rise above 105 degree F.

Extreme heat poses a potentially greater risk to the elderly, children, and people with certain medical conditions, such as heart disease. However, even young and healthy individuals can succumb to heat if they participate in strenuous physical activities during hot weather. Hot summer days can also worsen air pollution. With increased extreme heat, urban areas of the Northeast are likely to experience more days that fail to meet air quality standards.

The Town of Concord does not collect data on excessive heat occurrences. The best available local data are for Middlesex County, through the National Climatic Data Center. From 1999 - 2016, there have been a total of 3 excessive heat events, with one reported deaths, no injuries, and no property damage resulting from excessive heat (see Table 18).

Extreme temperature events are projected to be medium frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan, 2013. Both extreme cold and hot weather events occur between once in five years to once in 50 years, or a 2 percent to 20 percent chance of occurring each year.

Table 18 Middlesex County Extreme Heat Occurrences

Date	Deaths	Injuries	Damage
7/6/2010	0	0	0
7/7/2010	0	0	0
7/5/2013	1	0	0

Source: NOAA, National Climatic Data Center

Drought

Drought is a temporary irregularity in precipitation and differs from aridity since the latter is restricted to low rainfall regions and is a permanent feature of climate. Drought is a period characterized by long durations of below normal precipitation. Drought conditions occur in virtually all climatic zones yet its characteristics vary significantly from one region to another, since it is relative to the normal precipitation in that region. Drought can affect agriculture, water supply, aquatic ecology, wildlife, and plant life.

In Massachusetts, droughts are caused by the prevalence of dry northern continental air and a decrease in coastal- and tropical-cyclone activity. During the 1960's, a cool drought occurred because dry air from the north caused lower temperatures in the spring and summer of 1962-65. The northerly winds drove frontal systems to sea along the Southeast Coast and prevented the Northeastern States from receiving moisture (U.S. Geological Survey). This is considered the drought of record in Massachusetts.

Average annual precipitation in Massachusetts is 44 inches per year, with approximately 3 to 4 inch average amounts for each month of the year. Regional monthly precipitation ranges from zero to 17 inches. Statewide annual precipitation ranges from 30 to 61 inches. Thus, in the driest calendar year (1965), the statewide precipitation total of 30 inches was 68 percent of average.

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Although Massachusetts is relatively small, it has a number of distinct regions that experience significantly different weather patterns and react differently to the amounts of precipitation they receive. The DCR precipitation index divides the state into six regions: Western, Central, Connecticut River Valley, Northeast, Southeast, and Cape and Islands. Concord is located in the Northeast Region. In Concord drought is a potential town-wide hazard.

Five levels of drought have been developed to characterize drought severity: Normal, Advisory, Watch, Warning, and Emergency. These drought levels are based on the conditions of natural resources and are intended to provide information on the current status of water resources. The levels provide a basic framework from which to take actions to assess, communicate, and respond to drought conditions. They begin with a normal situation where data are routinely collected and distributed, move to heightened vigilance with increased data collection during an advisory, to increased assessment and proactive education during a watch. Water restrictions might be appropriate at the watch or warning stage, depending on the capacity of each individual water supply system. A warning level indicates a severe situation and the possibility that a drought emergency may be necessary. A drought emergency is one in which mandatory water restrictions or use of emergency supplies is necessary. Drought levels are used to coordinate both state agency and local response to drought situations.

As dry conditions can have a range of different impacts, a number of drought indices are available to assess these various impacts. Massachusetts uses a multi-index system that takes advantage of several of these indices to determine the severity of a given drought or extended period of dry conditions. Drought level is determined monthly based on the number of indices which have reached a given drought level. Drought levels are declared on a regional basis for each of six regions in Massachusetts. County by county or watershed-specific determinations may also be made.

A determination of drought level is based on seven indices:

1. Standardized Precipitation Index (SPI) reflects soil moisture and precipitation.
2. Crop Moisture Index: (CMI) reflects soil moisture conditions for agriculture.
3. Keetch Byram Drought Index (KBDI) is designed for fire potential assessment.
4. Precipitation Index is a comparison of measured precipitation amounts to historic normal precipitation.
5. The Groundwater Level Index is based on the number of consecutive month's groundwater levels are below normal (lowest 25% of period of record).
6. The Stream flow Index is based on the number of consecutive months that stream flow levels are below normal (lowest 25% of period of record).
7. The Reservoir Index is based on the water levels of small, medium and large index reservoirs across the state, relative to normal conditions for each month.

Determinations regarding the end of a drought or reduction of the drought level focus on two key drought indicators: precipitation and groundwater levels. These two factors have the greatest long-term impact on stream flow, water supply, reservoir levels, soil moisture and potential for forest fires.

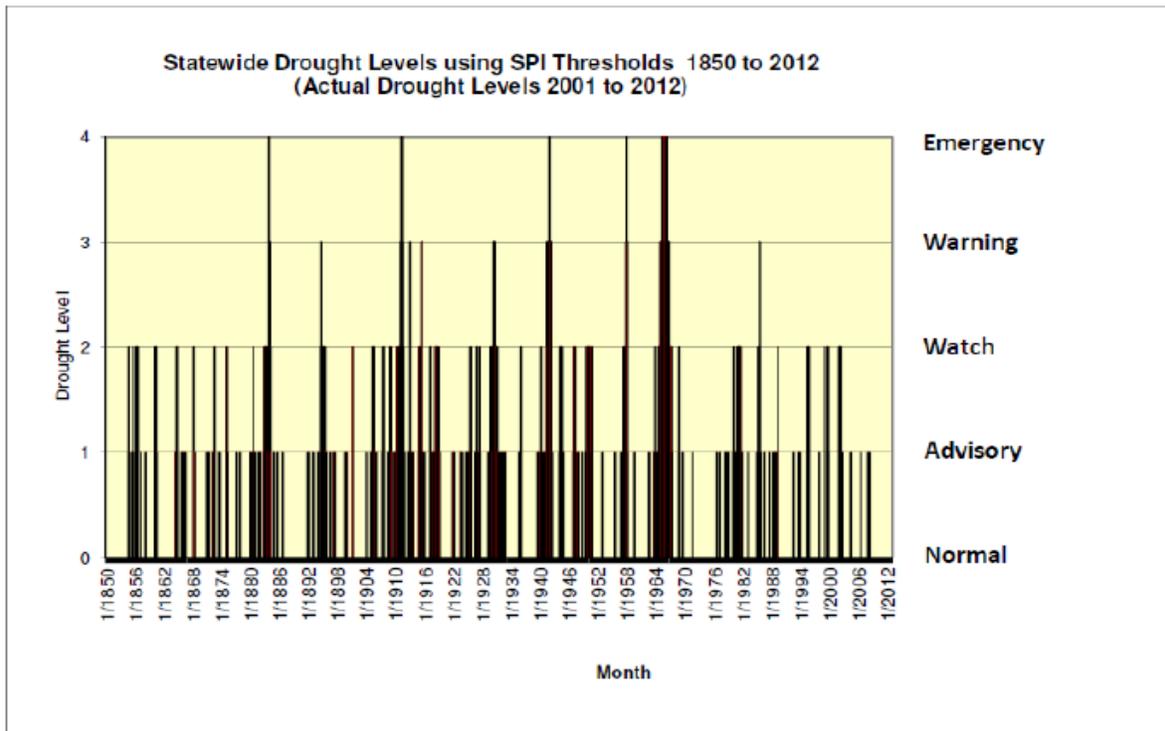
Previous Occurrences

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Concord does not collect data relative to drought events. Because drought tends to be a regional natural hazard, this plan references state data as the best available data for drought. The statewide scale is a composite of six regions of the state. Regional composite precipitation values are based on monthly values from six stations, and three stations in the smaller regions (Cape Cod/Islands and West).

Figure 5 depicts the incidents of drought levels' occurrence in Massachusetts from 1850 to 2012 using the Standardized Precipitation Index (SPI) parameter alone. On a monthly basis, the state would have been in a Drought Watch to Emergency condition 11 percent of the time between 1850 and 2012. Table 19 summarizes the chronology of major droughts since the 1920's.

Figure 5 Statewide Drought Levels using SPI Thresholds 1850 – 2012



(Source: Mass. State Drought Management Plan 2013)

Drought Emergency

Drought emergencies have been reached infrequently, with 5 events occurring in the period between 1850 and 2012: in 1883, 1911, 1941, 1957, and 1965-1966. The 1965-1966 drought period is viewed as the most severe drought to have occurred in modern times in Massachusetts because of its long duration. On a monthly basis over the 162-year period of record, there is a one percent chance of being in a drought Emergency.

Drought Warning

Drought Warning levels not associated with drought Emergencies have occurred four times, in 1894, 1915, 1930, and 1985. On a monthly basis over the 162-year period of record, there is

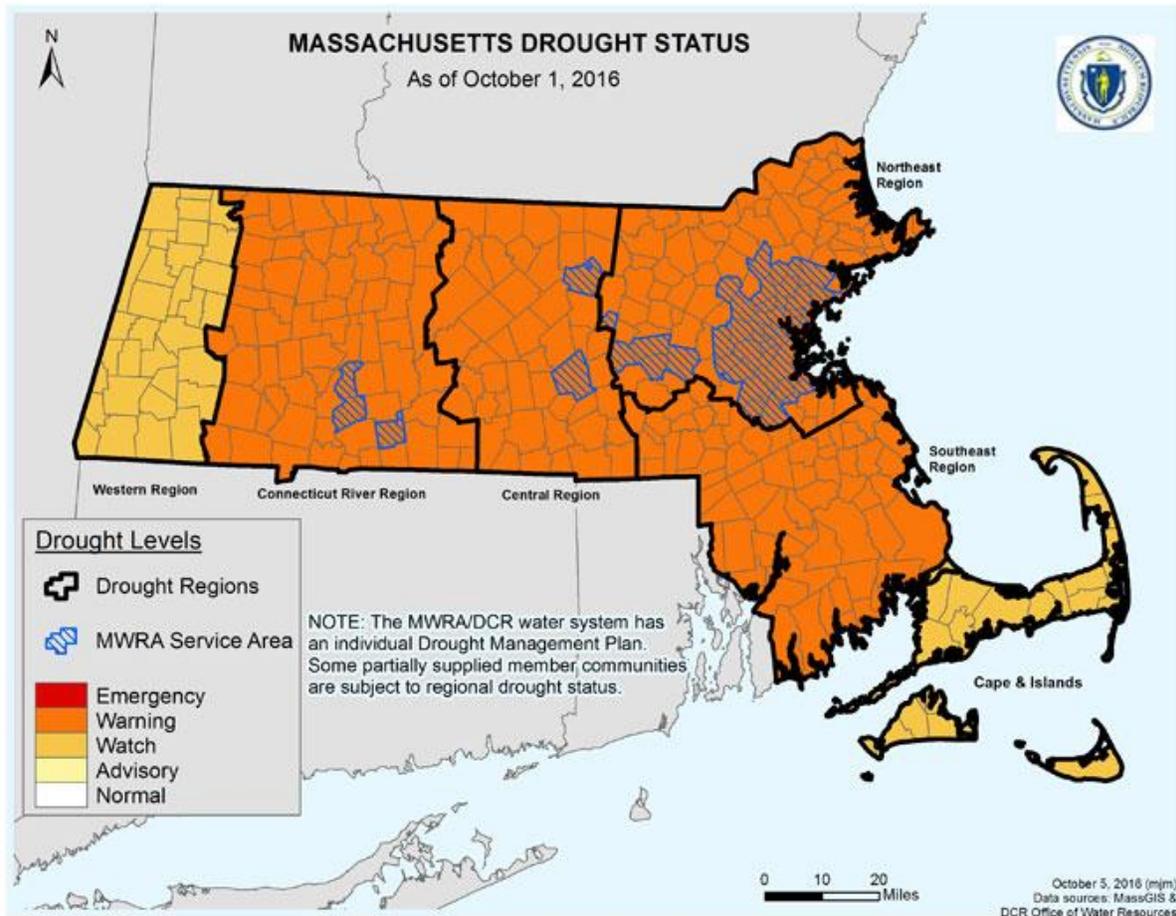
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a two percent chance of being in a drought Warning level. As of July 2016, a fifth Drought Warning has been declared for the region that includes the Town of Concord. September 1, 2016 marked the sixth consecutive month of below average rainfall. In response to the drought, the Water and Sewer Division of the Department of Public Work has declared an outdoor watering emergency which prohibits nearly all outdoor water use.

Drought Watch

Drought Watches not associated with higher levels of drought generally have occurred in three to four years per decade between 1850 and 1950. In the 1980s, there was a lengthy drought Watch level of precipitation between 1980 and 1981, followed by a drought Warning in 1985 (see Table 19). A frequency of drought Watches at a rate of three years per decade resumed in the 1990s (1995, 1998, 1999). In the 2000s, Drought Watches occurred in 2001, 2002, and 2016. The overall frequency of being in a drought Watch is 8 percent on a monthly basis over the 162-year period of record.

Figure 6 Massachusetts Drought Status as of October 2016



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Table 19 Chronology of Major Droughts in Massachusetts

Date	Area affected	Recurrence interval (years)	Remarks
1929-32	Statewide	10 to >50	Water-supply sources altered in 13 communities. Multistate.
	Statewide	15 to >50	More severe in eastern and extreme western Massachusetts. Multistate.
1957-59	Statewide	5 to 25	Record low water levels in observation wells, northeastern Massachusetts.
1961-69	Statewide	35 to >50	Water-supply shortages common. Record drought. Multistate.
1980-83	Statewide	10 to 30	Most severe in Ipswich and Taunton River basins; minimal effect in Nashua River basin. Multistate.
1985-88	Housatonic River basin	25	Duration and severity unknown. Stream flow showed mixed trends elsewhere.
2016	Statewide	N/A	Drought declaration began in July 2016 with a Drought Watch, which was upgraded to a Drought Warning in August 2016. The Central and Northeast regions were the most severely affected.

Under a severe long term drought the Town of Concord could be vulnerable to restrictions on water supply. Potential damages of a severe drought could include losses of landscaped areas if outdoor watering is restricted and potential loss of business revenues if water supplies were severely restricted for a prolonged period. As this hazard has never occurred to such a severe degree in Concord, there are no data or estimates of potential damages, but under a severe long term drought scenario it would be reasonable to expect a range of potential damages from several million to tens of millions of dollars. Another potential vulnerability of droughts could be increased risk of wildfires.

Probability of Future Occurrences

The state has experienced Emergency Droughts five times between 1850 and 2012. Even given that regional drought conditions may occur at a different interval than state data indicates, droughts remain primarily regional and state phenomena in Massachusetts. Emergency Drought conditions over the 162 period of record in Massachusetts are a Low Frequency natural hazard event that can occur from once in 50 years to once in 100 years (1% to 2% chance per year), as defined by the Massachusetts State Hazard Mitigation Plan, 2013.

Other Hazards

Main Street Bridge between Elm and Wood (27)

This bridge is a concern due to its weight restrictions and inability to carry loads from Emergency Response Vehicles.

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Pail Factory Bridge (29)

This bridge is a concern due to its weight restrictions and inability to carry loads from Emergency Response Vehicles.

Route 2 Nashoba Brook Bridge (30)

This bridge is a concern due to its weight restrictions.

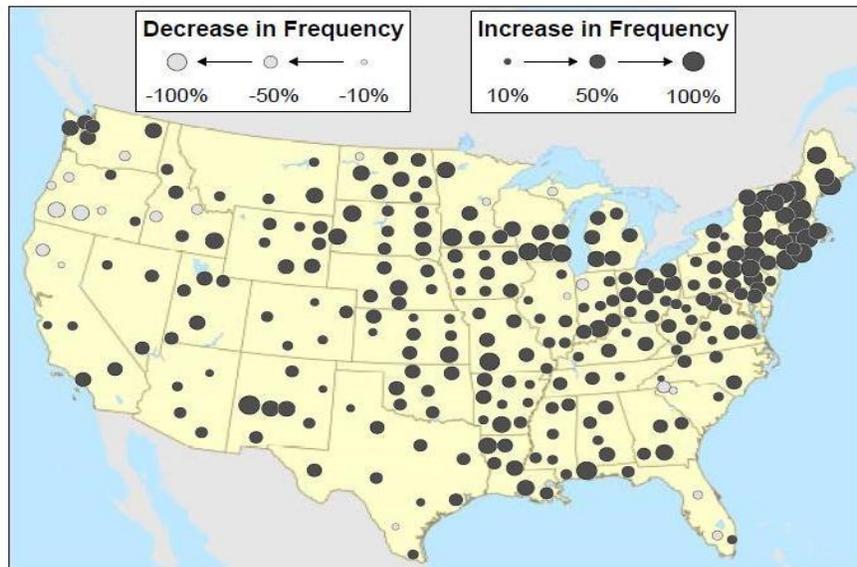
Impacts of Climate Change

Many of the natural hazards that Concord has historically experienced are likely to be exacerbated by climate change in future years. This is particularly true for flooding caused by extreme precipitation and extreme heat. These are described in more detail below.

Climate Change Impacts: Extreme Precipitation

Concord's average annual precipitation is 42 inches. While total annual precipitation has not changed significantly, according to the 2012 report *When It Rains It Pours – Global Warming and the Increase in Extreme Precipitation from 1948 to 2011* intense rainstorms and snowstorms have become more frequent and more severe over the last half century in the northeastern United States. Extreme downpours are now happening 30 percent more often nationwide than in 1948 (see Figure 7). In other words, large rain or snow storms that happened once every 12 months, on average, in the middle of the 20th century, now happen every nine months.

Figure 7 Changes in Frequency of Extreme Downpours, 1948 – 2011



Source: *When It Rains It Pours – Global Warming and the Increase in Extreme Precipitation*, Environment America Research and Policy Center, July 2012

Not only are these intense storm events more frequent, they are also more severe: the largest annual storms now produce 10 percent more precipitation, on average, than in 1948. In particular, the report finds that New England has experienced the greatest change with intense rain and snow storms occurring 85 percent more often than in 1948

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At the other extreme, changes in precipitation patterns and the projected future rising temperatures due to climate change (discussed below) will likely increase the frequency of short-term (one- to three-month) droughts and decrease stream flow during the summer.

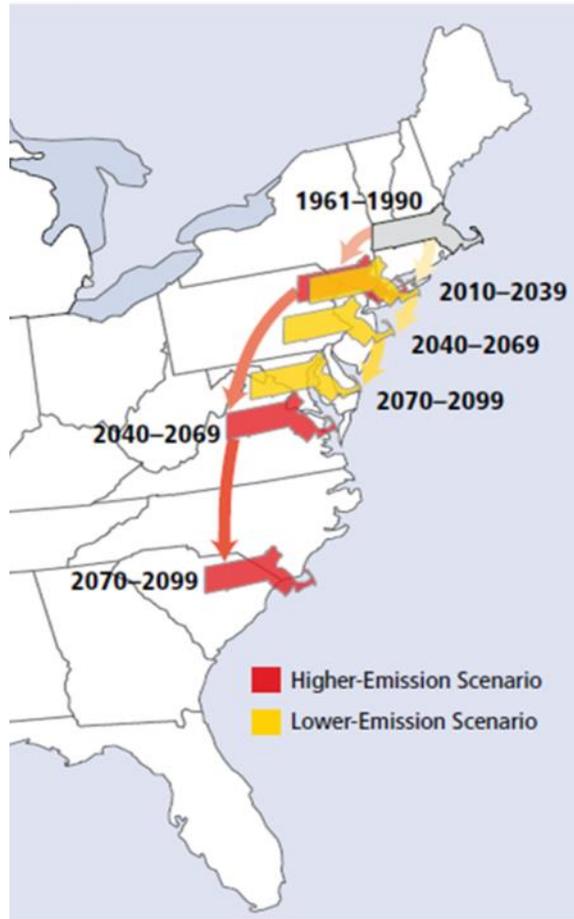
Climate Change Impacts: Extreme Heat

Recent temperature trends suggest greater potential impacts to come due to climate change. In the report “Confronting Climate Change in the U.S. Northeast,” (2007), the Union of Concerned Scientists presented temperature projections to 2099 based on two scenarios, one with lower carbon dioxide emissions, and the other with high emissions.

Between 1961 and 1990, Boston experienced an average of 11 days per year over 90°F. That could triple to 30 days per year by 2095 under the low emissions scenario, and increase to 60 days per year under the high emissions scenario. Days over 100°F could increase from the current average of one day per year to 6 days with low emissions or 24 days with high emissions. By 2099, Massachusetts could have a climate similar to Maryland's under the low emissions scenario, and similar to the Carolinas' with high emissions. Furthermore, the number of days with poor air quality could quadruple in Boston by the end of the 21st century under higher emissions scenario, or increase by half under the lower emissions scenario. These extreme temperature trends could have significant impacts on public health, particularly for those individuals with asthma and other respiratory system conditions, which typically affect the young and the old more severely.

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Figure 8 Mass. Extreme Heat Scenarios



Source: Union of Concerned Scientists

Land Use and Development Trends

Existing Land Use

The most recent land use statistics available from the state are from aerial photography done in 2005. Table 20 shows the acreage and percentage of land in 20 categories. If the five residential categories are aggregated, residential uses make up nearly 20% of the area of the town (2,493 acres). Commercial and industrial combined make up 1.6% of the town, or 268 acres. Recreation, urban public, and golf courses comprise a total of 3.94%, or 651.5 acres.

Table 20 2005 Land Use

Land Use Type	Acres	Percent
Crop Land, Pasture, Orchard, Nursery	1311.7	7.94%
Forest	6827.3	41.31%
Non-Forested Wetlands	1302.5	7.88%
Forested Wetland	1538.8	9.31%
Brushland/Successional	36.0	.22%
Mining	2.1	0.01%

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Open & Urban Open Land	371.9	2.25%
Participation Recreation	152.2	0.92%
Water-based Recreation	3.1	0.02%
Multi-family Residential	198.1	1.2%
High Density Residential	184.1	1.11%
Medium Density Residential	786.9	4.76%
Low Density Residential	1241.6	7.51%
Very Low Density Residential	885.3	5.36%
Commercial	189.4	1.15%
Industrial	78.7	0.48%
Transportation	251.7	1.52%
Waste Disposal	52.3	0.32%
Junkyards	0.6	0.01%
Water	569.6	3.44%
Golf Course	164.2	0.99%
Marina	0.5	0.01%
Urban Public	332.0	2.01%
Cemetery	44.9	0.27%
Total Acres	16,525.5	100.0%

For more information on how the land use statistics were developed and the definitions of the categories, please go to <http://www.mass.gov/mgis/lus.htm>.

Economic Elements

Concord has eight distinct business districts. These include: Town Center (Milldam, Walden St. and historic sites), West Concord Center, Concord Depot/Thoreau School/Sudbury Road, Baker Avenue, Old Road to Nine Acre Corner at Rt. 2, Virginia Road, and Forest Ridge. According to the Comprehensive Plan, the service sector constitute more than half of all employment and the tourism industry is an important part of the local economy. There are approximately 960 businesses in Concord.

Historic, Cultural, and Natural Resource Areas

According to the Concord Comprehensive Plan, the Town has considerable historic and cultural resources. The Town has 5 Local Historic Districts, 3 National Historic Districts and 18 structures on the National Register of Historic Houses and Districts. Concord is home to the Minute Man National Historic Park, including the town-owned North Bridge. Other important historic sites include the Old Hill and South Bury Grounds, the Thoreau birthplace, Walden Pond Reservation, and the Harrington, Town, Cuming, and Warden's Houses.

Cultural resources include the Free Public Library and numerous theatre, music and arts organizations. Concord is home to six museums and houses open to the public, including the Concord Museum, the Concord Art Association, the Emerson and Orchard Houses, Old Manse and Wayside.

Concord's topography includes rolling landscape, extensive low-lying wetlands, and rivers and streams. Its glacial history is seen in the drumlins and kettle ponds that dot the landscape. The

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confluence of the Sudbury and Assabet Rivers is located in the center of Concord. From this confluence, the Concord River flows to the Merrimac River. Significant protected open space includes the Great Meadows National Wildlife Refuge, the Minute Man National Historic Park, and the State Reservation at Walden Pond. The Open Space Plan has identified nine “Large Natural Areas” that provide ecosystem services and protection. Great Meadows and Walden Pond are among the nine identified large natural areas.

Development Trends

According to the Open Space and Recreation Plan, following a long period of rapid growth, Town population has grown slowly since 2000.

Under current zoning, the Town of Concord is largely built out. Approximately 35% of the land is developed with residential, commercial and industrial buildings and 30% is permanently protected open space (federal, state, municipal and private). Much of the land area is occupied by existing residential neighborhoods, commercial districts and corridors, open space and recreational spaces, and conservation land and undevelopable wetlands. Most of the larger and more easily developed parcels in Concord have already been developed or protected as conservation land, so the development that is occurring in the Town is largely infill development and redevelopment.

Development trends throughout the metropolitan region are tracked by MAPC’s Development Database, which provides an inventory of new development over the last decade. The database tracks both completed developments and those currently under construction. The database includes 35 developments in the Town of Concord since 2010, of which 17 are completed and 18 were under construction or planned in 2015.

The database also includes several attributes of the new development, including site acreage, housing units, and commercial space. The 35 developments in Concord include a total of 870 housing units, 865,000 square feet of commercial space, and are sited on a total of over 1,000 acres. See Table 21 below.

Table 21 Summary of Concord Developments 2010-2015

DEVELOPMENTS COMPLETED 2007-2015	Acres	HOUSING UNITS	COMMERCIAL (SQ FEET)	PROJECT TYPE
Warner Woods 40B, 247 Laws Brook Rd.	9.2	80	0	Residential
New England Deaconess, 80 Deaconess Rd.	35	99	0	Residential
Lalli Woods	1.37	8	0	Residential
Concord Mews 40B, 48 Old Powder Mill Rd.	30	350	0	Residential
Vanguard Medical Office; 330 Baker Ave.	78	0	50000	Office
Bradford Mill	1.98	0	84500	
Concord River Walk PRD, 1631 & 1641 Main St.	3.775	13	0	Residential

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Middlesex School Faculty Housing	37.22	5	0	Residential
Marx Fencing, 119 Commonwealth Ave.	0.34	0	4802	Retail
135 Commonwealth Ave.	0.63	0	10708	Retail and Office
CCHS - New High School	93.76	0	250000	
Shaw Farm	1.21	8	0	
TD Bank - 1112 Main Street	0.52	0	2900	
Trinity Episcopal Church Expansion	1.37	0	19105	
Minute Man ARC	5.43	0	29822	Office
Woods Hill Table Restaurant	0.23	0	5200	
Middlesex School Paine Barn	37.21	0	8050	
SUBTOTAL	337.3	563	465087	
UNDER CONSTRUCTION/PLANNED				
Brookside Square; 50 Beharrell	5	74	30000	
Monsen Road Subdivision	6.72	8	0	Residential
Marriott Hotel	6.738	0	0	Hotel
Middlesex School Residence Hall	290	39	0	Retail
506 Old Bedford Rd. PRD	4.8	8	0	Residential
Concord Housing Authority, Peter Bulkeley Terrace 40B Amendment, 115 Stow St.	2.94	28	0	Residential
Period Realty Trust, 68-86 Thoreau St.	0.74	0	10000	Restaurant
Concord Academy Science Center	24	0	18000	
Middlesex Green - 521 to 575 Virginia Rd	24.51	0	288430	
Ingham Lane PRD; 1888 Main St	2.62	7	0	Residential
13B Commonwealth Avenue	0.74	0	6000	Retail
Black Horse Place PRD; 140 Commerford Rd	44.68	22	0	
Forest Ridge Rd PRD	15.57	25	0	
Concord Academy Bradford Hall	24	0	0	
Junction Village Assisted Living Facility	2	83	0	
Fenn School, 516 Monument St.	23.97	0	16030	
Millbrook Tarry	3.85	13	5000	Commercial
Middlesex School Music Center	296.18	0	18000	
Total	1116.3	870	865547	

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Potential Future Development

MAPC consulted with town planning staff to determine areas that may be developed in the future, based on the Town’s comprehensive planning efforts and current trends and projects. These areas are described below. In order to characterize any change in the town’s vulnerability associated with new developments, a GIS mapping analysis was conducted which overlaid the development sites with the FEMA Flood Insurance Rate Map. The analysis shows that five of the eight developments are located partially within a flood zone.

Emerson Hospital (E)

Expansion

Junction Village (G)

83 Units, assisted living, 40B, 6X Winthrop Street

Millbrook Tarr (H)

Commercial expansion, 97 Lowell

Black Birch II (I)

16 units, Forest Ridge Rd.

Bruce Freeman Rail Trail (J)

(Lowell to Framingham) 4.5 miles in Concord

Keuka Road (K)

11 units

Concord Museum (L)

Expansion, 200 Lexington

Brookside (M)

6,000 sq/ft commercial, Commonwealth Avenue

Table 22 shows the relationship of these parcels to three of the mapped hazards. This information is provided so that planners can ensure that development proposals comply with flood plain zoning and that careful attention is paid to drainage issues.

Table 22 Relationship of Potential Development to Hazard Areas			
Parcel	Landslide risk	Flood Zone	Brush Fire
E. Emerson Hospital	Low	NA	No
G. Junction Village	Low	4.9% in AE Zone	No
H. Millbrook Tarry	Moderate	51.2% in AE Zone	No
I. Black Birch II	Low	NA	No
J. Bruce Freeman Rail Trail	Low	2.9% In AE Zone	No
K. Keuka Road	Low	4.6% In AH Zone	No
L. Concord Museum	Moderate	50.9% In AE Zone	No
M. Brookside	Low	NA	No

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Critical Infrastructure in Hazard Areas

Critical infrastructure includes facilities that are important for disaster response and evacuation (such as emergency operations centers, fire stations, water pump stations, etc.) and facilities where additional assistance might be needed during an emergency (such as nursing homes, elderly housing, day care centers, etc.). There are 131 facilities identified in Concord. These are listed in Table 23 and are shown on the maps in Appendix B.

Land

Explanation of Columns in Table 23	
Column 1: ID #:	The first column in Table 23 is an ID number which appears on the maps that are part of this plan. See Appendix B.
Column 2: Name:	The second column is the name of the site. If no name appears in this column, this information was not provided to MAPC by the community.
Column 3: Type:	The third column indicates what type of site it is.
Column 4: Landslide Risk:	The fourth column indicates the degree of landslide risk for that site. This information came from NESEC. The landslide information shows areas with either a low susceptibility or a moderate susceptibility to landslides based on mapping of geological formations. This mapping is highly general in nature. For more information on how landslide susceptibility was mapped, refer to http://pubs.usgs.gov/pp/p1183/pp1183.html .
Column 5: FEMA Flood Zone:	The fifth column addresses the risk of flooding. A “No” entry in this column means that the site is not within any of the mapped risk zones on the Flood Insurance Rate Maps (FIRM maps). If there is an entry in this column, it indicates the type of flood zone.
Column 5: Local Flooding Risk:	The sixth column indicates that the facility is located in an area identified as at risk of flooding by the local hazard mitigation team.
Column 6: Snowfall.	Areas designated "low" receive an annual average of 36.1 to 48.0 inches of snow. Areas designated "high" receive an annual average of 48.1 to 72 inches of snow, as shown on Map 6 in Appendix B.

Table 23 Critical Facilities and Relationship to Hazard Areas						
ID	NAME	TYPE	LANDSLIDE	WITHIN FEMA FLOOD ZONE	WITHIN LOCALLY IDENTIFIED AREA OF FLOODING	AVERAGE ANNUAL SNOW FALL
1	Concord Carlisle Regional High School	School	Moderate	No	No	High
2	Emerson Hospital	Hospital	Low	No	No	High
3	Alcott School	School	Moderate	No	No	High
4	Thoreau School	School	Low	No	No	High
5	Willard School	School	Moderate	No	No	High
6	Peabody Middle School	School	Low	No	No	High

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Table 23 Critical Facilities and Relationship to Hazard Areas						
ID	NAME	TYPE	LANDSLIDE	WITHIN FEMA FLOOD ZONE	WITHIN LOCALLY IDENTIFIED AREA OF FLOODING	AVERAGE ANNUAL SNOW FALL
7	Sanborn Middle School	School	Low	No	No	High
9	Concord Academy	School	Moderate	No	Concord Center	High
10	Fenn School	School	Moderate	No	No	High
11	Nashoba Brooks School	School	Low	No	No	High
12	Middlesex School	School	Low	No	No	High
13	Rivercrest Deaconess/Newbury Court	Nursing Home	Low	No	No	High
14	Walden Rehabilitation and Nursing Center	Nursing Home	Low	No	No	High
15	CVS Pharmacy	Pharmacy	Moderate	No	No	High
16	Rite-Aid Pharmacy	Pharmacy	Moderate	No	Concord Center	High
17	West Concord Pharmacy	Pharmacy	Low	AE	No	High
18	Congregation Kerem Shalom	Place of Assembly	Low	No	No	High
19	Redeemer Presbyterian Church	Place of Assembly	Moderate	No	No	High
20	First Church of Christ	Place of Assembly	Moderate	No	Concord Center	High
21	First Parish in Concord	Place of Assembly	Moderate	No	Concord Center	High
22	New Life Community Church	Place of Assembly	Moderate	No	No	High
23	Holy Family Parish	Place of Assembly	Moderate	No	Concord Center	High
24	Trinitarian Congregational Church	Place of Assembly	Moderate	No	Concord Center	High
25	Trinity Episcopal Church	Place of Assembly	Moderate	No	No	High
26	West Concord Union Church	Place of Assembly	Low	No	No	High
27	Concord Municipal Light Plant	Utility	Low	No	No	High
28	Concord Public Works	DPW	Low	X500	No	High

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Table 23 Critical Facilities and Relationship to Hazard Areas						
ID	NAME	TYPE	LANDSLIDE	WITHIN FEMA FLOOD ZONE	WITHIN LOCALLY IDENTIFIED AREA OF FLOODING	AVERAGE ANNUAL SNOW FALL
29	Concord Town House	Town Hall	Moderate	No	Concord Center	High
30	Concord Planning & Land Management	Municipal	Moderate	AE	Concord Center	High
31	Concord Police Department	Police	Moderate	AE	Police/Fire Station	High
32	State Police Concord	Police	Low	No	No	High
33	Concord Fire Department	Fire	Low	No	No	High
34	Concord Fire Department	Fire	Moderate	AE	Police/Fire Station	High
35	A Place to Grow at Concord Day Care	Daycare	Moderate	No	No	High
36	Hunt After-School Center	Daycare	Moderate	No	No	High
37	Concord Carousel Day Care	Daycare	Low	No	No	High
38	Concord Children's Center #1	Daycare	Low	No	No	High
39	Concord Children's Center #2	Daycare	Moderate	No	No	High
40	Concord Children's Center #3	Daycare	Low	No	No	High
41	Concord Recreation After School Program	Daycare	Low	No	No	High
42	Holt-Tuttle, Diane F. Day Care	Daycare	Moderate	No	No	High
43	LEAP School at Concord	Daycare	Moderate	No	Concord Center	High
44	Milldam Nursery School	Daycare	Moderate	No	Concord Center	High
45	Minute Man ARC for Human Services, Inc.	Daycare	Low	X500	No	High
46	Simpson, Phyllis E. Day Care	Daycare	Low	No	No	High
47	The Barn Coop Nursery School	Daycare	Moderate	No	Concord Center	High
48	The Children's Meetinghouse Day Care	Daycare	Low	No	No	High
49	Umina, Catherine Day Care	Daycare	Low	No	No	High

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Table 23 Critical Facilities and Relationship to Hazard Areas						
ID	NAME	TYPE	LANDSLIDE	WITHIN FEMA FLOOD ZONE	WITHIN LOCALLY IDENTIFIED AREA OF FLOODING	AVERAGE ANNUAL SNOW FALL
50	MC-Concord	Correctional Facility	Low	No	No	High
51	Northeastern Correctional Center	Correctional Facility	Low	No	No	High
52	Walden Street School for Girls	School	Moderate	No	No	High
53	Annursnac Hill Tower	Communication	Low	No	No	High
54	Annursnac Hill Repeater Tower	Repeater Tower	Low	No	No	High
55	Annursnac Hill Water Tank	Water Tank	Low	No	No	High
56	Concord District Court	Courthouse	Moderate	AE	No	High
57	Hugh Cargill Water Pump Station	Water Pumping Station	Moderate	No	No	High
58	Robinson Water Pump Station	Water Pumping Station	Moderate	No	No	High
59	Robinson Public Well	Well	Moderate	AE	No	High
60	Rt. 2A Water Pump Station	Water Pumping Station	Low	No	No	High
61	Nagog Water Treatment Plant	Water Treatment Plant	Low	No	No	High
62	Second Division Water Pump Station	Water Pumping Station	Low	No	No	High
63	White Pond Water Pump Station	Water Pumping Station	Moderate	No	No	High
64	Jennie Duggan Water Treatment Plant	Water Pumping Station	Low	No	No	High
65	Deaconess Water Pump Station	Water Pumping Station	Low	X500	No	High
66	Pine Hill Reservoir	Reservoir	Moderate	No	No	High
67	Concord Wastewater Treatment Facility	Wastewater Treatment Plant	Moderate	No	No	High
68	Bedford Street Sewer Pump Station	Wastewater Pump Station	Moderate	No	No	High
69	Lowell Road Sewer Pump Station	Sewer Pumping Station	Moderate	AE	Lowell Road Sewer Pump Station / Concord Center	High
70	Concord Water/Sewer/Highway Department	Municipal	Moderate	X500	Concord Center	High

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Table 23 Critical Facilities and Relationship to Hazard Areas						
ID	NAME	TYPE	LANDSLIDE	WITHIN FEMA FLOOD ZONE	WITHIN LOCALLY IDENTIFIED AREA OF FLOODING	AVERAGE ANNUAL SNOW FALL
71	Laurel Street Sewer Pump Station	Sewer Pumping Station	Moderate	AE	No	High
72	Assabet Sewer Pump Station	Sewer Pumping Station	Low	No	No	High
73	Cousins Park Sewer Pump Station	Sewer Pumping Station	Low	No	No	High
74	Park Lane Sewer Pump Station	Sewer Pumping Station	Low	X500	No	High
75	Pilgrim Road Sewer Pump Station	Sewer Pumping Station	Moderate	No	No	High
76	Gifford Land Sewer Pump Station	Sewer Pumping Station	Low	No	No	High
77	Harvey Wheeler Community Center	Place of Assembly	Low	No	No	High
78	Concord Health Care	Nursing Home	Low	No	No	High
79	Mobil Gas Station	HazMat	Moderate	No	Cambridge Turnpike	High
80	Sudbury Road Mobil Gas Station	HazMat	Moderate	No	No	High
81	Cumberland Farm Gas Station	HazMat	Moderate	No	No	High
82	Commonwealth Avenue Gulf Gas Station	HazMat	Low	No	No	High
83	Colonial Motors Gas Station	HazMat	Low	No	No	High
84	Gas Station	HazMat	Moderate	No	No	High
85	Main Street Mobil	HazMat	Low	No	No	High
86	Concord Oil Company	HazMat	Moderate	AE	Concord Center	High
87	Exxon Gas Station	HazMat	Low	No	No	High
88	Citco Gas Station	Gas Station	Moderate	AE	Concord Center	High
89	Concord Park Assisted Living	Assisted Living	Low	No	No	High
90	Warners Pond Dam	Dam	Low	AE	No	High
91	Kennedy's Pond Dam	Dam	Low	No	Harrington Avenue	High

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Table 23 Critical Facilities and Relationship to Hazard Areas						
ID	NAME	TYPE	LANDSLIDE	WITHIN FEMA FLOOD ZONE	WITHIN LOCALLY IDENTIFIED AREA OF FLOODING	AVERAGE ANNUAL SNOW FALL
92	Damondale Dam	Dam	Low	AE	AE	High
93	Harrington Ave Dam	Dam	Low	AE	AE	High
94	Lower Musquetaquid Pond Dam	Dam	Low	No	No	High
95	Upper Musquetaquid Pond Dam	Dam	Low	No	No	High
96	Batemans Pond Dam	Dam	Low	No	No	High
97	Barretts Mill Road Dam	Dam	Low	A	Barretts Mill Road east of Strawberry Hill Road	High
98	Dakin Brook Dam	Dam	Low	AE	No	High
99	Crosby Brook Dam	Dam	Moderate	AE	Crosby Pond	High
100	Pine Street Bridge	Town-Owned Bridge	Low	AE	Pine Street Bridge	High
101	Sudbury Road - Heath's Bridge	Town-Owned Bridge	Moderate	AE	Sudbury Road - Heath's Bridge	High
102	Nashawtuc Road - Nashawtuc Bridge	Town-Owned Bridge	Moderate	X500	Nashawtuc Road	High
103	Monument Street - Flint's Bridge	Town-Owned Bridge	Moderate	AE	No	High
104	Main Street Bridge between Elm and Wood	State-Owned Bridge	Moderate	AE	No	High
105	Route 2 Bridge over Sudbury River	State-Owned Bridge	Moderate	AE	Route 2 Bridge over Sudbury River	High
106	Main Street Bridge near Derby	State-Owned Bridge	Low	AE	No	High
107	Little Sprouts Day Care Center	Day Care	Low	No	No	High
108	Concord Montessori	School	Low	No	No	High
109	Guild School/Baypath College	School	Moderate	No	No	High
110	Dialysis Clinic, Inc.	Medical Facility	Low	.2% chance	No	High
113	Concord Housing Authority/Peter Bulkeley	Housing	Moderate	No	No	High
114	Concord Housing Authority/Everett Gardens	Housing	Moderate	No	No	High

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Table 23 Critical Facilities and Relationship to Hazard Areas						
ID	NAME	TYPE	LANDSLIDE	WITHIN FEMA FLOOD ZONE	WITHIN LOCALLY IDENTIFIED AREA OF FLOODING	AVERAGE ANNUAL SNOW FALL
115	Marriott Extended Stay	Hotel	Low	AE	No	High
116	Best Western	Hotel	Low	No	No	High
117	Fiber Node Point	Utility	Low	No	No	High
118	Public School Bus Depot	Transportation	Low	No	No	High
119	Concord MBTA Station	Transportation	Moderate	No	No	High
120	West Concord MBTA Station	Transportation	Low	No	No	High
121	Rectrix	Hazardous Materials	Moderate	No	No	High
122	The New Church	Place of Assembly	Low	No	No	High
123	Harvard Vanguard	Medical Facility	Low	AE	No	High
124	Emerson Specialty Care	Medical Facility	Low	No	No	High
125	Emerson Specialty Care	Medical Facility	Low	No	No	High
126	300 Baker offices	Office	Low	AE	No	High
127	Emerson Hospital PT/Labs	Medical Facility	Low	AE	No	High
128	Minuteman National Park Hdq.	Park Hdq.	Moderate	No	No	High
129	Walden Pond Reservation Hdq./State Police Mounted Unit	Park Hdq.	Moderate	No	No	High
130	Concord Museum	Museum	Moderate	No	No	High
131	Powder Mill Dam (in Acton, MA)	Dam	Low	AE	No	High

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Vulnerability Assessment

The purpose of the vulnerability assessment is to estimate the extent of potential damages from natural hazards of varying types and intensities. A vulnerability assessment and estimation of damages was performed for hurricanes, earthquakes, and flooding. The methodology used for hurricanes and earthquakes was the HAZUS-MH software. The methodology for flooding was developed specifically to address the issue in many of the communities where flooding was not solely related to location within a floodplain.

Introduction to HAZUS-MH

HAZUS-MH (multiple-hazards) is a computer program developed by FEMA to estimate losses due to a variety of natural hazards. The following overview of HAZUS-MH is taken from the FEMA website. For more information on the HAZUS-MH software, go to <http://www.fema.gov/plan/prevent/hazus/index.shtm>

“HAZUS-MH is a nationally applicable standardized methodology and software program that contains models for estimating potential losses from earthquakes, floods, and hurricane winds. HAZUS-MH was developed by the Federal Emergency Management Agency (FEMA) under contract with the National Institute of Building Sciences (NIBS). Loss estimates produced by HAZUS-MH are based on current scientific and engineering knowledge of the effects of hurricane winds, floods and earthquakes. Estimating losses is essential to decision-making at all levels of government, providing a basis for developing and evaluating mitigation plans and policies as well as emergency preparedness, response and recovery planning.

HAZUS-MH uses state-of-the-art geographic information system (GIS) software to map and display hazard data and the results of damage and economic loss estimates for buildings and infrastructure. It also allows users to estimate the impacts of hurricane winds, floods and earthquakes on populations.”

There are three modules included with the HAZUS-MH software: hurricane wind, flooding, and earthquakes. There are also three levels at which HAZUS-MH can be run. Level 1 uses national baseline data and is the quickest way to begin the risk assessment process. The analysis that follows was completed using Level 1 data. Level 1 relies upon default data on building types, utilities, transportation, etc. from national databases as well as census data. While the databases include a wealth of information on the Town of Concord, it does not capture all relevant information. In fact, the HAZUS-MH training manual notes that the default data is “subject to a great deal of uncertainty.”

However, for the purposes of this plan, the analysis is useful. This plan is attempting to generally indicate the possible extent of damages due to certain types of natural disasters and to allow for a comparison between different types of disasters. Therefore, this analysis should be considered to be a starting point for understanding potential damages from the hazards.

Estimated Damages from Hurricanes

The HAZUS-MH 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

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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.

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.

Table 24 Estimated Damages from Hurricanes

	100 Year	500 Year
Building Characteristics		
Estimated total number of buildings	6,555	
Estimated total building replacement value (2006 \$)	\$3,143,000	
Building Damages		
# of buildings sustaining minor damage	128	832
# of buildings sustaining moderate damage	8	115
# of buildings sustaining severe damage	0	5
# of buildings destroyed	0	2
Population Needs		
# of households displaced	0	2
# of people seeking public shelter	0	0
Debris		
Building debris generated (tons)	2,491	7,940
Tree debris generated (tons)	5,285	13,629
# of truckloads to clear building debris	22	118
Value of Damages		
Total property damage (buildings and content)	\$ 15,006,000	\$51,678,000
Total losses due to business interruption	\$ 419,570	\$3,032,000

Estimated Damages from Earthquakes

The HAZUS-MH 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, two earthquakes were selected: magnitude 5.0 and a magnitude 7.0. Historically, major earthquakes are rare in New England, though a magnitude 5 event occurred in 1963.

Table 24 Estimated Damages from Earthquakes

	Magnitude 5.0	Magnitude 7.0
Building Characteristics		
Estimated total number of buildings	6,555	
Estimated total building replacement value (2006 \$)	\$3,143,000	

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Building Damages		
# of buildings sustaining slight damage	1,904	211
# of buildings sustaining moderate damage	1,045	1,368
# of buildings sustaining extensive damage	297	1,863
# of buildings completely damaged	77	3,098
Population Needs		
# of households displaced	238	3,490
# of people seeking public shelter	121	1,773
Debris		
Building debris generated (tons)	80,000	610,000
# of truckloads to clear debris (@ 25 tons/truck)	3,160	24,200
Value of Damages		
Total property damage	\$385,390,000	\$2,846,440,000
Total losses due to business interruption	\$ 87,730,000	\$463,660,000

Estimated Damages from Flooding

The Hazus-MH flood risk module was used to estimate damages to the municipality at the 100 and 500 return periods. These return periods correspond to flooding events that have a 1% and a 0.2% likelihood of occurring in any given year.

Table 26 Estimated Damages from Flooding

	100 Year	500 Year
Building Characteristics		
Estimated total number of buildings	6,555	
Estimated total building replacement value (2006 \$)	\$3,143,000	
Building Damages		
# of buildings sustaining slight damage (<10%)	57	50
# of buildings sustaining moderate damage (10-50%)	92	100
# of buildings sustaining substantial damage (>50%)	0	0
Population Needs		
# of households displaced	228	111
# of people seeking public shelter	389	64
Value of Damages		
Total property damage (buildings and content)	\$ 52,850,000	\$70,460,000
Total losses due to business interruption	\$ 590,000	\$ 690,000

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V. HAZARD MITIGATION GOALS

The Concord Local Hazard Mitigation Planning Team reviewed and discussed the goals from the 2010 Hazard Mitigation Plan for the Town of Concord. All of the goals were found to continue to be reflective of the Town's priorities and concerns relative to natural hazard mitigation. All of the goals are considered critical for the Town and they are not listed in order of importance.

Goal 1: Prevent and reduce the loss of life, injury, public health impacts and property damages resulting from all major natural hazards.

Goal 2: Identify and seek funding for measures to mitigate or eliminate each known significant flood hazard area.

Goal 3: Integrate hazard mitigation planning as an integral factor in all relevant municipal departments, committees and boards.

Goal 4: Prevent and reduce the damage to public infrastructure resulting from all hazards.

Goal 5: Encourage the business community, major institutions and non-profits to work with the Town to develop, review and implement the hazard mitigation plan.

Goal 6: Work with surrounding communities, state, regional and federal agencies to ensure regional cooperation and solutions for hazards affecting multiple communities.

Goal 7: Ensure that future development meets federal, state and local standards for preventing and reducing the impacts of natural hazards.

Goal 8: Take maximum advantage of resources from FEMA and MEMA to educate Town staff and the public about hazard mitigation.

Goal 9: Consider the potential impacts of future climate change. Incorporate climate sustainability and resiliency in hazard mitigation planning.

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VI. EXISTING MITIGATION MEASURES

The existing protections in the Town of Concord are a combination of zoning, land use, and environmental regulations, infrastructure maintenance and drainage infrastructure improvement projects. Infrastructure maintenance generally addresses localized drainage clogging problems, while large scale capacity problems may require pipe replacement or invert elevation modifications. These more expensive projects are subject to the capital budget process and lack of funding is one of the biggest obstacles to completion of some of these.

The Town's existing mitigation measures, from the original 2010 Plan, are listed by hazard type here and are summarized in Table 27 below.

Flooding – Existing Town-Wide

Concord employs a number of practices to help minimize potential flooding and impacts from flooding, and to maintain existing drainage infrastructure. Existing town-wide mitigation measures include the following:

National Flood Insurance Program (NFIP) – Concord participates in the NFIP with 136 policies in force as of the November 30, 2016. FEMA maintains a database on flood insurance policies and claims. This database can be found on the FEMA website at <http://bsa.nfipstat.fema.gov/reports/1011.htm#MAT>.

The following information is provided for the Town of Concord:

Flood insurance policies in force (as of November 30, 2016)	127
Coverage amount of flood insurance policies	\$41,103,400
Premiums paid	\$173,408
Total losses (all losses submitted regardless of the status)	60
Closed losses (Losses that have been paid)	45
Open losses (Losses that have not been paid in full)	0
CWOP losses (Losses that have been closed without payment)	15
Total payments (Total amount paid on losses)	\$372,955.95

The Town complies with the NFIP by enforcing floodplain regulations, maintaining up-to-date floodplain maps, and providing information to property owners and builders regarding floodplains and building requirements.

Massachusetts State Building Code - The Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing, and snow loads. The town has adopted the state building code.

GIS inventory - Engineering staff developed a Drainage System Inventory and integrated the data into the Town's Geographical Information System (GIS).

Catch basins and street sweeping - Catch basins on public roads and property are cleaned annually. Street sweeping also occurs on an annual basis, and more often in the village center areas.

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Infrastructure maintenance - The Public Works Department provides maintenance to culverts, drainage pipes, and other drainage infrastructure on an as-needed basis. Drainage maintenance activities are coordinated with the Division of Natural Resources and are performed under the general maintenance permit issued by the Natural Resources Commission.

Stormwater/Drainage Upgrade Plan - The town has established a multi-year program to fund and improve drainage and has a 20 Year Stormwater/Drainage Management Plan to address a backlog of deferred repairs and the need for replacement of approximately 17 large culverts. Recent drainage improvement projects have been completed or are near completion at Valley Road, Hayward Mill Road, Williams Road, Fairhaven Road, Spring Road, Lowell Road, Walden Pond, Commerford Road, Main Street, Keyes Road, Cottage Lane, Warner's Pond Dam, and the Mill Dam culvert. Reconstruction of Heath's Bridge at the Sudbury River is underway, and Mass Highway is in the process of designs to repair Flint's Bridge and the Pine Street Bridge.

Beaver mitigation - The Town mitigates for beavers on a case-by-case basis. The town will use a trapper as necessary if there is an immediate threat and is a public health issue. A permit to do so is required by state law through the local Board of Health. In some instances pond levels will be lowered in anticipation of potential flooding. In other instances, water flow devices will be installed by Public Works, such as at Hutchins Pond in 2004. The town uses an interdepartmental approach to deal with beavers.

Flood Plain Conservancy District - Concord's Zoning has a Flood Plain Conservancy District (Section 7.2) that restricts certain activities and requires a special permit for activities located within a flood zone.

Wetlands Conservancy District - Concord's Zoning has a Wetlands Conservancy District, intended to protect wetland resource areas and minimize flooding (Section 7.3).

Stormwater policy - The Massachusetts Stormwater Policy is applied to developments within the jurisdiction of the Natural Resources Commission.

Subdivision regulations - The Town's subdivision regulations have general language about avoiding impacts to flood plains and minimizing drainage issues. Peak flows and runoff from the property cannot be greater than pre-development rates. Drainage requirements for Site Plans are also general and require post-development rates to meet pre-development runoff rates.

Open space development - Open Space Residential Developments are allowed under Concord's Zoning.

Groundwater Conservancy District - The Town's Zoning also has a Groundwater Conservancy District to protect its drinking water supplies.

Open space protection - Concord has substantial protected open space and proactive land acquisition and preservation programs, including:

- The town's Open Space Plan, Long-Range Plan, and Community Preservation Plan are comprehensive and identify key parcels for purchase or protection.
- The town adopted the Community Preservation Act with a 1.5% surcharge in 2004.

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- Low-lying wetland areas provide significant flood storage for the town's rivers.
- Flood plain has been preserved and is effective at minimizing flooding.
- The Natural Resources Commission, Concord Land Conservation Trust, and Concord Land Foundation help oversee conservation areas in the town.
- The Community Preservation Committee helps administer the Community Preservation Act, and developed a Community Preservation Plan in 2008.

NPDES stormwater - The town continues to implement its NPDES Phase II stormwater program which includes public education programs.

Flooding – Existing Site Specific Mitigation

Pine Street Bridge -The Pine Street Bridge over the Assabet River has been closed in the past due to flooding (approximately once every 5 years). If any upstream dams were to give way, the impacts to this bridge would be of concern. Tree stumps in the river wear on the bridge and the banks are eroded. As of the 2017 update, The bridge has been upgraded so that weight restrictions no longer apply.

Commonwealth Avenue at Warners Pond -This site at Commonwealth Avenue up to Maple Court has experienced flooding caused by Warner's Pond. Warner's Pond dam is currently being reconstructed and therefore flooding at this site will be greatly reduced due to better control of the dam.

Pedestrian Bridge at Warner's Pond - This pedestrian bridge behind the Warner's Pond dam connecting Winthrop to Commonwealth Avenue is old and of concern due to scouring. This issue should improve upon completion of the Warner's Pond Dam upgrades. Warner's Pond dam is currently being reconstructed and therefore flooding at this site will be greatly reduced due to better control of the dam.

Sudbury Road – Heath's Bridge - Heath's Bridge over the Sudbury River has caused water backing up to houses, but so far it has not impacted the structures. The town has had to redirect traffic in the Sudbury and Oxbow Drive areas. This site does have potential for property damage, but this has not yet occurred. The flooding occurs during the wet season or during a major storm such as a hurricane. This bridge is currently being reconstructed by the state.

Concord Center - The Concord Center Area is located within the floodplain where the Assabet, Sudbury and Concord Rivers converge, as well as the culverted Mill Brook enters the Concord River. Mill Brook runs under the buildings, many of which are historic. This area floods around once every 10 years. Basements have been impacted, access has been restricted, roads have closed, and floor drains have backed up. A collapse of the culverted brook could greatly impact buildings, which is of great concern to the town. The Mill Dam culvert under Main Street is currently being rehabilitated by the Department of Public Works.

Cambridge Turnpike - The Cambridge Turnpike experiences flooding every year over approximately a 2-mile stretch. It had two road closures in 2006 due to rising water levels. The water damages the road bed and the town has spent money to keep repairing the bed, which is constructed on peat moss. Beaver dams in the area also worsen the flooding. The town has used beaver deceivers to mitigate for beaver activity in the area. Improvements to the Crosby Dam

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will also help alleviate some of the flooding (see Crosby Pond discussion below), however, a complete solution would require significant culvert upgrades and raising of the road bed. Work is scheduled to commence in 2017.

Nashawtuc Road – Nashawtuc Bridge - This town-owned bridge is an area of concern due to the failure of its sidewalls and the large debris dams that form during a flood. Jersey barriers have been temporarily installed to maintain the integrity of the side walls. Professional engineering services were solicited by the town and a report was provided to investigate the movement along the parapet walls and to provide recommendations for any proposed repairs. Repairs are complete as of the 2017 update.

Crosby Pond - Crosby Pond and dam, located adjacent the Cambridge Turnpike, have flooded and exacerbated the flooding at Cambridge Turnpike. In addition, beaver activity has worsened the situation. The dam is in poor condition due to infiltration through the earthen dam, and trees growing in the embankment. The town has lowered pond levels in the past in anticipation of flooding, however, the owner is currently in the process of upgrading the dam per court order.

Monument Street – Flint’s Bridge – As of the 2017 update, the bridge has been upgraded so that weight restrictions no longer apply.

Existing Dam Failure Mitigation Measures

DCR dam safety regulations – In 2002 the Massachusetts legislature enacted revisions of the Dam Safety Statute, MGL Chapter 253 §§ 44-50, which significantly changes the responsibilities of dam owners to register, inspect and maintain dams in good operating condition. Amendments to Dam Safety Regulations 302 CMR 10.00-10.16 became effective November 4, 2005 and are reflective of the statutory changes. MGL Chapter 253 and 302 CMR 10.00 requires Emergency Action Plans be prepared, maintained and updated by dam owners, for High Hazard Potential dams and certain Significant Hazard Potential dams.

Dam Failure – Existing Site Specific Mitigation

Warner’s Pond Dam – Warner’s Pond Dam, located in West Concord tributary to the Assabet River, is town-owned and has caused flooding of downstream properties in the past. Upstream issues in neighboring towns have led to siltation and filling of the pond. This dam is currently in the process of being repaired following local studies that determined the dam was in poor condition. Reconstruction is complete as of the 2017 update to this plan.

Crosby Pond Dam - Crosby Pond and dam, located adjacent the Cambridge Turnpike, have flooded and exacerbated the flooding at Cambridge Turnpike. In addition, beaver activity has worsened the situation. The lengthy dam is privately-owned and is in poor condition due to infiltration through the earthen dam, and trees growing in the embankment. The town has lowered pond levels in the past in anticipation of flooding, however, the owner is currently in the process of upgrading the dam per court order.

Existing Wind Hazard Mitigation Measures

Massachusetts State Building Code – The town enforces the Massachusetts State Building Code whose provisions are generally adequate to mitigate against most wind damage. The code’s

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provisions are the most cost-effective mitigation measure against tornados given the extremely low probability of occurrence. If a tornado were to occur, the potential for severe damages would be extremely high.

Tree trimming - The Public Works Department has an effective tree trimming in public areas and along Rights-of-Ways. They have a multi-year plan trimming program (approximately a 3 year cycle) to go over their whole system. The Concord Municipal Light Department also effectively maintains trees around the wires and substations and will occasionally take down a tree on private property. They have a multi-year plan trimming program (approximately a 3 year cycle) to go over their whole system.

Underground utilities - New developments must install buried utilities. The town currently has 40% of its wires installed underground , and is slowly retroactively burying wires where street work is underway for other purposes.

Existing Winter Hazard Mitigation Measures

Snow removal - The Public Works Department provides standard snow plowing operations, including salting and sanding, but with a restricted salt policy. They also are in the process of using a brine solution. The town has a Snow and Ice Disposal bylaw that states no person shall put any snow or ice in any public place or upon any part of a public street or sidewalk. The town has sufficient snow storage – one site is at the former landfill and the other is at the prison

Parking - Overnight parking bans are in effect from November 1 – April 1.

Public Education - Winter Maintenance information is available on the town website. The Town provides public education to residents regarding roof collapses due to snow when conditions are dangerous. The town works with the Chamber of Commerce to get the word out, such as via email. In addition, new codes are more stringent to better guard against roof collapses.

Existing Brush Fire Hazard Mitigation Measures

Permits for opening burning - Town bylaws allow controlled open burning in accordance with state regulations, but a permit is required from the Fire Chief for each day of intended burning.

Review of development plans - The Fire department reviews all subdivision and site plans for compliance with site access, water supply needs, and all other applicable regulations.

Public education - The Fire Department maintains a website with substantial public education on fire prevention at: <http://www.concordnet.org/166/Fire-Rescue>. The town provides public education and notices during “drought watches.”

Site specific training - The Fire Department is trained for protecting the Federal Wildlife Preserve and the National Park.

Equipment - The Concord Fire Department obtained a new brush truck in 2006.

Existing Geologic Hazard Mitigation Measures

Earthquakes

Massachusetts State Building Code – The State Building Code, updated in 2010, contains a section on designing for earthquake loads (780 CMR 1612.0). Section 1612.1 states that the purpose of

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these provisions is “to minimize the hazard to life to occupants of all buildings and non-building structures, to increase the expected performance of higher occupancy structures as compared to ordinary structures, and to improve the capability of essential facilities to function during and after an earthquake”. This section goes on to state that due to the complexity of seismic design, the criteria presented are the minimum considered to be “prudent and economically justified” for the protection of life safety. The code also states that absolute safety and prevention of damage, even in an earthquake event with a reasonable probability of occurrence, cannot be achieved economically for most buildings.

Section 1612.2.5 sets up seismic hazard exposure groups and assigns all buildings to one of these groups according to Table 1612.2.5. Group II includes buildings which have a substantial public hazard due to occupancy or use and Group III are those buildings having essential facilities which are required for post-earthquake recovery, including fire, rescue and police stations, emergency rooms, power-generating facilities, and communications facilities.

Shelters - The town does have shelters and backup facilities (see multi-hazard mitigation below).

Water system protection - The Concord Water Department is proactive in being able to isolate portions of the water system and identify alternative firefighting water supply sources.

Evacuation plan - The town does have an evacuation plan as specified in its Comprehensive Emergency Management Plan (CEMP).

Landslides

Maximum slope requirements - The subdivision regulations do have maximum slope requirements for new roads.

Earth removal bylaw - The town has an earth removal bylaw.

Other Hazards – Bridge Weight Restrictions

The town of Concord has many bridges that cross the numerous waterways throughout the town. Many of these bridges are older structures that are not rated for the weights of the emergency vehicles such as fire trucks. As a result, the Fire Department must take alternate routes around these bridges to reach an emergency situation that can be a detour of up to 3 miles. This greatly hinders the emergency response efficiency for a natural hazard or any other emergency.

The three bridges of greatest concern are as follows. Please note the numbers in parentheses refer to the Areas of Concern located on map 8 in Appendix A.

Existing Site Specific Mitigation

Pine Street Bridge – This bridge adds a two mile detour for emergency vehicles. Upgrades are complete as of the 2017 update; detours are no longer required.

Flint’s Bridge on Monument Street – This bridge has a 6 ton rating and a detour of 3 miles. This detour happens approximately 2-3 times per week. Upgrades are complete as of the 2017 update; detours are no longer required.

Main Street Bridge between Elm & Wood – This bridge has a 7 ton rating and adds a 2 mile detour. This detour happens several times per week.

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EXISTING MULTHAZARD MITIGATION MEASURES

The Town of Concord has several mitigation measures in place that address more than one hazard. In general the town has a very thorough emergency response process, however, the challenge it faces is sheltering for residents and a number of non-traditional groups. The high school provides shelter, but it does not have a generator. The town also must coordinate options for shelters for the elderly, Emerson hospital, the prisons, and even farm animals. The following describes the measures that are in place to mitigate for multiple hazards:

Multi-Department Review of Developments – Multiple departments, such as Planning, Zoning, Health, Public Works, Fire, Police, and Natural Resources, review all subdivision and site plans prior to approval.

Comprehensive Emergency Management Plan (CEMP) – Every community in Massachusetts is required to have a Comprehensive Emergency Management Plan. These plans address mitigation, preparedness, response and recovery from a variety of natural and man-made emergencies. These plans contain important information regarding flooding, dam failures and winter storms. Therefore, the CEMP is a mitigation measure that is relevant to many of the hazards discussed in this plan. The CEMP is available online through secure access for town personnel.

Enforcement of the State Building Code – The Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing and snow loads.

Local Emergency Management Planning Committee (LEPC) – The LEPC consists of representatives from Public Works, Fire, Police, Health, School Transportation, Select Board, Emergency Management, Emerson Hospital, MCI-Concord, and local businesses. Concord is also part of a CrossRoads Regional Emergency Management Planning Committee (REPC) that consists of the towns of Acton, Lincoln, Weston, Wayland, Sudbury and Concord.

Emergency Preparedness - Public education is available on the town's website. The town has a reverse 911 system and names can be added to the database via the town's website. The Carlisle/Concord High School is the designated community shelter site, although it currently does not have a generator. The Police and Fire Stations have a backup generator, but it runs on natural gas and would be inoperable in the event that the gas system was to go down. They do have backup diesel generators, but these are not as powerful. The town has a Citizen Emergency Response Team (CERT) that provides training, supplies, and public education to neighborhoods. The town also has a Medical Reserve Corps. The town has a critical responder shelter center.

Gas Leaks - El Paso Tenneco Energy Company flies helicopter routinely and monitors flow and looks for leaks and damage in its natural gas line.

Heat emergencies - The town works with the Council on Aging to help provide shelter to the elderly during extreme heat.

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Climate Change

To address climate change at the local level, Concord is pursuing a number of measures to reduce greenhouse gases. In 2007, the Town established the Comprehensive Sustainable Energy Committee. The overall purpose of the committee is to assist the Town in identifying, designing, and implementing programs and projects for fostering energy conservation, efficiency, and renewable-energy generation.

The Town of Concord has been designated by the state as a “Green Community”. Major projects completed include replacement of aging boilers at the Peabody and Sanborn School, the HVAC system at Hunt Gymnasium, the dehumidification system at the Beede Center and solar panel installation at Willard School. Other projects have included lighting upgrades and weatherization/insulation at town facilities. A \$1.7 million gift from a town resident provided significant support for many of the town’s energy efficiency projects. Through a state grant and town funds, the Town established a program that provided weatherization rebates for homeowners with heating systems other than natural gas. Natural gas homeowners continued participation in the state MassSAVE program.

From 2008 to 2016, through specific projects and a workplace energy conservation campaign, the town reduced electricity consumption by 14% in municipal facilities and streetlights.

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Table 27 EXISTING MITIGATION MEASURES

Hazard	Area	Mitigation Measure	Update/Comments
Flood-Related	Town-Wide	The town participates in the National Flood Insurance Program and has adopted the effective FIRM maps. The town actively enforces the floodplain regulations.	Effective
		The Town enforces the Massachusetts Building Code	Effective
		Stormwater system is mapped in GIS	Effective
		Annual catch basin cleaning and street sweeping	Effective
		Drainage system maintenance under permit with Natural Resources Commission	Effective
		Long-term stormwater plan and funding, and ongoing system improvements	Effective, six projects, including 10 culvert replacements completed.
		Beaver mitigation	Effective
		Flood Plain Conservancy District	Effective
		Wetlands Conservancy District	Effective
		Massachusetts Stormwater Policy	Effective
		Stormwater Requirements in Subdivision Regulations and Site Plan Review	Effective, stormwater regulations were updated in 2012
		Open Space Residential Developments allowed	Effective
		Groundwater Conservancy District	Effective
		Protected open space and proactive land preservation programs	Effective, two 80-acre sites were protected.
	Public Education on stormwater through the NPDES Phase II program	Effective	
	Pine Street Bridge	Under reconstruction by the state for structural upgrades, not necessarily to improve water flow	Complete
	Commonwealth Ave at Warner's Pond	Warner's Pond Dam is currently under reconstruction, which will help alleviate flooding at this location.	Complete, (privately owned)
Pedestrian Bridge at Warner's Pond	Warner's Pond Dam is currently under reconstruction, which will help alleviate flooding at this location.	Complete, (privately owned)	
Sudbury Road – Heath's Bridge	Under reconstruction by the state	Complete	
Concord Center	The Mill Dam culvert under Main	Complete	

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Table 27 EXISTING MITIGATION MEASURES

Hazard	Area	Mitigation Measure	Update/Comments
		street is currently being rehabilitated.	
	Cambridge Turnpike	Future improvements to Crosby Dam (private owner) will help alleviate some flooding at the Cambridge Turnpike.	On-going, under the supervision of the Office of Dam Safety
	Nashawtuc Road-Nashawtuc Bridge	Jersey barriers have been installed to maintain the side walls. Professional engineering services are being solicited by the town for proposed repairs.	Complete
	Crosby Pond	Town has lowered pond levels in anticipation of flooding. The owner is currently in the process of upgrading the dam.	On-going, under the supervision of the Office of Dam Safety
	Monument Street – Flint’s Bridge (26)	This bridge is scheduled for upgrades by the state.	Complete
Dams	Town-Wide	DCR Dam Safety Regulations	Effective
	Warner’s Pond Dam	Currently being reconstructed	Complete, (privately owned)
	Crosby Pond Dam	Town has lowered pond levels in anticipation of flooding. The owner is currently in the process of upgrading the dam.	On-going, under the supervision of the Office of Dam Safety
Wind-Related	Town-Wide	Enforcement of the Massachusetts Building Code.	Effective
		Tree Maintenance Program by Public Works and by Concord Municipal Light.	Effective (see new mitigation measures)
		Requirement for new developments to install underground utilities. Town continually removing existing overhead wires and installing them underground	Effective
Winter-Related	Town-Wide	<ul style="list-style-type: none"> A) Standard snow operations, restricted salt B) Overnight parking ban November – April C) Public Education on snow operations and winter maintenance is on the town website D) Snow and Ice Disposal Bylaw E) Public Education on how to prevent roof collapses from snow loads F) Sufficient space for municipal snow storage 	<p>Effective</p> <p>F – see new mitigation measures</p>

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Table 27 EXISTING MITIGATION MEASURES

Hazard	Area	Mitigation Measure	Update/Comments
Fire-Related	Town-Wide	A) Open burning permits required B) Fire Department reviews all development plans C) Fire Department provides public education on its website D) Fire Department is trained for protecting the Federal Wildlife Preserve and National Park E) Fire department obtained new brush fire vehicle in 2006 F) Town provides public education on drought watches	Effective
Geologic - Earthquake	Town-Wide	Shelters and backup facilities available (see multi-hazard mitigation below)	See multi-hazard mitigation below
		Water Department able to isolate portion of the water system and identify alternate firefighting supply sources	Effective
		Evacuation plan in CEMP	Effective
Geologic - Landslides	Town-Wide	Maximum slopes for subdivision roads	Effective
		Earth Removal Bylaw	Effective
Other – Bridge Weight Restrictions	Pine Street Bridge (2)	Currently being upgraded by the state	Complete
	Flint’s Bridge on Monument Street (26)	Scheduled for upgrades by the state	Complete
	Main Street Bridge b/t Elm and Wood	No planned upgrades underway	Not done (see future mitigation)
Multi-Hazard	Town-Wide	A) Multi-department review of developments B) Comprehensive Emergency Management Plan (CEMP) C) Enforcement of State Building Code D) Local Emergency Management Planning Committee (LEPC) and CrossRoads Regional Emergency Management Committee (REPC) E) Emergency Preparedness public education on the town website F) Reverse 911 G) Carlisle/Concord High School is designated as a community shelter (although it has no generator) H) Police and Fire Stations have	Effective G) Harvey Wheeler Community Center is new shelter

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Table 27 EXISTING MITIGATION MEASURES

Hazard	Area	Mitigation Measure	Update/Comments
		backup generators (although they are on natural gas or are limited diesel) I) Citizen Emergency Response Team (CERT) J) Medical Reserve Corps K) El Paso Tenneco Energy company monitors its gas line L) Sheltering available for elderly during extreme heat	

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Mitigation Capabilities and Local Capacity for Improvements

Under the Massachusetts system of “Home Rule,” the Town of Concord is authorized to adopt and from time to time amend a number of local bylaws and regulations that support the town’s capabilities to mitigate natural hazards. These include Zoning Bylaws, Subdivision and Site Plan Review Regulations, Wetlands Bylaws, Health Regulations, Public Works regulations, and local enforcement of the State Building Code. Local Bylaws may be amended each year at the annual Town Meeting to improve the town’s capabilities, and changes to most regulations simply require a public hearing and a vote of the authorized board or commission. The Town of Concord has recognized several existing mitigation measures that require implementation or improvements, and has the capacity based on these Home Rule powers within its local boards and departments to address these.

The Concord Department of Public Works will address the needs for catch basin cleaning, repairs and upgrades to drainage infrastructure. The town’s Planning Board will address the updates to the Master Plan and implementation of the Zoning Ordinance, Floodplain District, and Subdivision Rules and Regulations. The Conservation Commission will oversee implementation of the Wetlands Bylaw and the Open Space Plan. The Dept. of Public Works together with the Planning Board and Conservation Commission will coordinate implementation and enforcement of the Stormwater Bylaw.

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VII. MITIGATION MEASURES FROM THE 2010 PLAN

Implementation Progress on the Previous Plan

At a meeting of the Concord Hazard Mitigation Planning Committee, Town staff reviewed the mitigation measures identified in the 2010 Concord Hazard Mitigation Plan and determined whether each measure had been implemented or deferred. Of those measures that had been deferred, the committee evaluated whether the measure should be deleted or carried forward into this Hazard Mitigation Plan 2017 Update. The decision on whether to delete or retain a particular measure was based on the committee’s assessment of the continued relevance or effectiveness of the measure and whether the deferral of action on the measure was due to the inability of the Town to take action on the measure. Table 28 summarizes the status of mitigation measures, and mitigation projects completed are described in more detail below.

Table 28 Mitigation Measures from the 2010 Plan

Mitigation Measure	Priority	Lead Implementation	Current Status	Include in 2017 Plan/Priority
A. Drainage Improvements to the Cambridge Turnpike	High	Public Works	50% design stage, construction to commence late 2017	Yes
B. Establish Ability to Have a Portable Generator for the Town	High	Fire Department, Public Works	Not complete – determined to be impractical	No
C. Identify Options for Alternate Community Sheltering	High	Fire Department	Established new primary shelter, new alternate shelter needed	Yes
D. Upgrades to Bridges that have Weight Restrictions	High	Public Works / MHD	Pine Street and Flint’s Bridge complete. Main Street Bridge not complete	Yes
E. Develop Resource for Backup Pump Capacity	High	Public Works	2 of 3 pumps replaced, town to conduct alternatives analysis for pump station	Yes
F. Continuation of Open Space Protection and Land Acquisition	NFIP	Natural Resources / Planning	On-going, two 80-acre parcels protected	Yes
G. Regulatory Revisions for Stormwater Management	NFIP	Planning / Natural Resources	Complete	No

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Mitigation Measure	Priority	Lead Implementation	Current Status	Include in 2017 Plan/Priority
H. Update Hazardous Material Response Plan	Medium	Fire Department / Public Works	Complete	No
I. Assessment of Historic Structures for Natural Hazard Vulnerability	Medium	Fire Department / Public Works / Building	Not complete	Yes
J. Identify Potential back-up sites for Emergency Operations	Medium	Fire Department / Police Department	Location identified, implementation needed	Yes
K. Assessment of Municipal Structures for Susceptibility to Snow Loads	Other	Public Works / Building	Complete	No
L. Become Fully "Storm Ready" / TV alert notification	Other	Fire Department	Complete	No

Concord has made considerable progress on implementing mitigation measures identified in the 2010 Hazard Mitigation Plan. Several projects have been completed, including upgrades to the Pine Street and Flints Bridges, preservation of two 80-acre open space parcels, revisions to the town's stormwater management regulations and updating the Hazardous Materials Response Plan. Other projects were partially completed, including design and financing for the Cambridge Turnpike drainage improvement project, creating a back-up emergency operations center, and identifying an alternate shelter location. These mitigation measures will be continued in this 2017 Plan Update.

Overall, seven mitigation measures from the 2010 plan will be continued in the plan update. Six of the measures will retain the same priority in the 2017 plan. Identifying and implementing a back-up site for Emergency Operations has been upgraded to a High priority. One project, establishment of a portable generator, was deemed impracticable and will not be carried forth in the 2017 plan.

Moving forward into the next five year plan implementation period there will be many more opportunities to incorporate hazard mitigation into the Town's decision making processes.

The challenges the Town faces in implementing these measures are primarily due to limited funding and available staff time. This plan should help the Town prioritize the best use of its limited resources for enhanced mitigation of natural hazards.

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VIII. HAZARD MITIGATION STRATEGY

What is Hazard Mitigation?

Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, education programs, infrastructure projects and other activities. FEMA currently has three mitigation grant programs: the Hazards Mitigation Grant Program (HGMP), the Pre-Disaster Mitigation program (PDM), and the Flood Mitigation Assistance (FMA) program. The three links below provide additional information on these programs.

<https://www.fema.gov/hazard-mitigation-grant-program>

<https://www.fema.gov/pre-disaster-mitigation-grant-program>

<https://www.fema.gov/flood-mitigation-assistance-grant-program>

Hazard Mitigation Measures can generally be sorted into the following groups:

- **Prevention:** Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include planning and zoning, building codes, capital improvement programs, open space preservation, and stormwater management regulations.
- **Property Protection:** Actions that involve the modification of existing buildings or infrastructure to protect them from a hazard or removal from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, flood proofing, storm shutters, and shatter resistant glass.
- **Public Education & Awareness:** Actions to inform and educate citizens, elected officials, and property owners about the potential risks from hazards and potential ways to mitigate them. Such actions include outreach projects, real estate disclosure, hazard information centers, and school-age and adult education programs.
- **Natural Resource Protection:** Actions that, in addition to minimizing hazard losses also preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
- **Structural Projects:** Actions that involve the construction of structures to reduce the impact of a hazard. Such structures include storm water controls (e.g., culverts), floodwalls, seawalls, retaining walls, and safe rooms.
- **Emergency Services Protection:** Actions that will protect emergency services before, during, and immediately after an occurrence. Examples of these actions include protection of warning system capability, protection of critical facilities, and protection of emergency response infrastructure.

(Source: FEMA Local Multi-Hazard Mitigation Planning Guidance)

Regional and Inter-Community Considerations

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Some hazard mitigation issues are strictly local. The problem originates primarily within the municipality and can be solved at the municipal level. Other issues are inter-community and require cooperation between two or more municipalities. There is a third level of mitigation which is regional and may involve a state, regional or federal agency or three or more municipalities.

Regional Partners

In many communities, mitigating natural hazards is more than a local issue. The facilities that serve these communities are complex systems owned and operated by a wide array of agencies, government, and private entities. In Concord, this includes but is not limited to the Town of Concord, Massachusetts Department of Transportation (MassDOT), the Massachusetts Bay Transportation Authority (MBTA), El Paso Tennessee Gas Company, the Massachusetts Department of Corrections and MassPort. The planning, construction, operations and maintenance of these facilities are integral to the hazard mitigation efforts of communities. These agencies must be considered the communities' regional partners in hazard mitigation. These agencies also operate under the same constraints as communities do, including budgetary and staffing constraints and numerous competing priorities. In the sections that follow, the plan includes recommendations for activities to be undertaken by these other agencies. Implementation of these recommendations will require that all parties work together to develop solutions.

Overview of Regional Facilities within Concord

Major facilities owned, operated and maintained by federal, state, regional or private entities in Concord include: Great Meadows National Wildlife Refuge (US Fish and Wildlife) , Walden Pond State Reservation (MA DCR), Hanscom Air Force Base (US Air force), Hanscom Field Regional Airport (MassPort), Minuteman National Historic Park (U.S. National Park Service), MBTA Commuter Rail Fitchburg Line with stations in Concord and West Concord State Police Barracks on Elm Street (MA State Police), Massachusetts Highway Facility, Northeastern Correctional Facility - former "Farm Dormitory" (Mass Department of Correction) Massachusetts Correctional Institute at Concord (Mass Department of Correction), Emerson Hospital (177 beds with service to 25 communities), Walden Street School (Meadowridge Schools), Tenneco Gas Line (El Paso Energy Company), Army Corps of Engineers (ACOE) Regional Headquarters, and Routes 2, 2A, 62, 117, 119 and 126 (MassDOT).

Inter-Community Considerations

Mitigation measures for the following regional issues should be taken into account as Concord develops its own local plan:

A) Coordinate and Review Developments on a Regional Basis

As Concord and the surrounding communities are undergoing development, it is vital that these communities communicate and provide input during the review processes. When addressing housing, transportation, and economic development projects, the impacts to neighbors must be addressed. The Concord Mews rental development in Concord is a prime example of how one comprehensive permit development has the potential to create impacts in neighboring communities of Sudbury, Maynard, and Acton.

B) Long-Term Regional Management Plan to Control Beaver Activity

One regional issue of significance is the widespread effects of beaver dams in the area. Most streams, wetland areas, and ponds in the region have had some degree of beaver activity in the past several years. Much of the localized flooding that occurs is due to beaver activity. The towns

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will mitigate the problem temporarily by hiring trappers, removing dams, or installing pipes, but a long-term comprehensive approach should be considered.

C) Coordinate Community Sheltering with Emerson Hospital

In addition to seeking alternate sheltering for the Concord community as noted under proposed mitigation, the town should coordinate with other communities to address sheltering issues at Emerson hospital and other regional facilities such as the prison.

D) Dam Conditions and Emergency Plans Upstream of the Town of Concord

Dams in upstream communities are frequently of concern to downstream communities. In the case of Concord, the dams along the Assabet River upstream in Acton and Maynard have been the greatest concern, particularly in the past when the dams have been in poor condition. The Old High Street dam in Acton is currently undergoing significant upgrades that will help mitigate against future dam breaches. The Mill Pond Dam in Maynard has also undergone recent upgrades. The Town has identified the Powdermill Dam in Maynard as critical infrastructure of concern to the community. The communities should continue to coordinate with each other to address concerns of dam conditions and emergency response plans in the event of a hazardous storm event.

New Development and Infrastructure

As part of the process of developing recommendations for new mitigation measures for this plan update, the Town considered the issues related to new development, redevelopment, and infrastructure needs in order limit future risks. Taking into consideration the town's update to stormwater requirements, the Wetlands Bylaw enforced by the Conservation Commission, the Comprehensive Long Range Plan, and the Open Space Plan, the town determined that existing regulatory measures are taking good advantage of local Home Rule land use regulatory authority to minimize natural hazard impacts of development. Including sustainability and climate change measures in town plans and operations are envisioned as part of this plan. Open Space purchases and drainage upgrades are also priorities in this plan.

Process for Setting Priorities for Mitigation Measures

The last step in developing the Town's mitigation strategy is to assign a level of priority to each mitigation measure so as to guide the focus of the Town's limited resources towards those actions with the greatest potential benefit. At this stage in the process, the Local Hazard Mitigation Planning Team had limited access to detailed analyses of the cost and benefits of any given mitigation measure, so prioritization is based on the local team members' understanding of existing and potential hazard impacts and an approximate sense of the costs associated with pursuing any given mitigation measure.

Priority setting was based on local knowledge of the hazard areas, including impacts of hazard events, the extent of the area impacted, and the relation of a given mitigation measure to the k Town's goals. In addition, the local Hazard Mitigation Planning Team also took into consideration factors such as the number of homes and businesses affected, whether or not road closures occurred and what impact closures had on delivery of emergency services and the local economy,

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anticipated project costs, whether any environmental constraints existed, and whether the Town would be able to justify the costs relative to the anticipated benefits.

Table 29 below demonstrates the prioritization of the Town’s potential hazard mitigation measures. For each mitigation measure, the geographic extent of the potential benefiting area is identified as is an estimate of the overall benefit and cost of the measures. The benefits, costs, and overall priority were evaluated in terms of:

Estimated Benefits	
High	Action will result in a significant reduction of hazard risk to people and/or property from a hazard event
Medium	Action will likely result in a moderate reduction of hazard risk to people and/or property from a hazard event
Low	Action will result in a low reduction of hazard risk to people and/or property from a hazard event
Estimated Costs	
High	Estimated costs greater than \$100,000
Medium	Estimated costs between \$10,000 to \$100,000
Low	Estimated costs less than \$10,000 and/or staff time
Priority	
High	Action very likely to have political and public support and necessary maintenance can occur following the project, and the costs seem reasonable considering likely benefits from the measure
Medium	Action may have political and public support and necessary maintenance has potential to occur following the project
Low	Not clear if action has political and public support and not certain that necessary maintenance can occur following the project

Table 29 Mitigation Measure Prioritization

Mitigation Action	Geographic Coverage	Estimated Benefit	Estimated Cost	Priority
Flood Hazard Mitigation				
Drainage improvement to the Cambridge Turnpike	Cambridge Turnpike	High	High	High
Conduct alternatives analysis for flood protection at Lowell Road wastewater pump station	Mill Brook; Concord and Sudbury Rivers	High	Low	High

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Table 29 Mitigation Measure Prioritization

Mitigation Action	Geographic Coverage	Estimated Benefit	Estimated Cost	Priority
Continuation of Open Space Protection and Land Acquisition	Town-wide	High	High	High
Provide improved elevation resolution in GIS	Town-wide	High	Medium	High
Continue culvert replacement projects	Town-wide	High	High	High
Wind Mitigation Measures				
Conduct town-wide shade tree inventory and management plan	Town-wide	High	Medium	High
Maintain debris stockpile location at Walden St., identify back-up location	Town-wide	High	Low	High
Tree management at Annursnac Reservoir	Annursnac Reservoir	High	Low	High
Brushfire Mitigation				
Clear/create fire roads to brush fire risk areas	Forested open space locations	High	Medium	High
Winter Storm Hazard Mitigation				
Maintain location at Walden St., secure replacement location for West Concord	Town-wide	High	Medium	High
Investigate technology for better monitoring of roadway conditions during storms	Town-wide	High	Low	Medium
Optimize use of space for salt storage	Town-wide	High	Low	Medium
Research options for additional back-up fuel storage capacity	Town-wide	High	Low	High
Earthquake Mitigation				
Review status of historic buildings relative to earthquake resistance	Historic District	Medium	Medium	Medium
Dam Mitigation				
Continue to monitor private dams	Specific locations	High	Low	High
Extreme Temperature Mitigation				
Provide public information on the risks of extreme temperatures	Town-Wide	Medium	Medium	High
Drought Mitigation				

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Table 29 Mitigation Measure Prioritization

Mitigation Action	Geographic Coverage	Estimated Benefit	Estimated Cost	Priority
Add treatment for Nagog Pond	Town-Wide	High	High	High
Institute drought management plan	Town-wide	High	Low	High
Climate Resilience/Adaptation				
Include sustainability in planning efforts.	Town-Wide	High	Low	High
Include climate impacts in Comprehensive Long Range Plan	Town-wide	High	Low	High
Bridge Weight Restrictions				
Upgrades to bridges that have weight restrictions	Main St. Pail Factory	High	High	High
Multi-hazards				
Identify alternate option for community sheltering	Town-wide	High	Medium	High
Outfit back-up emergency operations location	Town-wide	High	Medium	High

Potential Mitigation Measures

The potential mitigation measures are provided in this section and summarized in Table 29.

Flooding, Drainage Infrastructure, and Dams

Drainage improvements for the Cambridge Turnpike are at 50% design stage. Construction is slated to begin late in 2017 and should be completed within two years. The previous plan included the need to improve pumping capacity at the Lowell Road wastewater pump station. Given the vulnerability of the location, this plan adds an alternatives analysis, including the option of rebuilding the pump station. Continue efforts to acquire and protect land in the floodplain. Continue to include culvert replacement projects in annual capital planning. Upgrade GIS elevation analysis for improved capacity to analyze flooding vulnerability. Continue to monitor status of private dams for flood risk.

Wind Hazards

Conduct town-wide shade tree inventory and management plan to identify trees in need of attention. Manage trees at Annursnac Reservoir that are a potential risk to town water supply. Maintain current debris stockpile location and identify a back-up location.

Fire Hazards

Develop plan to create or re-create fire road access to town lands that are at risk for brushfires.

Winter Hazards

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Maintain snow storage at Walden Street location; secure a replacement location for the West Concord snow stockpile location. Optimize space allocation at Keyes Road to improve capacity for salt storage. Research additional back-up fuel storage capacity options. Investigate technologies that will improve monitoring of roadway conditions during storms.

Earthquakes

Evaluate capacity of historic properties to resist earthquake damage.

Extreme Temperatures

Provide public information on the risk of extreme temperatures and mitigation strategies.

Drought

Add treatment for Nagog Pond in order to maintain its availability for water supply. Institute a drought management plan to protect town water supply.

Climate Change

Include sustainability in planning efforts. Include climate change impacts in the Comprehensive Long Range Plan Update.

Introduction to Potential Mitigation Measures Table (Table 30)

Description of the Mitigation Measure – The description of each mitigation measure is brief and cost information is given only if cost data were already available from the community. The cost data represent a point in time and would need to be adjusted for inflation and for any changes or refinements in the design of a particular mitigation measure.

Priority – As described above and summarized in Table 29, the designation of high, medium, or low priority was done considering potential benefits and estimated project costs, as well as other factors in the STAPLEE analysis.

Implementation Responsibility – The designation of implementation responsibility was done based on a general knowledge of what each municipal department is responsible for. It is likely that most mitigation measures will require that several departments work together and assigning staff is the sole responsibility of the governing body of each community.

Time Frame – The time frame was based on a combination of the priority for that measure, the complexity of the measure and whether or not the measure is conceptual, in design, or already designed and awaiting funding. Because the time frame for this plan is five years, the timing for all mitigation measures has been kept within this framework. The identification of a likely time frame is not meant to constrain a community from taking advantage of funding opportunities as they arise.

Potential Funding Sources – This column attempts to identify the most likely sources of funding for a specific measure. The information on potential funding sources in this table is preliminary and varies depending on a number of factors. These factors include whether or not a mitigation measure has been studied, evaluated or designed, or if it is still in the conceptual stages. MEMA and DCR assisted MAPC in reviewing the potential eligibility for hazard mitigation funding. Each grant program and agency has specific eligibility requirements that would need to be taken into consideration. In most instances, the measure will require a number of different funding sources.

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Identification of a potential funding source in this table does not guarantee that a project will be eligible for, or selected for funding. Upon adoption of this plan, the local team responsible for its implementation should begin to explore the funding sources in more detail.

Additional information on funding sources – The best way to determine eligibility for a particular funding source is to review the project with a staff person at the funding agency. The following websites provide an overview of programs and funding sources.

Army Corps of Engineers (ACOE) – The website for the North Atlantic district office is <http://www.nae.usace.army.mil/>. The ACOE provides assistance in a number of types of projects including shoreline/stream bank protection, flood damage reduction, flood plain management services and planning services.

Massachusetts Emergency Management Agency (MEMA) – The grants page <http://www.mass.gov/eopss/agencies/mema/resources/grants/> describes all of the FEMA grant programs that they manage.

Abbreviations Used in Table 30

FEMA Mitigation Grants includes:

FMA = Flood Mitigation Assistance Program.

HMGP = Hazard Mitigation Grant Program.

PDM = Pre-Disaster Mitigation Program

ACOE = Army Corps of Engineers.

DHS/EOPS = Department of Homeland Security/Emergency Operations

DEP (SRF) = Department of Environmental Protection (State Revolving Fund)

USDA = United States Department of Agriculture

Mass DOT = Massachusetts Department of Transportation

DCR = MA Department of Conservation and Recreation

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Table 30 Potential Mitigation Measures					
Mitigation Measure	Priority	Lead Implementation	Time Frame	Estimated Cost	Potential Funding Sources
FLOODING					
Drainage improvement to the Cambridge Turnpike	High	Public Works	2019	High	FEMA, Town
Conduct alternatives analysis for flood protection at Lowell Road wastewater pump station	High	Public Works		Low	Town, staff time
Continuation of Open Space Protection and Land Acquisition	High	Natural Resources	2117-2022	High	Town, CPA, Private
Provide improved elevation resolution in GIS	High	IT	2018	Low	Town, staff time
Continue culvert replacement projects	High	Public Works	2017-21022	High:	Town, FEMA
WIND RELATED HAZARDS					
Town wide shade tree inventory and management plan	High	Public Works	2017	Medium	Town, staff time
Maintain debris stockpile location at Walden St., identify back-up location	High	Public Works	2018-2019	Low	Town, staff time
Tree management at Annursnac Reservoir	High	Public Works	2017-2018	Medium	Town
BRUSHFIRES					
Clear/create fire roads to brush fire risk areas	High	Fire, Planning	2018-2019	Medium	Town
WINTER STORMS					
Maintain location at Walden St., secure replacement for West Concord location	High	Public Works	2018	Low	Town, staff time
Investigate technology for better monitoring of roadway conditions during storms	Medium	Public Works	2019	Medium	Town
Optimize use of space for salt storage	Medium	Public Works	2018	Low	Town

**TOWN OF CONCORD HAZARD MITIGATION PLAN
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Table 30 Potential Mitigation Measures					
Mitigation Measure	Priority	Lead Implementation	Time Frame	Estimated Cost	Potential Funding Sources
Research options for additional back-up fuel storage capacity	High	Public Works	2018	Low	Staff time
EARTHQUAKES					
Review status of historic buildings relative to earthquake resistance	Medium	Building	2020	Low	Staff time
DAMS					
Continue to monitor private dams	Medium	Fire	2017-2022	Low	Staff time
EXTREME TEMPERATURES					
Provide public information on the risks of extreme temperatures	Medium	Fire	2017-2022	Low	Staff time
DROUGHT					
Add treatment for Nagog Pond	High	Public Works	2020	High	Town
Institute drought management plan	High	Public Works	2018	Low	Staff time
CLIMATE RESILIENCE / ADAPTATION					
Include sustainability in planning efforts	High	Planning	2017-2022	Low	Staff time
Include climate impacts in Comprehensive Long Range Plan	High	Planning	2018	Low	Staff time
BRIDGE WEIGHT RESTRICTIONS					
Upgrades to Main St. and Pail Factory bridges	High	MassDOT Highway	2022	High	Town, State
MULTI-HAZARDS					
Identify alternate option for community sheltering	High	Fire	2022	Low	Town
Outfit back-up emergency operations center	High	Fire	2018	Low	Town

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IX. PLAN ADOPTION AND MAINTENANCE

Plan Adoption

The Concord Hazard Mitigation Plan 2017 Update was adopted by the Select Board on [ADD DATE]. See Appendix D for documentation. The plan was approved by FEMA on [ADD DATE] for a five-year period that will expire on [ADD DATE].

Plan Maintenance

Although several of the mitigation measures from the Town's previous Hazard Mitigation Plan have been implemented, since that plan was adopted there has not been an ongoing local process to guide implementation of the plan. Such a process is needed over the next five years for the implementation of this plan update, and will be structured as described below.

MAPC worked with the Concord Hazard Mitigation Planning Team to prepare this plan. After approval of the plan by FEMA, this group will meet to function as the Hazard Mitigation Implementation Team, with the Fire Chief designated as the coordinator. Additional members could be added to the local implementation team from businesses, non-profits and institutions. The Town will encourage public participation during the next 5-year planning cycle. As updates and a review of the plan are conducted by the Hazard Mitigation Implementation Team, these will be placed on the Town's web site, and any meetings of the Hazard Mitigation Implementation Team will be publicly noticed in accordance with town and state open meeting laws.

Implementation and Evaluation Schedule

Mid-Term Survey on Progress– The coordinator of the Hazard Mitigation Implementation Team will prepare and distribute a survey in year three of the plan. The survey will be distributed to all of the local implementation group members and other interested local stakeholders. The survey will poll the members on any changes or revisions to the plan that may be needed, progress and accomplishments for implementation, and any new hazards or problem areas that have been identified.

This information will be used to prepare a report or addendum to the local hazard mitigation plan in order to evaluate its effectiveness in meeting the plan's goals and identify areas that need to be updated in the next plan. The Hazard Mitigation Implementation Team, coordinated by the Fire Chief, will have primary responsibility for tracking progress, evaluating, and updating the plan.

Begin to Prepare for the next Plan Update -- FEMA's approval of this plan is valid for five years, by which time an updated plan must be approved by FEMA in order to maintain the town's approved plan status and its eligibility for FEMA mitigation grants. Given the lead time needed to secure funding and conduct the planning process, the Hazard Mitigation Implementation Team will begin to prepare for an update of the plan in year three. This will help the Town avoid a lapse in its approved plan status and grant eligibility when the current plan expires.

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The Hazard Mitigation Implementation Team will use the information from the Mid-Term progress review to identify the needs and priorities for the plan update and seek funding for the plan update process. Potential sources of funding may include FEMA Pre-Disaster Mitigation grants and the Hazard Mitigation Grant Program. Both grant programs can pay for 75% of a planning project, with a 25% local cost share required.

Prepare and Adopt an Updated Local Hazard Mitigation Plan –Once the resources have been secured to update the plan, the Hazard Mitigation Implementation Team may decide to undertake the update themselves, contract with the Metropolitan Area Planning Council to update the plan or to hire another consultant. However the Hazard Mitigation Implementation Team decides to update the plan, the group will need to review the current FEMA hazard mitigation plan guidelines for any changes. The Concord Hazard Mitigation Plan Update will be forwarded to MEMA and DCR for review and to FEMA for approval.

Integration of the Plans with Other Planning Initiatives

Upon approval of the Concord Hazard Mitigation Plan 2017 Update by FEMA, the Local Hazard Mitigation Team will provide all interested parties and implementing departments with a copy of the plan and will initiate a discussion regarding how the plan can be integrated into that department's ongoing work. At a minimum, the plan will be reviewed and discussed with the following departments:

- Fire Department
- Emergency Management
- Police Department
- Public Works Department
- Engineering
- Planning and Community Development
- Conservation Commission
- Parks and Recreation
- Public Health
- Building

Other groups that will be coordinated with include large institutions, Chambers of Commerce, land conservation organizations and watershed groups. The plans will also be posted on a community's website with the caveat that local team coordinator will review the plan for sensitive information that would be inappropriate for public posting. The posting of the plan on a web site will include a mechanism for citizen feedback such as an e-mail address to send comments.

The Hazard Mitigation Plan will be integrated into other town plans and policies as they are updated and renewed, including the Concord Comprehensive Plan, Open Space Plan, Comprehensive Emergency Management Plan, and Capital Investment Program.

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X. LIST OF REFERENCES

Town of Concord, Annual Report 2015

Town of Concord, General Bylaws

Town of Concord, Zoning Bylaw, amended through 4/2010

Town of Concord Comprehensive Plan 2005 – 2020

Town of Concord Open Space Plan 2015

Town of Concord Water Quality Report 2011

FEMA, FIRM, Letter of Map Revision, 2015

Metropolitan Area Planning Council, GIS Lab, Regional Plans and Data.

Environment America Research and Policy Center, *When It Rains It Pours – Global Warming and the Increase in Extreme Precipitation*, July 2012

FEMA, Flood Risk Report, Concord River Watershed, 2/27/2013

FEMA, Flood Insurance Rate Maps for Middlesex County, MA, 2014

FEMA, Local Mitigation Plan Review Guide; October 1, 2011.

MA Emergency Management Agency, *State Hazard Mitigation Plan*, 2013

MA Geographic Information System, *McConnell Land Use Statistics*, 2005

MA Office of Dam Safety, *Inventory of Massachusetts Dams*

Metropolitan Area Planning Council, Geographic Information Systems Lab

New England Seismic Network, Weston Observatory, <http://aki.bc.edu/index.htm>

Northeast States Emergency Consortium, website <http://www.nesec.org/>

NOAA, National Climatic Data Center, website

Union of Concerned Scientists, *Confronting Climate Change in the U.S. Northeast*, 2007

U. S. Census, 2010, and American Community Survey, 2013

USGS, National Water Information Center, website <http://nwis.waterdata.usgs.gov/usa/nwis>

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2017 UPDATE**

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2017 UPDATE**

APPENDIX A

**HAZARD MITIGATION PLANNING TEAM
MEETING AGENDAS**

Concord Hazard Mitigation Plan 2016 Update

LOCAL HAZARD MITIGATION PLANNING TEAM

Meeting #1

Wednesday, January 20, 2016, 2:00 PM

Concord Fire Department HQ, 209 Walden Street, Concord, MA

AGENDA

- 2:00** **Welcome and Introductions**
- 2:05** **Overview of FEMA Hazard Mitigation Planning**
Presentation by Marybeth Groff from MEMA
Questions/Discussion
- 2:45** **Review of Project Scope and Milestones**

See handout materials
Martin Pillsbury, MAPC
- 2:55** **Questions/Next Steps**
- 3:00** **Meeting Adjourn**

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Concord Hazard Mitigation Plan 2016 Update

LOCAL HAZARD MITIGATION PLANNING TEAM

Meeting #2

Wednesday, August 31st, 10:00 AM

Fire Department Headquarters, 209 Walden Street, Concord MA

AGENDA

- 10:00 am Update Critical Facilities Inventory and Mapping **(35 minutes)**
- 10:35 am Identify/update local hazards: **(30 minutes)**
- a) Flood Hazard Areas
 - b) Fire Hazard Areas (brushfires/ wildfires)
 - c) Dams
 - d) Other hazards
- 11:05 am Identify/Update Potential New Development Sites **(30 minutes)**
- 11:40 am Discuss Public Involvement and Outreach **(25 minutes)**
- a) Identify local stakeholders
 - b) Schedule first public meeting
- 12:00 pm Meeting Adjourn

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AGENDA

**Concord Local Hazard Mitigation Planning Team
Meeting #3
Planning Process to Update the FEMA-Approved 2010 Plan**

Monday, January 23 – 1:00 – 3:00 PM
Station 1, Training Room, 209 Walden Street

WELCOME AND INTRODUCTIONS (10 minutes)

- Where we are in the process

REVIEW MITIGATION MEASURES FROM 2010 PLAN (20 minutes)

- Update status of mitigation
- Clarify existing mitigation

PROPOSE NEW MITIGATION MEASURES FOR 2017 PLAN (75 minutes)

- Identify new mitigation
- Prioritize the new mitigation and any continuing mitigation
- Include climate language and mitigation?

REVIEW MITIGATION PLAN GOALS AND UPDATE AS NEEDED (5 minutes)

NEXT STEPS (10 minutes)

- Review of draft plan
- Schedule final public meeting

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**APPENDIX B
HAZARD MAPPING**

The MAPC GIS (Geographic Information Systems) Lab produced a series of maps for each community. Some of the data came from the Northeast States Emergency Consortium (NESEC). More information on NESEC can be found at <http://www.nesec.org/>. Due to the various sources for the data and varying levels of accuracy, the identification of an area as being in one of the hazard categories must be considered as a general classification that should always be supplemented with more local knowledge.

The map series consists of eight maps as described below. The maps in this appendix are necessarily reduced scale versions for general reference. Full sized higher resolution PDF's of the maps can be downloaded from the MAPC File Transfer Protocol (FTP) website at:

ftp://ftp.mapc.org/Hazard_Mitigation_Plans/maps/Concord/

Map 1.	Population Density
Map 2.	Potential Development
Map 3.	Flood Zones
Map 4.	Earthquakes and Landslides
Map 5.	Hurricanes and Tornadoes
Map 6.	Average Snowfall
Map 7.	Composite Natural Hazards
Map 8.	Hazard Areas

Map 1: Population Density – This map uses the US Census block data for 2010 and shows population density as the number of people per acre in seven categories with 60 or more people per acre representing the highest density areas.

Map 2: Development – This map shows potential future developments, and critical infrastructure sites. MAPC consulted with town staff to determine areas that were likely to be developed or redeveloped in the future. The map also depicts current land use.

Map 3: Flood Zones – The map of flood zones used the FEMA NFIP Flood Zones as depicted on the FIRMs (Federal Insurance Rate Maps) for Middlesex County as its source. This map is not intended for use in determining whether or not a specific property is located within a FEMA NFIP flood zone. The currently adopted FIRMS for Concord are kept by the Town. For more information, refer to the FEMA Map Service Center website <http://www.msc.fema.gov>. The definitions of the flood zones are described in detail on this site as well. The flood zone map for each community also shows critical infrastructure and repetitive loss areas.

Map 4: Earthquakes and Landslides – This information came from NESEC. For most communities, there was no data for earthquakes because only the epicenters of an earthquake are mapped.

The landslide information shows areas with either a low susceptibility or a moderate susceptibility to landslides based on mapping of geological formations. This mapping is highly general in

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nature. For more information on how landslide susceptibility was mapped, refer to <http://pubs.usgs.gov/pp/p1183/pp1183.html>.

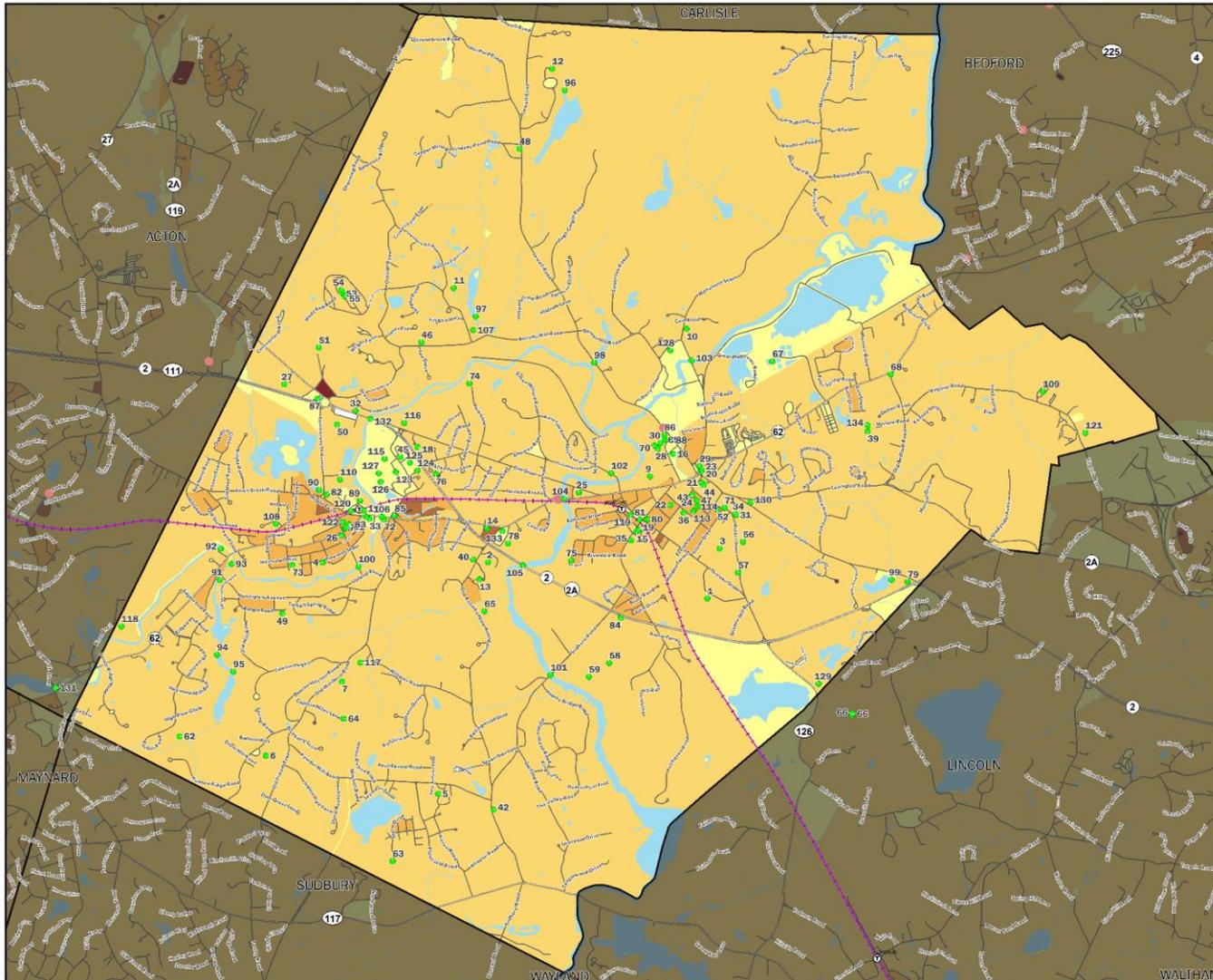
Map 5: Hurricanes and Tornadoes – This map shows a number of different items. The map includes the storm tracks for both hurricanes and tropical storms, if any occurred in this community. This information must be viewed in context. A storm track only shows where the eye of the storm passed through. In most cases, the effects of the wind and rain from these storms were felt in other communities even if the track was not within that community. This map also shows the location of tornadoes with a classification as to the level of damages. What appears on the map varies by community since not all communities experience the same wind-related events. These maps also show the 100 year wind speed.

Map 6: Average Snowfall - - This map shows the average snowfall. It also shows storm tracks for nor'easters, if any storms tracked through the community.

Map 7: Composite Natural Hazards - This map shows four categories of composite natural hazards for areas of existing development. The hazards included in this map are 100 year wind speeds of 110 mph or higher, low and moderate landslide risk, FEMA Q3 flood zones (100 year and 500 year) and hurricane surge inundation areas. Areas with only one hazard were considered to be low hazard areas. Moderate areas have two of the hazards present. High hazard areas have three hazards present and severe hazard areas have four hazards present.

Map 8: Hazard Areas – For each community, locally identified hazard areas are overlaid on an aerial photograph dated April, 2008. The critical infrastructure sites are also shown. The source of the aerial photograph is Mass GIS.

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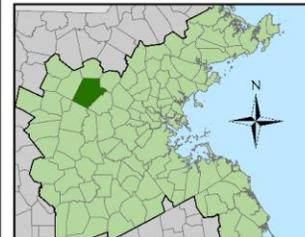


FEMA Hazard Mitigation Planning Grant CONCORD, MA

Map 1: Population Density

- Critical Infrastructure Sites*
- Repetitive Loss Sites
- * See details in separate table
- Water Bodies
- Train Stations
- Commuter Rail Lines
- Trains
- Population Density
2010 Census Blocks
People Per Acre**
- 0 or No Data
- 0.1 - 5.0
- 5.1 - 15.0
- 15.1 - 30.0
- More than 30
- All Roads**
- Interstate
- U.S. Highway
- State Route
- Street

0 0.25 0.5 Miles



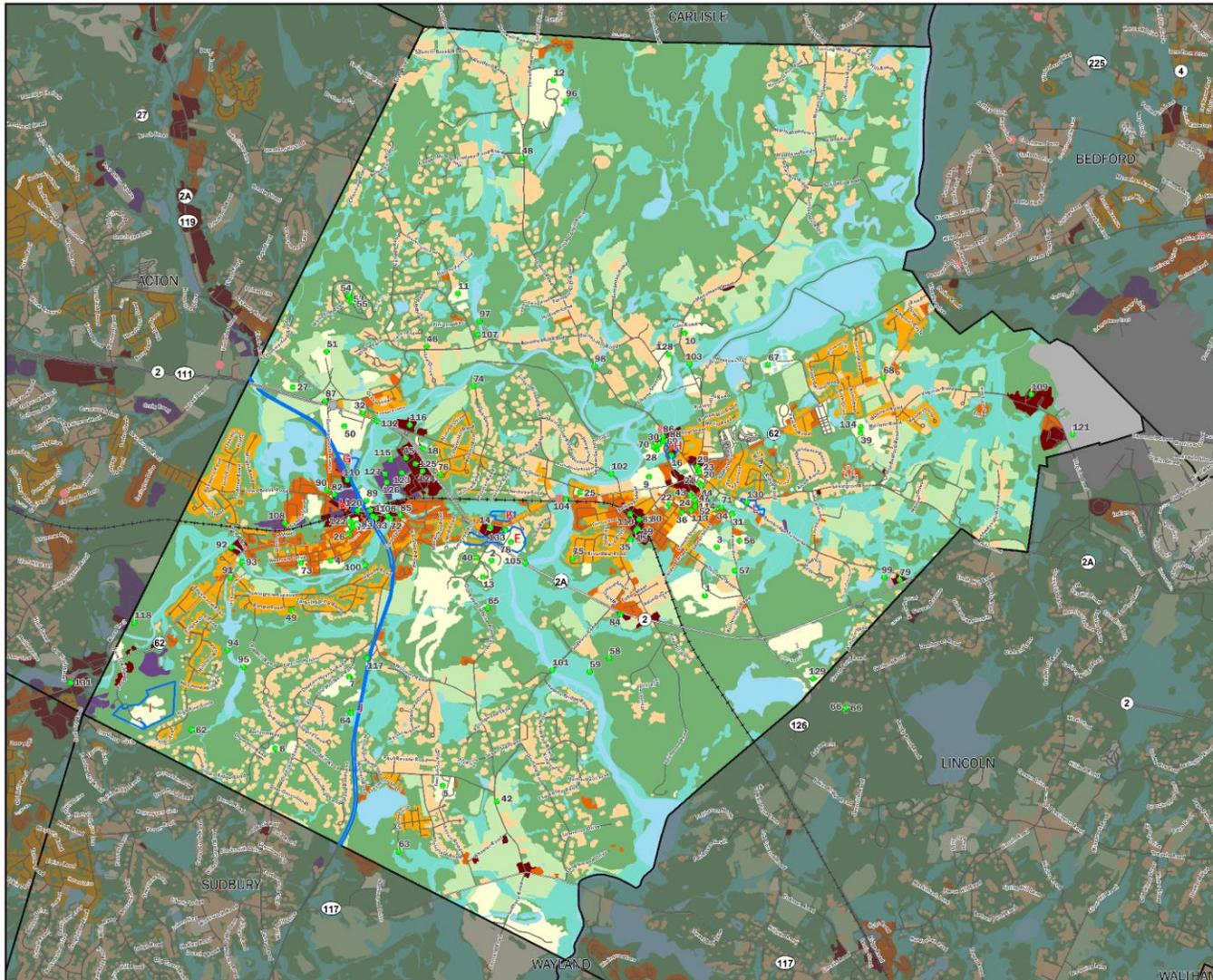
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel level analysis.

Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770

Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NISEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
CONCORD, MA

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TOWN OF CONCORD HAZARD MITIGATION PLAN 2017 UPDATE

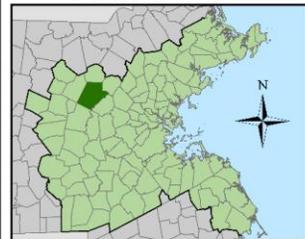




 FEMA Hazard
 Mitigation Planning Grant
CONCORD, MA
 Map 2: Land Use

- Sites**
- Critical Infrastructure Sites*
 - Repetitive Loss Sites
 - * See details in separate table
- Development Areas**
- Development Areas
 - * See details in separate table
- Land Use (2005)**
- High Density Residential
 - Medium Density Residential
 - Low Density Residential
 - Non-Residential Developed
 - Commercial
 - Industrial
 - Transportation
 - Agriculture
 - Undeveloped
 - Undeveloped Wetlands
- Other Features**
- + Train Stations
 - Commuter Rail Lines
 - Trains
- All Roads**
- Interstate
 - U.S. Highway
 - State Route
 - Street
 - Water Bodies

0 0.25 0.5 Miles



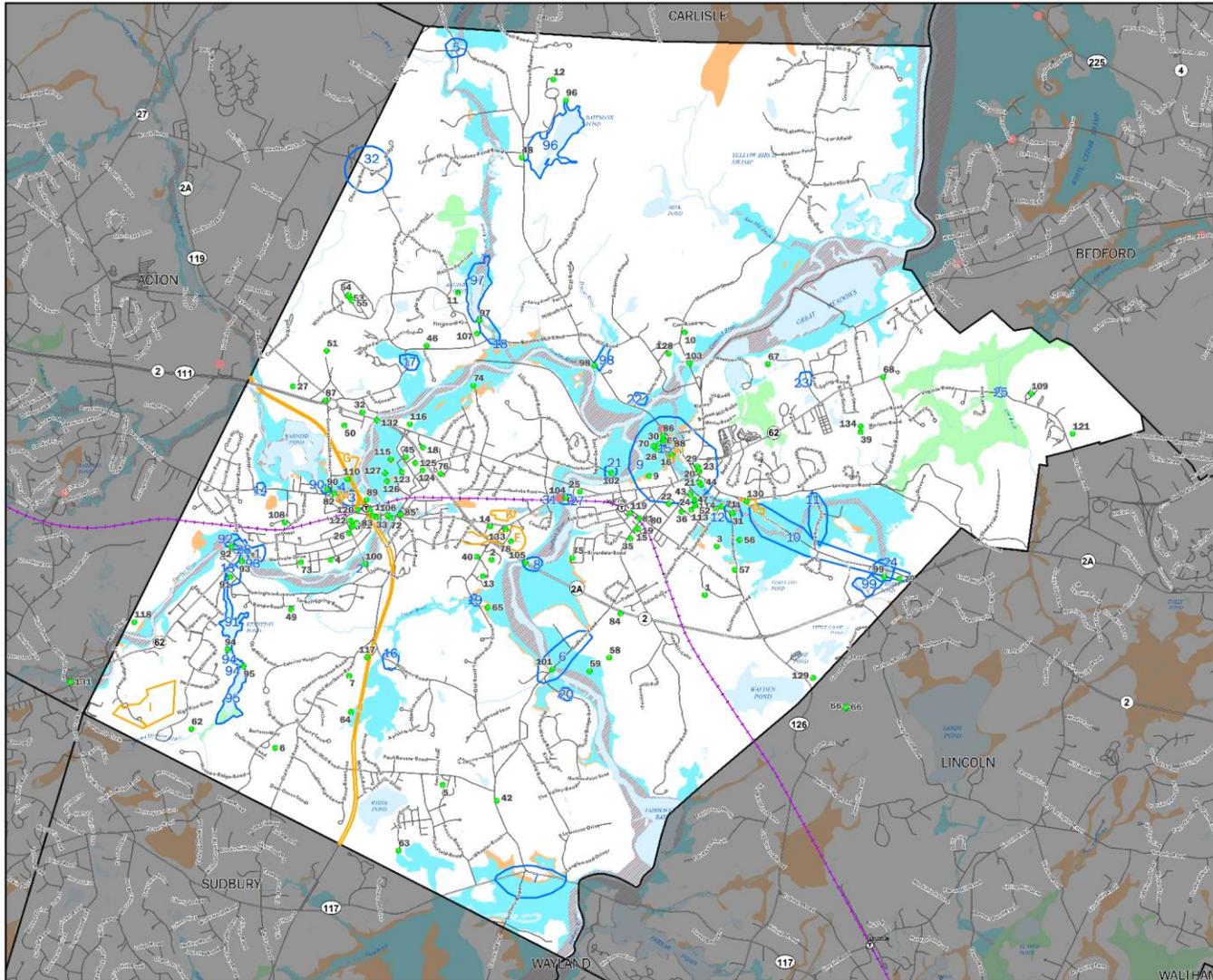
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel level analyses.

Produced by MAPC Data Services
 60 Temple Place, Boston, MA 02111 (617) 451-2770

Data Sources:
 Metropolitan Area Planning Council (MAPC)
 Massachusetts Geographic Information System (MassGIS)
 Northeast States Emergency Consortium (NESEC)
 Massachusetts Emergency Management Agency (MEMA)
 Federal Emergency Management Agency (FEMA)
 CONCORD, MA

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 Date: 2/3/2017

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FEMA Hazard Mitigation Planning Grant CONCORD, MA Map 3: Flood Zones

- Sites**
- Critical Infrastructure Sites*
 - Repetitive Loss Sites
 - * See details in separate table
- Locally Identified Hazard Areas***
- Water Bodies
 - Flooding
 - * See Section IV Risk Assessment
- Flood Zones, 2014 (Annual Chance)**
- AE: 1% Annual Chance of Flooding, no BFE
 - AE: 1% Annual Chance of Flooding, with BFE
 - AE: Regulatory Floodway
 - AH: 1% Annual Chance of 1-3ft Ponding, with BFE
 - X: 0.2% Annual Chance of Flooding
- Development Areas***
- Train Stations
 - Commuter Rail Lines
 - Trains
- All Roads**
- Interstate
 - U.S. Highway
 - State Route
 - Street
- 0 0.25 0.5 Miles



The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analysis.

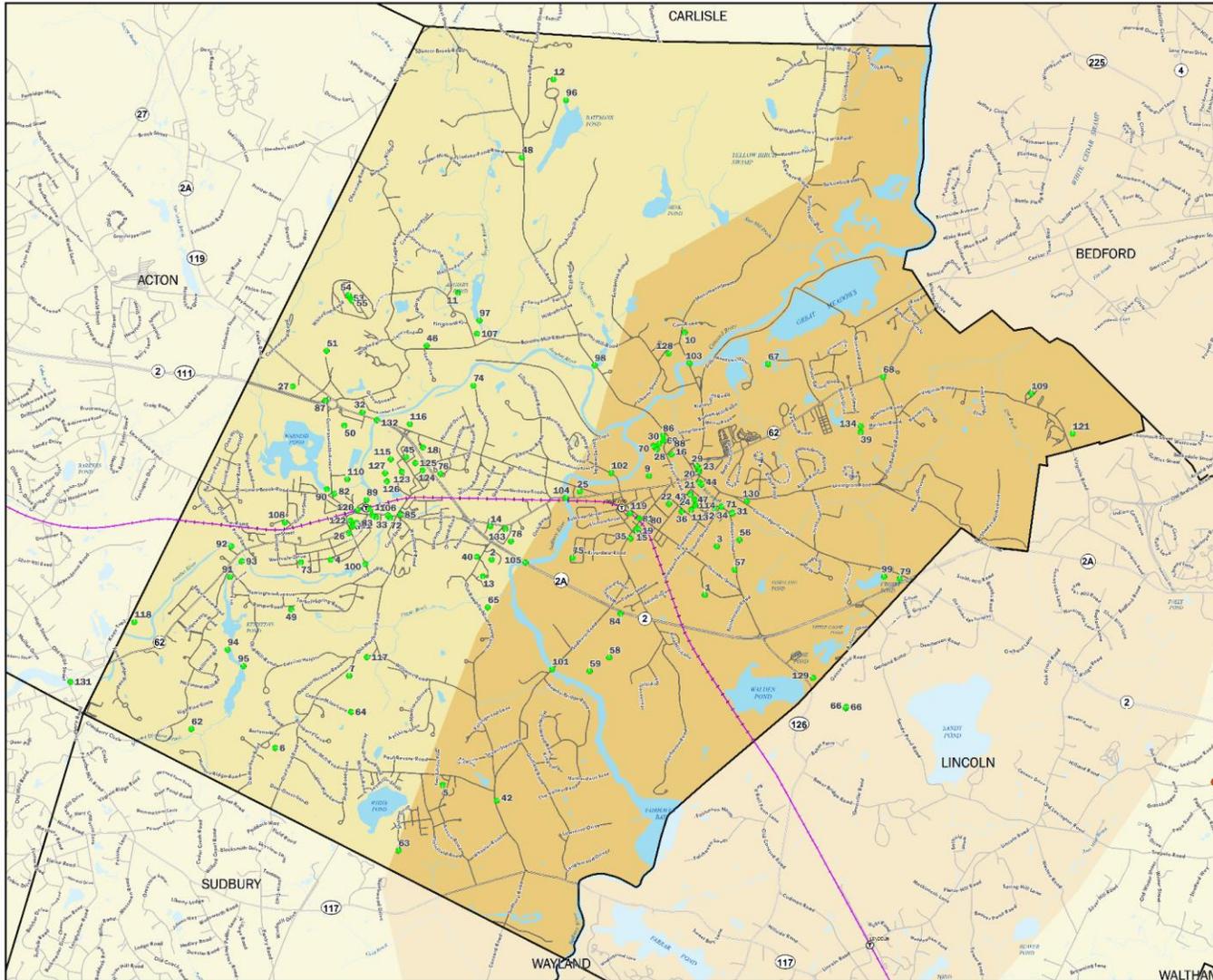
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770

Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)

Flood Zones datalayer updated by MassGIS October 2013
from finalized data provided by
Federal Emergency Management Agency (FEMA)
CONCORD, MA

Map 3: Hazard Mitigation Planning Grant (Current Version) PDM Update, Final PDM, Map 3.mxd
Date: 2/3/2017

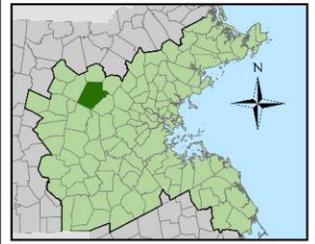
TOWN OF CONCORD HAZARD MITIGATION PLAN 2017 UPDATE





 FEMA Hazard Mitigation Planning Grant
CONCORD, MA
 Map 4: Earthquakes / Landslides

- Sites**
- Critical Infrastructure Sites*
 - Repetitive Loss Sites
- * See details in separate table
- Earthquakes**
- Epicenters
 -  Train Stations
 -  Commuter Rail Lines
 -  Trains
- All Roads**
-  Interstate
 -  U.S. Highway
 -  State Route
 -  Street
- Landslides**
- High landslide incidence (greater than 15% of the area is involved in landsliding)
 - High susceptibility to landsliding and moderate incidence
 - High susceptibility to landsliding and low incidence
 - Moderate susceptibility to landsliding and low incidence
 - Low landslide incidence (less than 1.5% of the area is involved in landsliding)
- 0 0.25 0.5 Miles



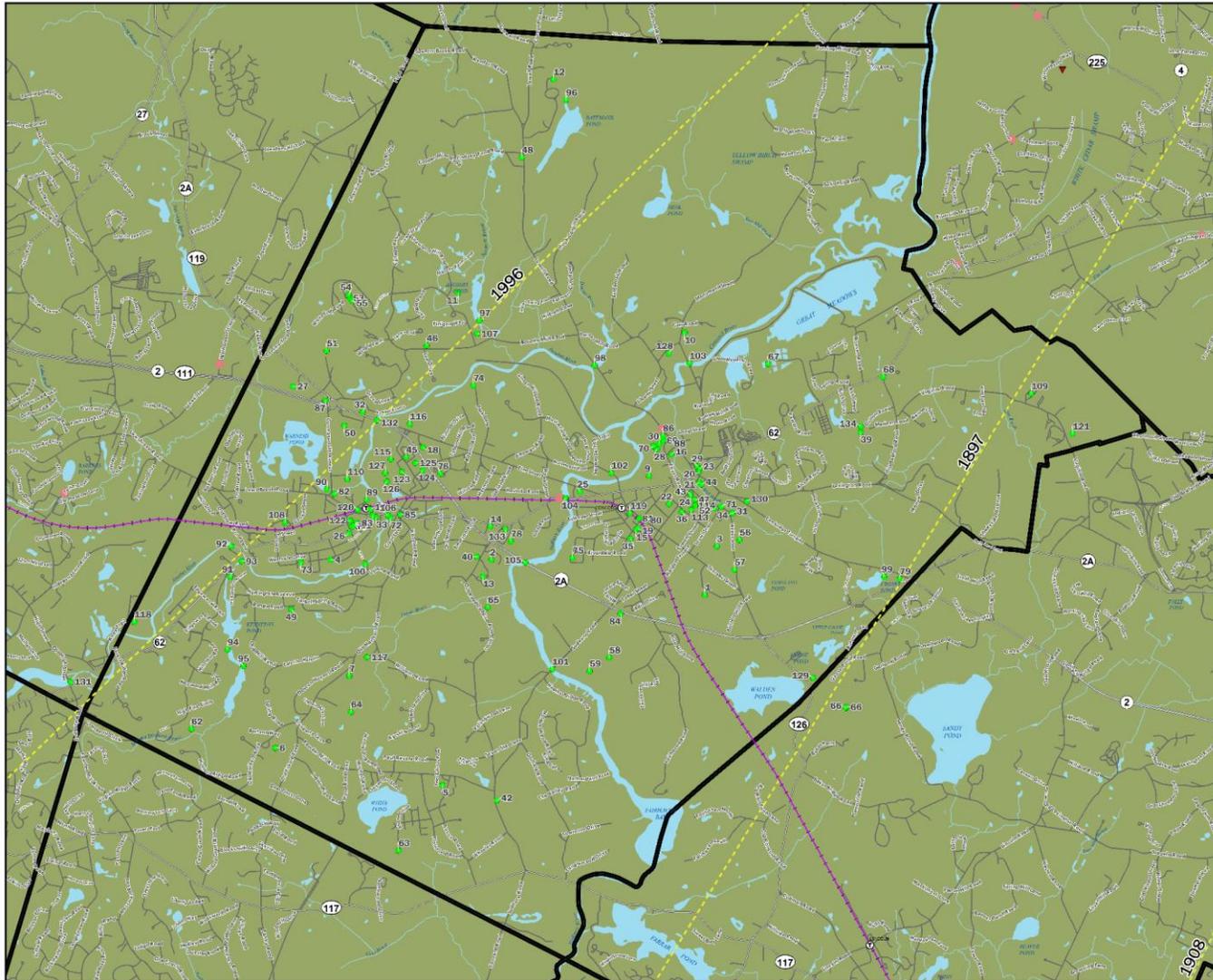
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.

Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770

Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
CONCORD, MA

File: H:\Data\GIS\Public\CD\mxd\2017\CD\Map4_2017_Map1.mxd
Date: 2/3/2017

TOWN OF CONCORD HAZARD MITIGATION PLAN 2017 UPDATE



FEMA Hazard Mitigation Planning Grant CONCORD, MA

Map 5: Hurricanes / Tornadoes

Sites

- Critical Infrastructure Sites*
- Repetitive Loss Sites
- * See details in separate table

Tornadoes

- ▼ Tornado

Storm Tracks

- Tropical Depression
- Tropical Storm
- Category 1 Hurricane
- Category 2 Hurricane
- Category 3 Hurricane
- Year of storm noted on map

100 Year Wind Speeds

Miles Per Hour
90 MPH
100 MPH
110 MPH
120 MPH
130 MPH

Hurricane Surge Inundation Areas

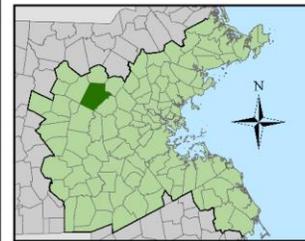
- ⊕ Train Stations
- ⊕ Commuter Rail Lines
- ⊕ Trains

All Roads

- Interstate
- U.S. Highway
- State Route
- Street

Water Bodies

0 0.25 0.5 Miles



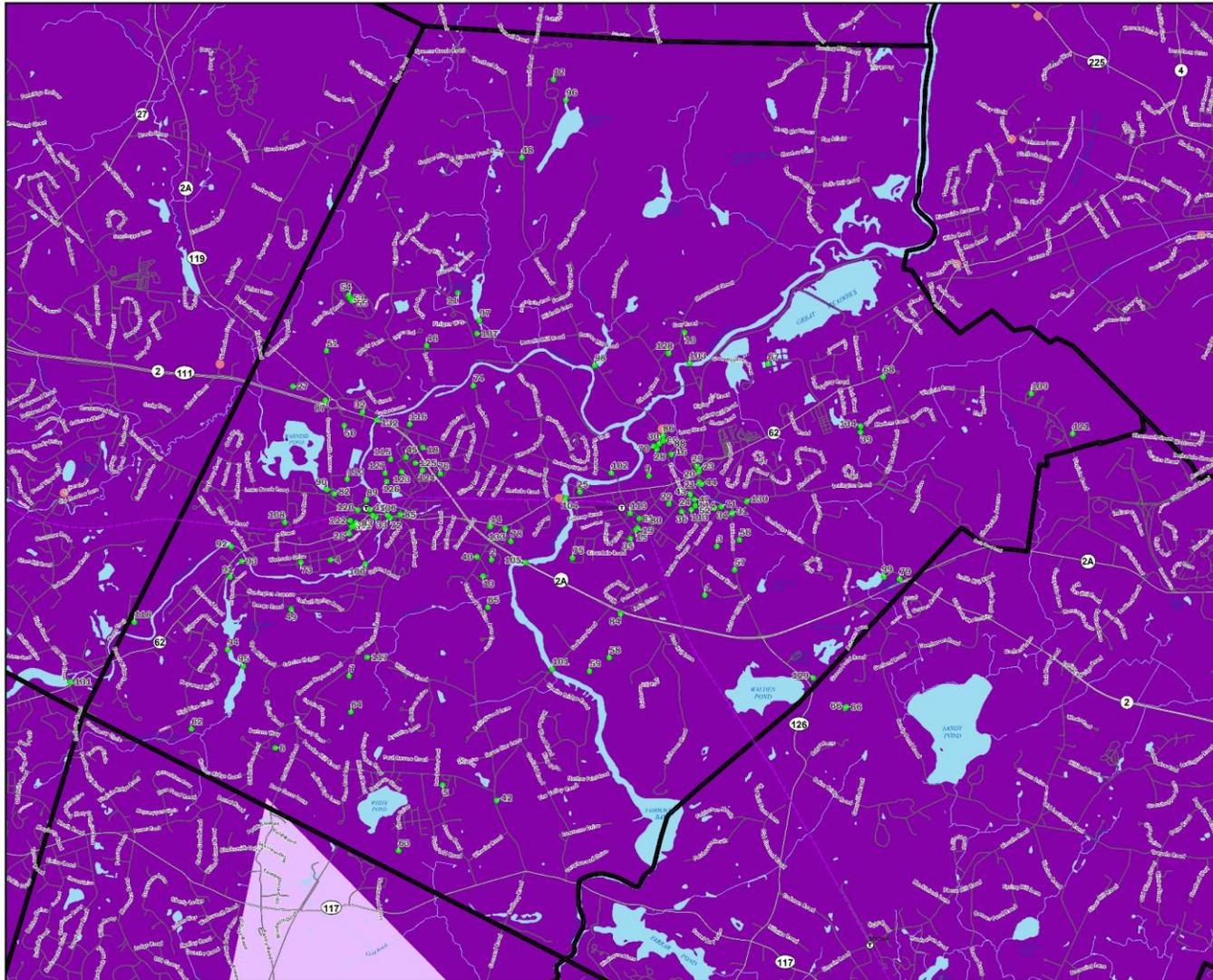
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel level analyses.

Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770

Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
CONCORD, MA

Map: K:\GIS\GIS\Projects\2017_HazMit\Figures\FEMA_gisprint_Map5HV_Arizona.mxd
Date: 2/3/2017

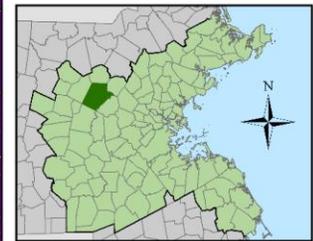
TOWN OF CONCORD HAZARD MITIGATION PLAN 2017 UPDATE



FEMA Hazard Mitigation Planning Grant CONCORD, MA Map 6: Average Snowfall

- | | | |
|---------------------------------|--------------------------------|---------------------|
| Sites | Critical Infrastructure Sites* | Water Bodies |
| | Repetitive Loss Sites | Train Stations |
| * See details in separate table | | Commuter Rail Lines |
| Average Annual Snowfall | | |
| | 36.1 to 48.0 inches | Trains |
| | 48.1 to 72.0 inches | |
| All Roads | | |
| | Interstate | |
| | U.S. Highway | |
| | State Route | |
| | Street | |

0 0.25 0.5 Miles



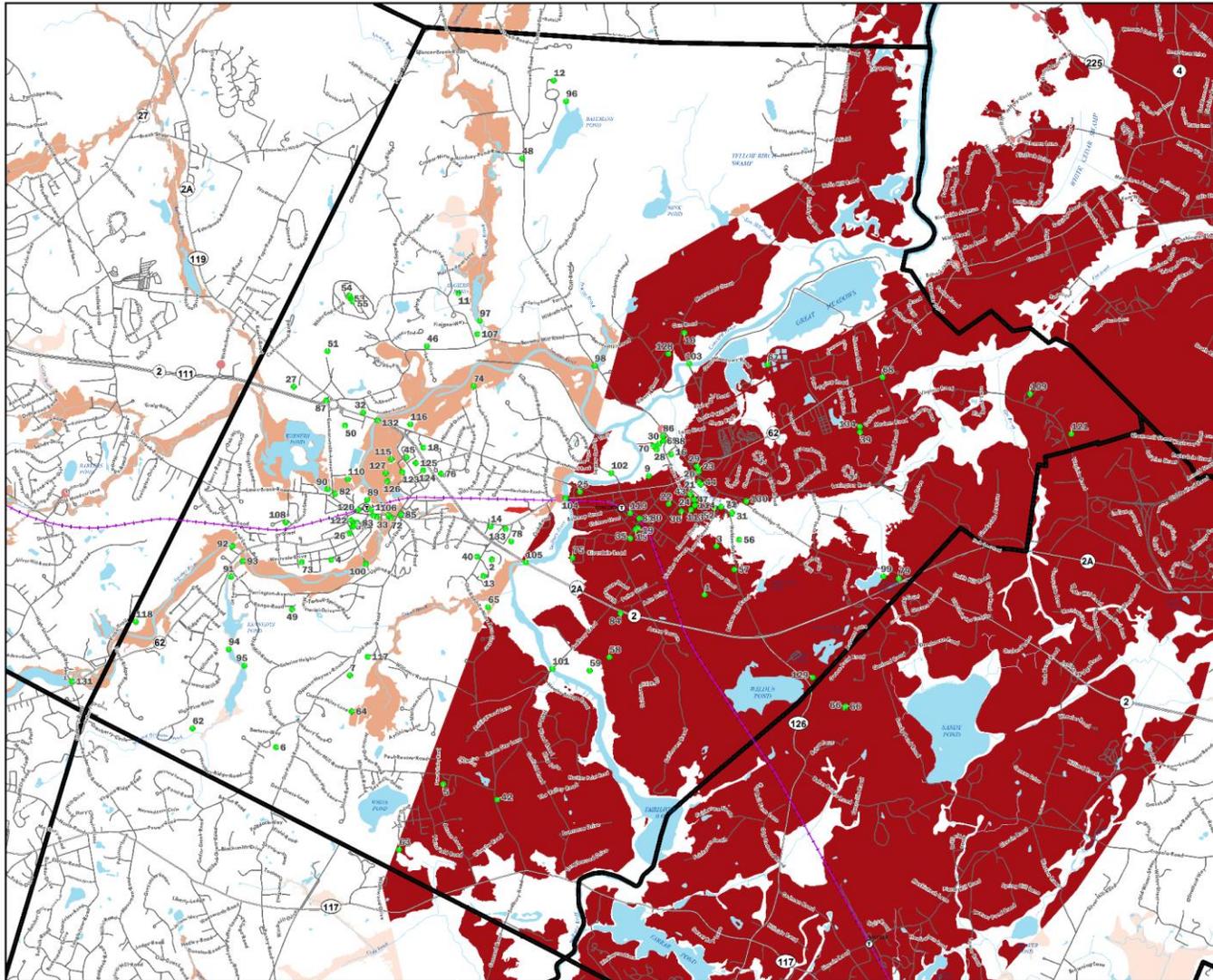
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel level analyses.

Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770

Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
CONCORD, MA

Map 6: Average Annual Snowfall
Date: 2/3/2017

TOWN OF CONCORD HAZARD MITIGATION PLAN 2017 UPDATE



FEMA Hazard Mitigation Planning Grant
CONCORD, MA
Map 7: Composite Natural Hazards

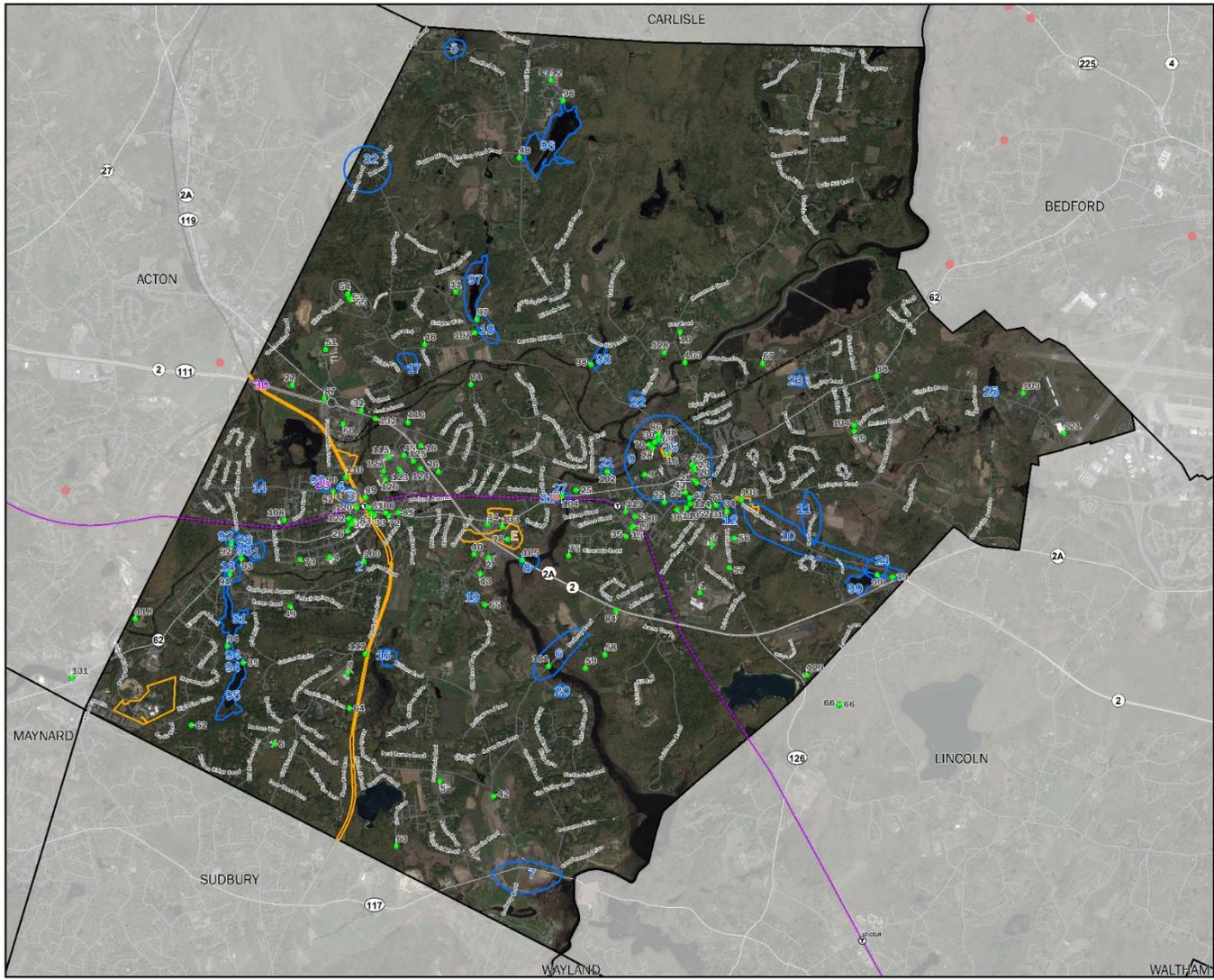
<p>Composite Natural Hazards</p> <ul style="list-style-type: none"> Low (2 Hazards) Moderate (3 Hazards) High (4 Hazards) Very High (5 Hazards) <p>Composite natural hazards shown for areas of existing development. Hazards include:</p> <ul style="list-style-type: none"> • 100 year wind speed of 110 MPH or higher • Moderate landslide risk • FEMA Q3 flood zones (100 year and 500 year) • Average snowfall of 36.1" or more • Hurricane surge inundation areas 	<p>Sites</p> <ul style="list-style-type: none"> ● Critical Infrastructure Sites* ● Repetitive Loss Sites * See details in separate table <p>Water Bodies</p> <ul style="list-style-type: none"> — Water Bodies <p>All Roads</p> <ul style="list-style-type: none"> Interstate U.S. Highway State Route Street ● Train Stations — Commuter Rail Lines — Trains <p>0 0.25 0.5 Miles</p>
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The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel level analyses.

Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770

Data Sources
Composite Natural Hazard: Wind, Landslide Risk, Snow - Northeast States Emergency Consortium (NISEC)
Flood Zones - 2013 FEMA/MassGIS
Hurricane Surge - 2013 U.S. Army Corps of Engineers, New England District
Roads/Trains: MassDOT/CTPS
Repetitive Loss Sites: DCR/Office of Flood Hazard Management
Critical Infrastructure: Metropolitan Area Planning Council (MAPC)/CONCORD, MA
Date: 2/3/2017

TOWN OF CONCORD HAZARD MITIGATION PLAN 2017 UPDATE

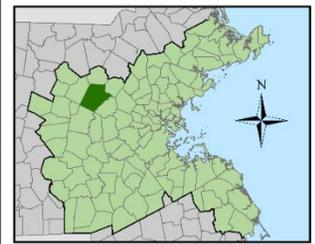




 FEMA Hazard Mitigation Planning Grant
CONCORD, MA
 Map 8: Local Hazard Areas

- | | |
|--|---|
| Sites
<ul style="list-style-type: none"> ● Critical Infrastructure Sites* ● Repetitive Loss Sites <p><small>* See details in separate table</small></p> | <ul style="list-style-type: none"> Train Stations Commuter Rail Lines Trains |
| Locally Identified Hazard Areas
<ul style="list-style-type: none"> Brush Fires Flooding Drifting Snow Development Sites <p><small>* See Section IV Risk Assessment</small>
 <small>* See details in separate table</small></p> | All Roads
<ul style="list-style-type: none"> Interstate U.S. Highway State Route Street |

0 0.5 1 Miles



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Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770

Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Imagery © Google
CONCORD, MA
Map 8: Local Hazard Areas
Date: 2/3/2017

**TOWN OF CONCORD HAZARD MITIGATION PLAN
2017 UPDATE**

**APPENDIX C
DOCUMENTATION OF PUBLIC MEETINGS**

**TOWN OF CONCORD HAZARD MITIGATION PLAN
2017 UPDATE**

Amanda Linehan, Communications Manager, Metropolitan Area Planning Council
617-933-0705, alinehan@mapc.org

CALENDAR LISTING / MEDIA ADVISORY

**CONCORD'S DRAFT HAZARD MITIGATION PLAN TO BE PRESENTED
AT NOVEMBER 15 PUBLIC MEETING**

Meeting to present the 2017 update of Concord's Hazard Mitigation Plan and solicit public comments

Who: Concord residents, business owners, representatives of non-profit organizations and institutions, and others who are interested in preventing and reducing damage from natural hazards.

What: At the Concord Planning Board meeting on Tuesday, November 15 at 7:00 PM, a presentation will be made by the Metropolitan Area Planning Council (MAPC), which is assisting the Town on the 2016 update of its Hazard Mitigation Plan.

The Town of Concord adopted its first Hazard Mitigation Plan in 2010, which was approved by the Federal Emergency Management Agency (FEMA). The plan identifies natural hazards affecting Concord such as floods, hurricanes, winter storms, and earthquakes, as well as actions that the Town can take to reduce its vulnerability to these hazards.

When: Tuesday, November 15 2016, 7:00 PM

Where: 1st floor Meeting Room, 141 Keyes Road, Concord, MA

MAPC is the regional planning agency for 101 communities in the metropolitan Boston area, promoting smart growth and regional collaboration. More information about MAPC is available at www.mapc.org.

##

HAZARD MITIGATION PLAN PUBLIC MEETING

Natural hazards can have serious impacts
on the Town of Concord and its residents



The Concord Hazard Mitigation Plan is being updated to help the town reduce its vulnerability to natural hazard events such as flooding, hurricanes and winter storms. Please join the Town for a public presentation and discussion about the update to the Concord Hazard Mitigation Plan at a public meeting of the Planning Board:

Date: Tuesday, November 15, 2016
Time: 7:00 PM
Location: 1st Floor Meeting Room
141 Keyes Road, Concord MA

For more information, please contact Anne Herbst via phone at (617) 933-0781 or email aherbst@mapc.org



**TOWN OF CONCORD HAZARD MITIGATION PLAN
2017 UPDATE**



**Town of Concord
Planning Board Agenda
November 15, 2016 at 7:00 p.m.
141 Keyes Road – 1st Floor Meeting Room**

- 7:00 p.m. Update to Concord’s Hazard Mitigation Plan discussion and presentation by Metropolitan Area Planning Council Staff
- 7:30 p.m. Potential Tree Preservation Bylaw Discussion & 2017 Annual Town Meeting Potential Zoning Bylaw Amendment to Section 7.1.5
- 8:00 p.m. Recommendation to the Board of Appeals re: Application of the Concord Museum for a Special Permit and Site Plan Approval, under Sections 7.7.2.12, 11.6, and 11.8, for relief from the parking requirements, to demolish an existing structure (Davis Building) and construct an addition to the existing museum for educational and philanthropic uses at 200/216/226 Lexington Road & 9A/73 Cambridge Turnpike (Parcels # 0109, 0108, 0107, 0106, & 0105)
- 8:30 p.m. Review of Preliminary Subdivision Plan #241: Application of Keuka Road LLC for a Preliminary Subdivision Plan “Hosmer Meadow Subdivision” to allow a road improvement with waivers for a 5-lot subdivision for the future development of 11 dwelling units on 12.48 acres off Keuka Road (Parcels 3838, 3842-2, 3849, 3850, 3851, and 3825).
APPLICANT HAS REQUESTED A CONTINUANCE TO THE DECEMBER 13, 2016 MEETING. THE BOARD WILL VOTE ON THE CONTINUANCE ONLY, WITH NO DISCUSSION.

Also to be discussed:

1. Approval Not Required Plan, land of Thoreau Realty Trust at 235 & 275 Forest Ridge Road, Parcel 2970-1-5
2. Comprehensive Long Range Plan update & discussion session
3. Minutes: October 25, 2016
4. Committee Liaison Reports and staff updates
5. Public Comment

Please note: Plans and/or supporting documentation on the above agenda items are available for review in the Department of Planning & Land Management office, 141 Keyes Road, 8:30 a.m. to 4:30 p.m., Monday – Friday. Agenda items will be taken up in the order shown above and not before the times shown. However, the times scheduled are not intended to represent any estimate of the time that may be necessary to discuss each item.

**TOWN OF CONCORD HAZARD MITIGATION PLAN
2017 UPDATE**

Amanda Linehan, Communications Manager, Metropolitan Area Planning Council
617-933-0705, alinehan@mapc.org

CALENDAR LISTING / MEDIA ADVISORY

**CONCORD'S DRAFT HAZARD MITIGATION PLAN TO BE
PRESENTED AT MAY 8 PUBLIC MEETING**

*Meeting to present the 2017 update of Concord's Hazard Mitigation Plan and
solicit public comments*

Who: Concord residents, business owners, representatives of non-profit organizations and institutions, and others who are interested in preventing and reducing damage from natural hazards.

What: The Concord Hazard Mitigation Team will hold a public meeting to present an overview of the draft Concord Hazard Mitigation Plan Update 2017. The Metropolitan Area Planning Council (MAPC) is assisting the Town on the plan update, and a representative of MAPC will present an overview of the plan update.

The Town of Concord adopted its first Hazard Mitigation Plan in 2010, which was approved by the Federal Emergency Management Agency (FEMA). The plan identifies natural hazards affecting Concord such as floods, hurricanes, winter storms, and earthquakes, as well as actions that the Town can take to reduce the impacts of these hazards. FEMA requires that plans be updated regularly, so MAPC is assisting the Town prepare a 2017 updated plan.

When: Monday, May 8, 2017, 7:00 PM

Where: Concord Town House, 22 Monument Square, Concord, MA

MAPC is the regional planning agency for 101 communities in the metropolitan Boston area, promoting smart growth and regional collaboration. More information about MAPC is available at www.mapc.org.

##

HAZARD MITIGATION PLAN PUBLIC MEETING

Natural hazards can have serious impacts on the Town of Concord and its residents



The Concord Hazard Mitigation Plan is being updated to help the town reduce its vulnerability to natural hazard events such as flooding, hurricanes and winter storms.

Join the town's Hazard Mitigation Team for a presentation and discussion about the draft 2017 update to the Concord Hazard Mitigation Plan at a public meeting of the Concord Select Board:

Date: Monday, May 8, 2017
Time: 7:00 PM
Location: 22 Monument Square
Concord MA

For more information, please contact Anne Herbst via phone at (617) 933-0781 or email aherbst@mapc.org



**TOWN OF CONCORD HAZARD MITIGATION PLAN
2017 UPDATE**

**TOWN OF CONCORD HAZARD MITIGATION PLAN
2017 UPDATE**

**APPENDIX D
DOCUMENTATION OF PLAN ADOPTION**

**TOWN OF CONCORD HAZARD MITIGATION PLAN
2017 UPDATE**

<TOWN LETTERHEAD>

**CERTIFICATE OF ADOPTION
SELECT BOARD
TOWN OF CONCORD, MASSACHUSETTS**

A RESOLUTION ADOPTING THE
TOWN OF CONCORD HAZARD MITIGATION PLAN 2017 UPDATE

WHEREAS, the Town of Concord established a Committee to prepare the *Town of Concord Hazard Mitigation Plan 2017 Update*; and

WHEREAS, the *Town of Concord Hazard Mitigation Plan 2017 Update* contains several potential future projects to mitigate potential impacts from natural hazards in the Town of Concord, and

WHEREAS, duly-noticed public meetings were held by the LOCAL HAZARD MITIGATION PLANNING TEAM on November 15, 2016, and May 8, 2017, and

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

NOW, THEREFORE BE IT RESOLVED that the Town of Concord SELECT BOARD adopts the *Town of Concord Hazard Mitigation Plan 2017 Update*, in accordance with M.G.L. 40 §4 or the charter and bylaws of the Town of Concord.

ADOPTED AND SIGNED this Date. _____

Name(s)

Title(s)

Signature(s)

ATTEST