# TOWN OF CONCORD
# HAZARD MITIGATION PLAN
## 2023 UPDATE

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

**FINAL PLAN**
**Adopted by the Town**
**April 3, 2023**

# ACKNOWLEDGEMENTS & 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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# SECTION 1: 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. This plan considers how our warming climate will affect natural hazards. Warming temperatures will fuel changing precipitation patterns, sea level rise, and an increasing frequency and intensity of severe storms. The Federal Disaster Mitigation Act of 2000 requires all municipalities that wish to receive FEMA funding for hazard mitigation grants, to adopt a local multi-hazard mitigation plan and update this plan in five-year intervals in order to maintain FEMA eligibility.

## PLANNING PROCESS

The Hazard Mitigation Plan 2023 Update was led by the Concord Local Hazard Mitigation Planning Team ("Local HMP Team" or "Local Team"), composed of staff from different town departments and boards including Fire, Police, Engineering, Water and Sewer, Public Health, Natural Resources, Planning, Inspections, Concord Municipal Light Plant, Highway and Grounds, Town Manager's Office, and Climate Action Advisory Board. The Local HMP Team convened on July 13, August 25, and November 8, 2022, to discuss the impacts of natural hazards on various areas in town, the effects of climate change, goals for addressing these impacts, updates to the Town's existing mitigation measures, and new or revised hazard mitigation measures that would enhance resiliency of the town and its residents.

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 Local HMP Team also hosted two public meetings. The first meeting on October 12, 2022, was held via Zoom. The second meeting was held on November 30, 2022, also via Zoom. The draft plan was also posted on the Town's website for a 10-day public review from December 1 through December 15, 2022. Key stakeholders and neighboring communities were notified and invited to review the draft plan and submit comments. See Public Comments for feedback.

## 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, drought, and invasive species. For each risk, the assessment identifies the projected impacts of a warming climate. These are shown in the map series in Appendix B. The Concord Local HMP Team identified 142 critical facilities throughout the town. These are also shown on the map series in Appendix B and listed in Table 30, identifying which facilities are located within the mapped hazard zones.

Hazards U.S. – Multihazards (HAZUS-MH) is a standardized methodology developed by FEMA that utilizes Geographic Information Systems (GIS) to estimate physical, economic, and social

impacts of disasters. The HAZUS-MH analysis for Concord estimates property damages from Hurricanes of category 2 and 4 ($19.1 million to $246.1 million), earthquakes of magnitudes 5 and 7 ($563.1 million to $3.9 billion), and the 1% and .2% chance of flooding ($92.3 million to $135.1 million).

## HAZARD MITIGATION GOALS

The Local HMP Team endorsed the following seven hazard mitigation goals at the August 25, 2022, team meeting. The team added a ninth goal focused on incorporating future climate change projections.

1. Prevent and reduce the loss of life, injury, public infrastructure, public health impacts and property damage resulting from all major natural hazards.
2. Identify and seek funding for measures to mitigate or eliminate each known significant hazard area.
3. Incorporate hazard mitigation planning as an integral factor in all relevant municipal departments, committees, and boards.
4. Prevent and reduce the damage to public infrastructure and resources resulting from all hazards, especially the critical services for climate-vulnerable populations.
5. Work with the business community, major institutions, and non-profits to develop, review, and implement the hazard mitigation plan that ensures prompt recovery and continuity of operations during and post emergency events of disasters.
6. Work with surrounding communities, state, regional and federal agencies to ensure regional cooperation, communications, and solutions for hazards affecting multiple communities.
7. Ensure that future development meets federal, state, and local standards for preventing and reducing the impacts of natural hazards.
8. Take maximum advantage of resources from FEMA and MEMA to communicate and educate Town staff and the public about hazard mitigation.
9. Consider the current and future impacts of climate change. Incorporate climate sustainability and resiliency in hazard mitigation planning.

## HAZARD MITIGATION STRATEGY

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

## PLAN REVIEW & UPDATE PROCESS

A summary of the process for developing Concord's Hazard Mitigation Plan 2023 Update is provided in Table 1 below.

**Table 1: Plan Review and Update Process**

| | Reviews and Updates |
|---|---|
| **Section 3: Public Participation** | The Local HMP Team placed an emphasis on public participation for the update of the Hazard Mitigation Plan, 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 Hazard Mitigation Team. The plan was also available on the Town's website for public comment. See Public Comments for feedback. |
| **Section 4: Risk Assessment** | MAPC gathered the most recently available climate, 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 to create an up-to-date list. The Risk Assessment integrates projected climate impacts. MAPC also used the most recently available version of HAZUS and assessed the potential impacts of flooding using the latest data. |
| **Section 5: Goals** | The Concord Local HMP Team updated and endorsed the Hazard Mitigation Goals. |
| **Section 6: Existing Mitigation Measures** | The list of existing mitigation measures has been updated to reflect current mitigation activities in town. |
| **Sections 7 and 8: Hazard Mitigation Strategy** | Mitigation measures from the 2017 Plan were reviewed and assessed as to whether they were completed, in progress, or deferred. The Local HMP Team determined whether to carry forward measures into the 2023 Plan Update or modify or delete them. The Plan Update's hazard mitigation strategy reflects both new measures and measures carried forward from the 2017 plan. The Local HMP prioritized these mitigation measures based on current conditions. |
| **Section 9: 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 planning and regulatory review processes and better prepare the Town for the next comprehensive plan update. |

The Town of Concord has made progress implementing mitigation measures identified in the 2010 as well as 2017 HMPs. Since 2017, medium and high priority projects that were completed include drainage upgrades in various locations; conducting town-wide shade tree inventory and management planning; improving communications and monitoring during winter storms; and integrating sustainability in planning efforts.

Many of the mitigation measures are also in progress or continue as ongoing operations and maintenance programs and community outreach efforts. Overall, many of the "in progress" or "ongoing" mitigation measures from the 2017 plan will be continued in this plan update. Most retain the same priority in this 2023 Update, a couple measures previously indicated as "Medium" will be elevated to "High" priority in this 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.

# SECTION 2: 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 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.

The Federal Emergency Management Agency (FEMA) administers federal hazard mitigation planning and grant programs 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).

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. Concord has since completed the first Plan Update in 2017. This 2023 Plan serves as the second update upon completion and adoption.

## 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. This plan incorporates consideration of future risks due to projections for the increased frequency and severity of extreme weather fueled by a warming planet.

## PREVIOUS FEDERAL/STATE DISASTERS

As noted in the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP), Middlesex County, in which Concord is located, has experienced 22 natural hazards that triggered federal or state disaster declarations since 1991 (see Table 2 for statewide list of disasters). The majority of these events involved flooding, while others were due to hurricanes or nor'easters, and severe winter weather.

**Table 2: Federal/State Disaster Declarations, 1991-2018**

| Disaster Name | Date of Event | Declared Areas |
|---|---|---|
| Hurricane Bob | August 1991 | Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk |
| Severe Coastal Storm No Name Storm | October 1991 | Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk |
| Blizzard | December 1992 | Counties of Barnstable, Dukes, Essex, Plymouth, Suffolk |
| Blizzard | March 1993 | Statewide |
| Blizzard | January 1996 | Statewide |
| Windstorm | May 1996 | Counties of Essex, Plymouth, Norfolk, Bristol |
| Severe Storms, Flood | October 1996 | Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk |
| Heavy Rain, Flood | June 1998 | Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester |
| Severe Storms, Flood | March 2001 | Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester |
| Snowstorm | March 2001 | Counties of Berkshire, Essex, Franklin, Hampshire, Middlesex, Norfolk, Worcester |
| Snowstorm | February 2003 | Statewide |
| Snowstorm | December 2003 | Counties of Barnstable, Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, Worcester |
| Flooding | April 2004 | Counties of Essex, Middlesex, Norfolk, Suffolk, Worcester |
| Blizzard | January 2005 | Statewide |
| Hurricane Katrina | August 2005 | Statewide |
| Severe Storms, Flooding | October 2005 | Statewide |
| Severe Storms, Flooding | May 2006 | Statewide |
| Nor'easter | April 2007 | Statewide |
| Severe Storms, Flooding | December 2008 | Counties of Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Suffolk, and Worcester |
| Severe Storms, Flooding | December 2008 | Statewide |

| Disaster Name | Date of Event | Declared Areas |
|---|---|---|
| Severe Storms, Flooding | March/April 2010 | Counties of Bristol, Essex, Middlesex, Suffolk, Norfolk, Plymouth, Worcester |
| Severe Winter Storm, Snowstorm | January 2011 | Counties of Berkshire, Essex, Hampden, Hampshire, Middlesex, Norfolk, Suffolk |
| Severe Winter Storm, Snowstorm and Flooding | February, 2013 | Statewide |
| Severe Winter Storm, Snowstorm, and Flooding | April 2013 | Statewide |
| Severe Winter Storm, Snowstorm, and Flooding | April 2015 | Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester |
| Severe winter storm and flooding | March 2018 | Counties of Barnstable, Bristol, Essex, Nantucket, Norfolk, Plymouth |
| Severe winter storm and Snowstorm | March 2018 | Counties of Essex, Middlesex, Norfolk, Suffolk, Worcester |

Source: SHMCAP, 2018

## FEMA FUNDED MITIGATION PROJECTS

To date, the Town of Concord has received funding from FEMA for three mitigation projects under the Hazard Mitigation Grant Program (HMGP). The projects are summarized in Table 3 below.

**Table 3: FEMA-Funded Mitigation Projects**

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

(Source: database provided by MEMA)

## COMMUNITY PROFILE [1]

The Town of Concord is in Middlesex County, 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 west of Boston, and 34 miles northeast of Worcester. The Fitchburg line of the commuter rail runs through Concord, with two stations – Concord and West Concord. Major local roadways (maintained by Town) include Routes 62, 117, and 126. State roadways include Routes 2, 2A, 111/119, 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 State Reservation, and the Great Meadows National Wildlife Refuge. The Assabet and Sudbury Rivers converge in Concord to form the Concord River. The Northeastern Correctional Center and MCI-Concord are located in Concord. Concord is also home to several historic resources, including nine well-preserved colonial houses on or near Concord Green and witnesses to the famous Battle of Concord.

**Table 4: Town of Concord's Demographics and Characteristics**

- Population: 18,950 residents
  - 24% are under age 18
  - 55% are between age 18-64
  - 21% are over age 65
  - 79% of the population is White
  - 7% of the population is Hispanic
  - 4% of the population is Black
  - 8% of the population is Asian
- About 2.7% of residents are living below poverty level. Median household income in Concord is $160,392 (nearly double the amount of statewide median household income).
  - 2% of seniors are living below poverty level.
- Number of housing units: 7,066
  - 26% are renter-occupied

Source: 2020 U.S Census Bureau; 2020 American Community Survey (ACS).

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.

There are slightly fewer than 11,807 jobs in Concord. A part of Hanscom Airfield is located in eastern Concord. Emerson Hospital, a regional medical facility, is in Concord. According to the hospital's website, the facility provides medical services to more than 300,000 people in 25 communities.

1 Envision Concord Comprehensive Long-Range Plan (2018)

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, flow through 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 provide an important urban canopy and reduce heat-island effects.
- The town is home to over 50 registered farms with animals such as horses, goats, and chickens 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 natural, cultural, and 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's official website is https://www.concordma.gov/.

# SECTION 3: PLANNING PROCESS & 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 and regional climate change. Public participation is a central component of this process, providing critical information about the local occurrence of hazards while also serving to build a base of support for hazard mitigation activities. MAPC supports participation by the public and other plan stakeholders through two public meetings, posting of meeting materials and draft plan to the Town's website, and invitations sent to neighboring communities, town boards and commissions, and other local or regional entities to review the plan and provide comment.

## PLANNING PROCESS SUMMARY

The six-step planning process outlined below is based on the guidance provided by FEMA's 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. 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.

**Figure 1: Six-Step Planning Process**


1. **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.

2. **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 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, General Bylaws
   - Town of Concord, Zoning Bylaw
   - Town of Concord, Comprehensive Long-Range Plan "Envision Concord – Bridge to 2030," 2018
   - Town of Concord Open Space Plan, 2015
   - Town of Concord Water Quality Report, 2020
   - Town of Concord Climate Action and Resilience Plan, 2020
   - Town of Concord, Municipal Vulnerability Preparedness (MVP) Planning Report, 2019
   - Blue Hill Observatory
   - FEMA, Flood Insurance Rate Maps for Middlesex County, MA, 2013
   - FEMA, Hazards U.S. Multi-Hazard
   - FEMA, Local Mitigation Plan Review Guide, April 2022
   - Fourth National Climate Assessment, 2018
   - Massachusetts Flood Hazard Management Program
   - Massachusetts Office of Coastal Zone Management Shoreline Change Data
   - Massachusetts Office of Dam Safety, Inventory of Massachusetts Dams 2018
   - Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 2018 (and 2020 Draft Updates)
   - Metropolitan Area Planning Council, GIS Lab, Regional Plans and Data
   - National Weather Service
   - Nevada Seismological Library
   - New England Seismic Network, Boston College Weston Observatory, http://aki.bc.edu/index.htm
   - NOAA National Climatic Data Center, http://www.ncdc.noaa.gov/
   - Northeast Climate Adaptation Science Center
   - Northeast States Emergency Consortium, http://www.nesec.org/
   - Tornado History Project
   - US Census, 2020 and American Community Survey 2020
   - USGS, National Water Information System, http://nwis.waterdata.usgs.gov/usa/nwis
   - USDA Forest Service, Wildfire Risk to Communities, www.wildfirerisk.org
   - University of Massachusetts Boston, "Climate Change Impacts and Projections for the Greater Boston Area: Findings of the Greater Boston Research Advisory Group Report," 2022

3. **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. Many communities have started adopting regulations designed to promote climate resilience. All current municipal mitigation measures must be documented.

4. **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 Section 7.

5. **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 Section 9 and documentation of plan adoption can be found in Appendix D.

6. **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. Section 9 includes more detailed information on plan implementation.

## 2017 PLAN IMPLEMENTATION & MAINTENANCE

Town of Concord's 2017 Hazard Mitigation Plan Update 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. Examples of high priority projects that were completed to date included: drainage improvements to Cambridge Turnpike; conducting alternatives analysis for flood protection at Lowell Road wastewater pump station; culvert replacements (although this is an ongoing effort); and identifying alternate option for community sheltering (also an ongoing effort).

## THE LOCAL MULTIPLE HAZARD COMMUNITY PLANNING TEAM

MAPC worked with the local community representatives to organize a Local HMP Team for Concord. The Local HMP Team is central to the planning process, and it 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 team membership is listed below.

| | |
|---|---|
| Kerry Lafleur | Town Manager |
| Thomas Judge | Chief, Fire Department |
| Walter Latta | Assistant Fire Chief |
| Christopher Carmody | Risk Manager |
| Alan Cathcart | Director, Public Works |
| Aaron Miklosko | Highway & Grounds Superintendent |

| | |
|---|---|
| Jeffrey Murawski | Water/Sewer Superintendent |
| Steve Dookran | Town Engineer |
| David Wood | Director, Municipal Light Plant |
| Joseph O'Connor | Chief, Police Department |
| Erin Stevens | Manager, Public Information & Communications |
| Delia Kaye | Director, Natural Resources |
| Marcia Rasmussen | Director, Planning and Land Management |
| Melanie Dineen | Director, Public Health |
| Paul Creedon | Commissioner, Building & Inspections |
| Jason Bulger | Chief Technology Officer, IT |
| John Bolduc | Climate Action Advisory Board |

The Assistant Fire Chief convened and solicited feedback with representatives of other town departments, commissions and boards, and all entities responsible for regulating and maintaining operations of the town. The Department of Planning and Land Management, the Town Manager's Office, and Concord Public Works (CPW) are responsible for managing and regulating development in town. The Town's Climate Action Advisory Board also participated on the HMP Local Team to provide feedback and ensure the town's mitigation and resilience initiatives are also aligned with this hazard mitigation planning effort. In addition, MAPC, the State-designated regional planning authority for Concord, works with all agencies that regulate development in the region, including state agencies such as the Department of Transportation and the Department of Conservation and Recreation.

The Local HMP Team met on the following dates: July 13, August 25, and November 8, 2022. The purpose of the meetings was to provide an overview of the Hazard Mitigation planning program, consider climate impacts, review, and update hazard mitigation goals, and to gather information on local hazard mitigation issues and sites or areas related to these. Later meetings focused on verifying information gathered by MAPC staff and discussion of existing mitigation practices, the status of mitigation measures identified in the 2017 HMP Update, and potential new or revised mitigation measures. The agendas for these meetings are included in Appendix A.

## 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 and climate impacts, 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.

The public had an opportunity to provide input to the Town of Concord's hazard mitigation planning process during the first virtual public meeting (Zoom) held on October 12, 2022. The

draft plan update was presented at the second virtual public meeting on November 30, 2022, also on Zoom. Both meetings were publicized in accordance with the Massachusetts Open Meeting Law. See public meeting notices in Appendix C.

## 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. The draft plan was posted on the Town's website for 10 days for public comment; and notice of public meetings and opportunity to comment were promoted on the Town's social media outlets. Members of the public could access the draft document and submit comments or questions to the Town. Public meeting presentations were also shared across these communications platforms.

Notice of the draft plan was also sent to the following town boards and commissions, community organizations and neighboring municipalities inviting them to review the Hazard Mitigation Plan and submit comments to the Town:

- Planning Board
- Natural Resources Commission
- Emergency Planning Committee
- Climate Action Advisory Board
- Housing Authority
- Board of Health
- Council on Aging
- Park Commission
- Great Meadows National Wildlife Refuge (U.S. Fish and Wildlife)
- U.S. Army Corps of Engineers Regional Headquarters
- Walden Pond State Reservation (MA DCR)
- Emerson Hospital
- Concord Chamber of Commerce
- Walden Street School
- Concord Academy
- Concord Museum
- DeCordova Museum
- NE Deaconess Newbury Court
- Concord Business Partnership
- Concord Park Assisted Living
- Town of Acton
- Town of Bedford
- Town of Lincoln

- Town of Sudbury
- Town of Carlisle
- Town of Maynard
- Town of Wayland

## PUBLIC COMMENT

At the first public meeting, the Local HMP Team encouraged the public to share their experiences and concerns related to the natural hazards identified. Questions to prompt discussion include:

- What have you experienced at home/in your neighborhood? (Regarding flooding, extreme heat/heatwaves, or extreme storm events, etc.)
- What are your concerns?
- What are your suggestions?

There were 20 participants at the first public meeting. The Local HMP Team did not receive comments specific to these questions during this public meeting. Additional concerns posed from the public included status of completion of mitigation measures included in the 2017 HMP, preparedness measures in response to future extreme flood events as well as extreme weather events (such as tornadoes, wildfires, etc.), and consideration of the town's energy vulnerability and adaptive capacity. The Team assured the public that these are also the questions the group will discuss during the development of new potential mitigation measures to be included in the 2023 HMP Update.

There were 13 participants at the second public meeting. While there was no additional feedback on local hazard areas or identified critical infrastructure, questions from participants focused on clarifying details about the proposed mitigation measures. Participants indicate they are supportive of the proposed mitigation measures. Generally, the presentation of the draft plan was well received at the meeting.

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

## PLANNING TIMELINE

| | |
|---|---|
| July 13, 2022 | Meeting of the Concord Local Hazard Mitigation team |
| August 25, 2022 | Meeting of the Concord Local Hazard Mitigation team |
| October 12, 2022 | First Public Meeting held virtually |
| November 8, 2022 | Meeting of the Concord Local Hazard Mitigation Team |
| November 30, 2022 | Second Public Meeting held virtually |
| December 22, 2022 | Draft Plan Update submitted to MEMA |
| January 19, 2023 | Revised Draft Plan submitted to MEMA |
| April 3, 2023 | Plan Adopted by the Town of Concord |
| TBD | FEMA final approval of the plan for 5 years |

### POST-APPROVAL IMPLEMANTATION AND PLAN UPDATE TIMELINE

| | |
|---|---|
| 2024 | Conduct Mid-Term Plan Survey on Progress |
| 2025 | Seek FEMA grant to prepare next plant update |
| 2026 | Begin process to update the plan |
| 2027 | Submit Draft 2027 Plan Update to MEMA and FEMA |
| 2027 | FEMA approval of 2027 Plan Update |

# SECTION 4: 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 damage that could result from certain large-scale natural hazard events. To update Concord's risk assessment, MAPC gathered the most recently available hazard and land use data and discussed with Local HMP Team to identify changes in local hazard areas and development trends. MAPC also used FEMA's damage estimation software, HAZUS.

In this 2023 plan update, the projected impacts of our warming climate on natural hazards are integrated throughout the risk assessment. Key impacts include rising temperatures, which in turn affect precipitation patterns, sea level, and extreme weather. Analysis of these impacts included in this plan aligned closely with the data and assessment presented in Massachusetts's 2018 State Hazard Mitigation and Climate Adaptation Plan (2018 SHMCAP).

> *"Global climate is changing rapidly compared to the pace of natural variations in climate that have occurred throughout Earth's history. Global average temperature has increased by about 1.8°F from 1901 to 2016, and observational evidence does not support any credible natural explanations for this amount of warming; instead, the evidence consistently points to human activities, especially emissions of greenhouse or heat-trapping gases, as the dominant cause."*
>
> Fourth National Climate Assessment, 2018 (Chapter 2-1)

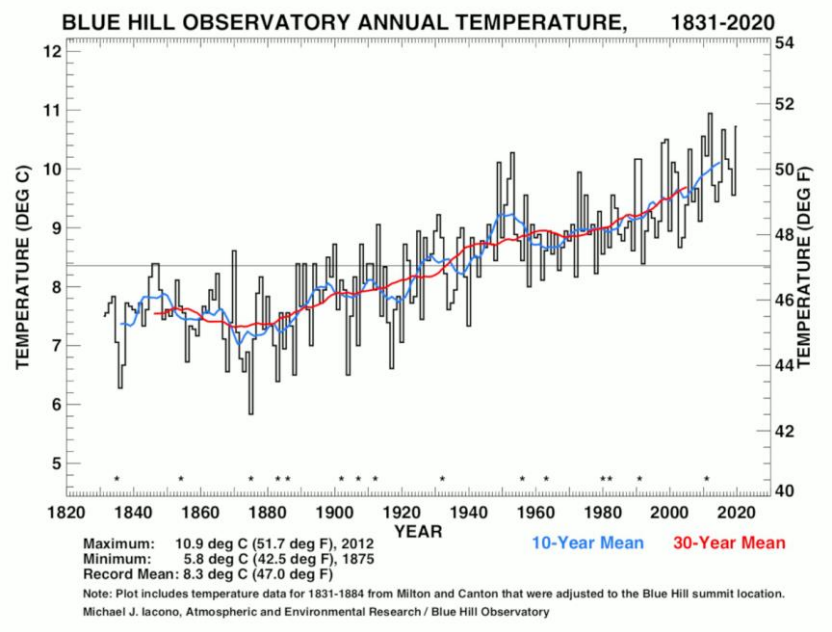
## CLIMATE CHANGE OBSERVATIONS AND PROJECTIONS

Climate change observations come from a variety of data sources that have measured and recorded changes in recent decades and centuries. Climate change projections, however, predict future climate impacts and, by their nature, cannot be observed or measured. As a result of the inherent uncertainty in predicting future conditions, climate projections are generally expressed as a range of possible impacts.

**Temperature**

Our climate has always been regulated by gases, including carbon dioxide, methane, and nitrous oxide, that blanket the earth. These gases trap heat that would otherwise be reflected out to space; without them our planet would be too cold to support life. We refer to these gases as "greenhouse gases" (GHGs) for their heat trapping capacity. The combustion of fossil fuels, our primary energy source in the age of industrialization, releases GHGs into the atmosphere. In the past century, human activity associated with industrialization has contributed to a growing concentration of GHGs in our atmosphere. Records from the Blue Hill Observatory in Milton, MA show that average temperatures (30-year mean) have risen approximately 3 degrees F in the almost 200 years since record keeping began in 1831 (Figure 2).

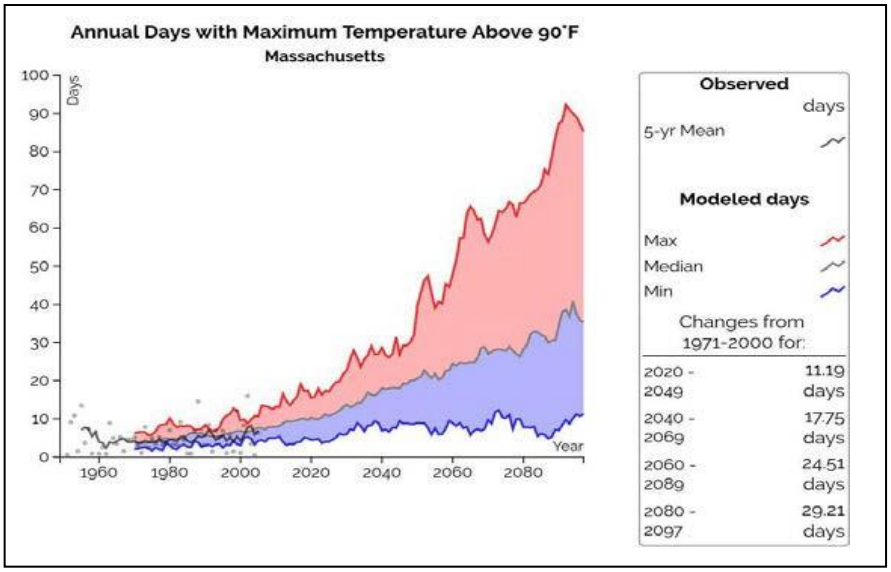
### Figure 2: Observed Increase in Temperature




Source: Northeast Climate Adaptation Science Center

Climate projections include an increase in average temperature and in the number of extreme heat days. Extreme cold days are projected to decrease in number. The Northeast Climate Adaptation Science Center (NECASC) projects average temperatures in Massachusetts will increase by 5 degrees F by mid-century and nearly 7 degrees F by the end of the century. Figure 3 shows the range of projections for increases in the number of days over 90 degrees annually.

### Figure 3: Projected Increase in Annual Days Over 90 Degrees F




Source: ResilientMA.org

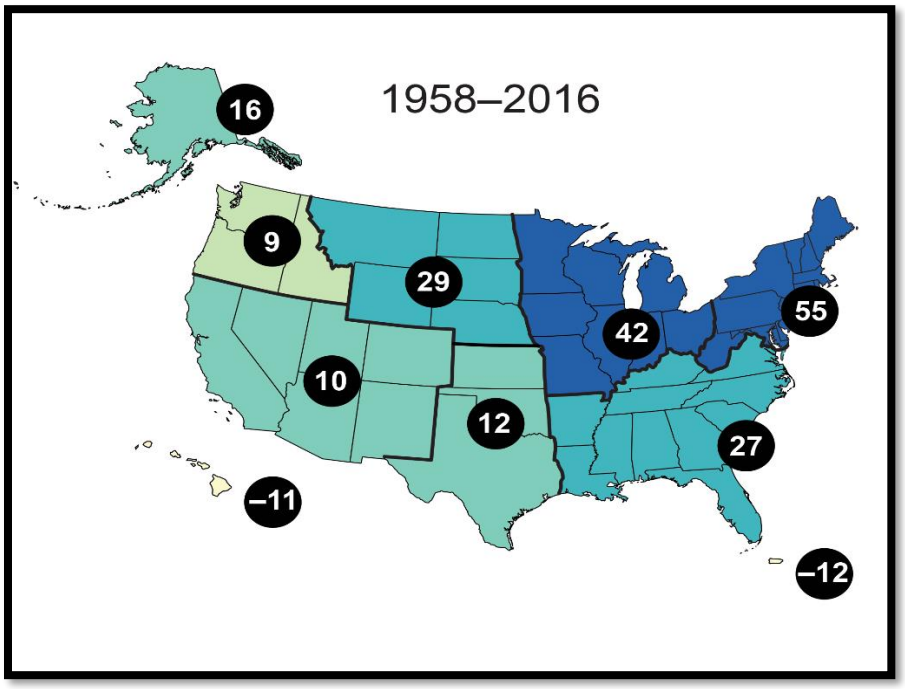
**Precipitation Patterns**

Annual precipitation in Massachusetts has increased by approximately 10% in the fifty-year period from 1960 to 2010 (MA Climate Adaptation Report, 2011). Moreover, there has been a significant increase in the frequency and intensity of large rain events. For the Northeast US, according to the Fourth National Climate Assessment 2018, in the past sixty years there has been a 55% increase in the amount of annual precipitation that falls in the top 1% of storm events (Figure 4). Changes in precipitation are fueled by warming temperatures which increase evaporation and, therefore, the amount of water vapor in the air.

Total annual precipitation in Massachusetts is projected to increase by 1 to 6 inches by mid-century, and by 1.2 to 7.3 inches by the end of this century (SHMCAP p. 2-22). The Fourth National Climate Assessment predicts that the pattern of increasing frequency and intensity of extreme rain events will continue. By 2070 to 2099, (relative to 1986 to 2015) they project a 30-40% increase in total annual precipitation falling in the heaviest 1% of rain events (Figure 5).

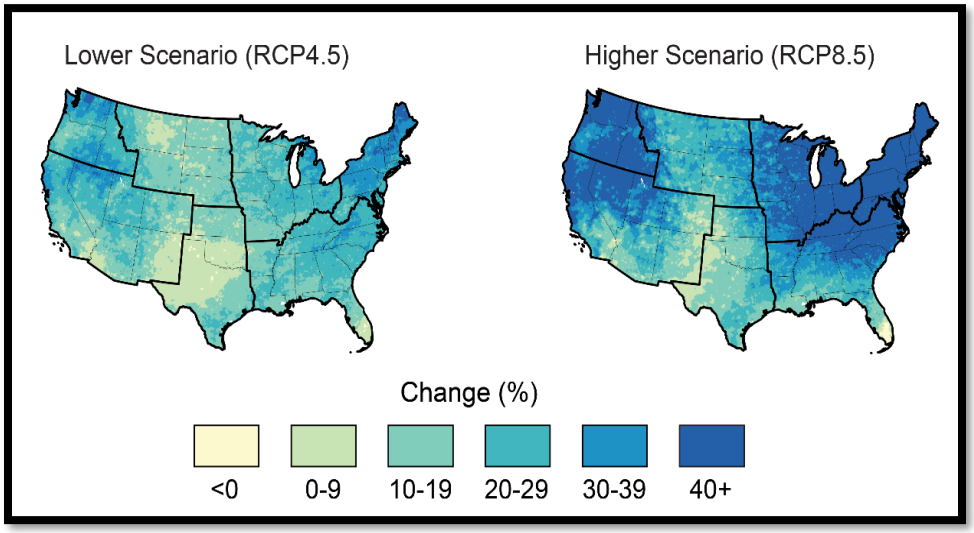
Despite overall increasing precipitation, more frequent and significant summer droughts are also a projected consequence of climate change. This is due to projections that precipitation will increase in winter and spring and decrease slightly in the summer, a result of earlier snow melt and higher temperatures that will reduce soil moisture.

**Figure 4: Observed Change in Total Annual Precipitation Falling in the Heaviest 1% of Events**




Numbers circled in black indicate % change.
Source: Fourth National Climate Assessment, 2018

**Figure 5: Projected Change in Total Annual Precipitation Falling in the Heaviest of 1% of Events for 2070-2099**




Source: Fourth National Climate Assessment, 2018

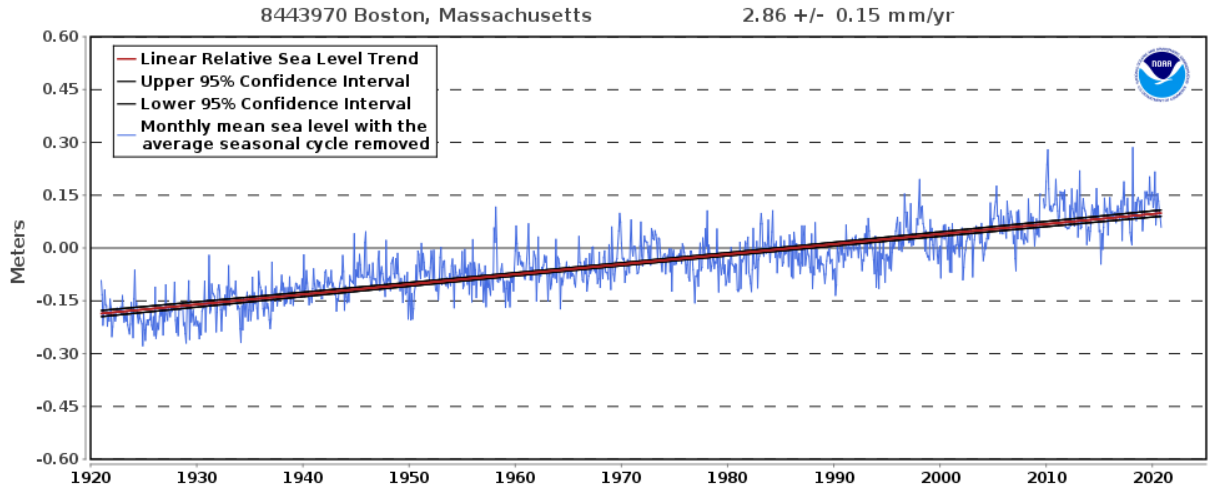
**Sea Level Rise**

While Concord is not a coastal community, high-level information on sea level rise is discussed here as the regional economy of Boston Metro may be impacted by sea level rise in the future.

Records from the Boston Tide Station show nearly one foot of sea level rise in the past century (Figure 6). Warming temperatures contribute to sea level rise in two ways. First, warm water expands to take up more space. Second, rising temperatures are melting land-based ice which enters the oceans as melt water. A third, quite minor, contributor to sea level rise in New England is not related to climate change. New England is still experiencing a small amount of land subsidence (drop in elevation) in response to the last glacial period.

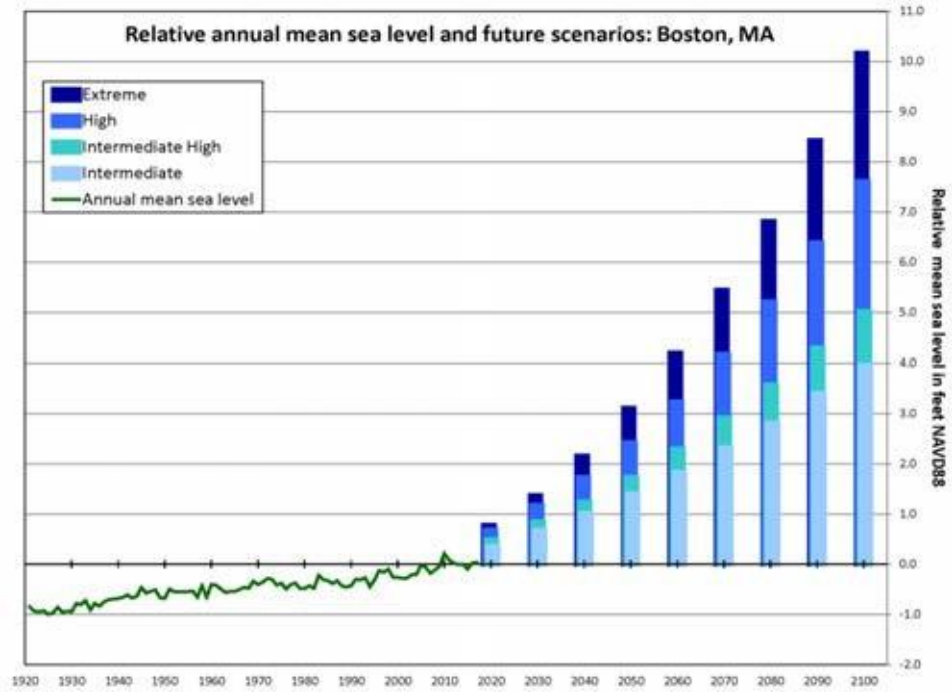
Projections of sea level rise through 2100 vary significantly depending on future greenhouse gas emissions and melting of land-based glaciers. Currently sea level is rising at an increasing rate. Figure 7 shows the recent rate of sea level rise, and a range of sea level rise scenarios. Projections for 2100 range from 4 feet to 10 feet. With 10 feet representing the most extreme scenario. For 2050, the projections range approximately 1.5 to 3 feet.

## Figure 6: Observed Increase in Sea Level Rise




Source: NOAA

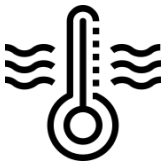
## Figure 7: Recent and Projected Increase in Sea Level Rise




Source: SHMCAP, 2018

Following the outline of 2018 SHMCAP, this local hazard mitigation plan organizes consideration of natural hazards based on their relationship to projected climate changes. Table 5 below, from the SHMCAP, summarizes the natural hazards reviewed in this plan, climate interactions, and expected impacts.

**Table 5: Climate Change and Natural Hazards**

| Primary Climate Change Interaction | Natural Hazard | Other Climate Change Interactions | Representative Climate Change Impacts |
|---|---|---|---|
|  **Changes in Precipitation** | Inland Flooding | Extreme Weather | Flash flooding, urban flooding, drainage system impacts (natural and human-made), lack of groundwater recharge, impacts to drinking water supply, public health impacts from mold and worsened indoor air quality, vector-borne diseases from stagnant water, episodic drought, changes in snow-rain ratios, changes in extent and duration of snow cover, degradation of stream channels and wetland |
| | Drought | Rising Temperatures, Extreme Weather | |
| | Landslide | Rising Temperatures, Extreme Weather | |
|  **Sea Level Rise** | Coastal Flooding | Extreme Weather | Increase in tidal and coastal floods, storm surge, coastal erosion, marsh migration, inundation of coastal and marine ecosystems, loss, and subsidence of wetlands |
| | Coastal Erosion | Changes in Precipitation, Extreme Precipitation | |
| | Tsunami | Rising Temperatures | |
|  **Rising Temperatures** | Average/Extreme Temperatures | N/A | Shifting in seasons (longer summer, early spring, including earlier timing of spring peak flow), increase in length of growing season, increase of invasive species, ecosystem stress, energy brownouts from higher energy demands, more intense heat waves, public health impacts from high heat exposure and poor outdoor air quality, drying of streams and wetlands, eutrophication of lakes and ponds |
| | Wildfires | Changes in Precipitation | |
| | Invasive Species | Changes in Precipitation, Extreme Weather | |
|  **Extreme Weather** | Hurricanes/Tropical Storms | Rising Temperatures, Changes in Precipitation | Increase in frequency and intensity of extreme weather events, resulting in greater damage to natural resources, property, and infrastructure, as well as increased potential for loss of life |
| | Severe Winter Storm / Nor'easter | Rising Temperatures, Changes in Precipitation | |
| | Tornadoes | Rising Temperatures, Changes in Precipitation | |
| | Other Severe Weather (Including Strong Wind and Extreme Precipitation) | Rising Temperatures, Changes in Precipitation | |
| **Non-Climate-Influenced Hazards** | Earthquake | N/A | There is no established correlation between climate change and this hazard |

## OVERVIEW OF HAZARDS AND IMPACTS

Table 6 summarizes the frequency and severity of hazard risks for Massachusetts and the Town of Concord, based on available data from the SHMCAP (for statewide assessment), the National Climatic Data Center (NOAA) for Middlesex County (where Concord is located), and from the local Hazard Mitigation Team's input. The statewide assessment was modified to reflect local conditions in Concord using the definitions for hazard frequency and severity listed below in the "notes" section of the table.

**Table 6: Hazards Risk Summary**

| Hazard | Frequency | | Severity | |
|---|---|---|---|---|
| | MA | Concord | MA | Concord |
| Inland Flooding | High | High | Serious | Serious |
| Drought | Medium | Medium | Minor | Minor |
| Landslides | Low | Very Low | Minor | Minor |
| Coastal Flooding | High | N/A | Serious | N/A |
| Coastal Erosion | Highly variable | N/A | Serious | N/A |
| Tsunami | Very Low | N/A | Extensive | N/A |
| Extreme Temperatures | High | High | Minor | Minor |
| Brush Fires | High | High | Minor | Serious |
| Invasives | N/A | N/A | Minor | Minor |
| Hurricane/Tropical Storm | Medium | Medium | Serious | Serious |
| Severe Winter Storms/Nor'easters | High | High | Extensive | Serious |
| Tornadoes | Medium | Low | Serious | Serious |
| Other Severe Weather (Thunderstorms/High Winds) | High | High | Minor | Minor |
| Earthquake | Very Low | Very Low | Extensive | Extensive |

Notes:

*Frequency:*

- *Very low: events that occur less frequently, less than 1% per year*
- *Low: events that occur 1% to 2% per year*
- *Medium: events that occur 2% to 20% per year*
- *High: events that occur more frequently, 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.*

It should be noted that several of the hazards listed in the 2018 Massachusetts State Hazard Mitigation plan are not applicable to the Town of Concord, as follows:

- **Coastal Flooding, Coastal Erosion, and Tsunami** are not applicable to Concord since the town is not a coastal community.
- **Ice jams** are not a hazard in Concord. The US Army Corps Ice Jam Database shows no record of ice jams in Concord, and the Town did not identify this as an issue of concern.

## FLOOD-RELATED HAZARDS

The Assabet and Sudbury Rivers converge in Concord to form the Concord River, and as such the town is home to a significant amount of floodplain. In addition to these three major rivers, Concord's waterways also consist of tributary streams, low-lying wetland areas, and both manmade and naturally occurring ponds. Flooding is the most prevalent serious natural hazard identified by local officials in Concord. The town is subject to the following kinds of flooding:

- ***Inland/riverine flooding***, where the rate of precipitation and/or amount of stormwater runoff overwhelms the capacity of natural or structured drainage systems causing overflows; and
- ***Urban flooding***, in which precipitation causes rivers and streams rise and leads to flooding of low-lying streets, structures, and underpasses.

Both kinds of flooding are generally caused by severe rainstorms, thunderstorms, Nor'easters, and hurricanes. Spring snowmelt may exacerbate flooding during storm events. Nor'easters are most common in the winter. Thunderstorms and hurricanes are most common in the summer and early fall. Climate change may intensify and worsen these issues over time, with the projected changing rainfall patterns leading to increasing extreme rainfall events. Increase in average annual rainfall may also lead to more incidents of basement flooding caused by high seasonal groundwater levels.

### Regionally Significant Storms

There have been a number of major floods that affect the Boston Metro region in the last fifty years. Significant historic flood events in the region (that also impacted Concord) included:

- The Blizzard of 1978
- January 1979
- April 1987
- October 1991 ("The Perfect Storm")
- October 1996
- June 1998
- March 2001
- April 2004
- May 2006
- April 2007
- March 2010
- March 2013
- January 2018
- March 2018

The best available local data on previous flooding events is for Middlesex County through the "Storm Events Database" of NOAA's National Centers for Environmental Information (NCEI). Between 2010 and 2022, Middlesex County, which includes the Town of Concord, experienced 53 flood events (see Table 7). There were no deaths or injuries reported and the total property damage in the county was over $42 million dollars. The March 2010 storms account for $35.2 million of total damage during this time.

The impacts of flooding on the Town of Concord have not been as severe as many neighboring communities but remain locally significant. Potential damage from flooding in the town was estimated using FEMA's HAZUS-MH program. The results, shown in Table 33, indicate potential damage from a 1% Annual Chance Flood at $92.3 million and from a 0.2% Annual Chance Flood at $135.07 million.

**Table 7: Middlesex County Flood Events, 2010-2022**

| Date | Deaths | Injuries | Property Damage ($) |
|---|---|---|---|
| 3/14/2010 | 0 | 0 | 26,430,000 |
| 3/29/2010 | 0 | 0 | 8,810,000 |
| 4/1/2010 | 0 | 0 | 0 |
| 8/28/2011 | 0 | 0 | 5,000 |
| 10/14/2011 | 0 | 0 | 0 |
| 6/8/2012 | 0 | 0 | 0 |
| 6/23/2012 | 0 | 0 | 15,000 |
| 7/18/2012 | 0 | 0 | 5,000 |
| 10/29/2012 | 0 | 0 | 0 |
| 6/7/2013 | 0 | 0 | 0 |
| 7/1/2013 | 0 | 0 | 0 |
| 7/23/2013 | 0 | 0 | 0 |
| 9/1/2013 | 0 | 0 | 10,000 |
| 3/30/2014 | 0 | 0 | 35,000 |
| 7/27/2014 | 0 | 0 | 0 |
| 8/31/2014 | 0 | 0 | 0 |
| 10/22/2014 | 0 | 0 | 20,000 |
| 10/23/2014 | 0 | 0 | 0 |
| 12/9/2014 | 0 | 0 | 5,000 |
| 12/9/2014 | 0 | 0 | 30,000 |
| 5/31/2015 | 0 | 0 | 0 |
| 8/4/2015 | 0 | 0 | 0 |
| 8/15/2015 | 0 | 0 | 125,000 |
| 9/30/2015 | 0 | 0 | 0 |

| Date | Deaths | Injuries | Property Damage ($) |
|---|---|---|---|
| 4/6/2017 | 0 | 0 | 0 |
| 6/27/2017 | 0 | 0 | 1,000 |
| 7/12/2017 | 0 | 0 | 1,000,000 |
| 7/18/17 | 0 | 0 | 0 |
| 8/2/2017 | 0 | 0 | 5,000 |
| 10/25/17 | 0 | 0 | 0 |
| 10/30/2017 | 0 | 0 | 0 |
| 1/12/2018 | 0 | 0 | 0 |
| 1/13/2018 | 0 | 0 | 0 |
| 4/16/2018 | 0 | 0 | 0 |
| 6/25/2018 | 0 | 0 | 15,000 |
| 8/8/2018 | 0 | 0 | 35,000 |
| 8/12/2018 | 0 | 0 | 30,000 |
| 8/17/2018 | 0 | 0 | 0 |
| 10/29/2018 | 0 | 0 | 0 |
| 11/3/2018 | 0 | 0 | 0 |
| 11/10/2018 | 0 | 0 | 0 |
| 7/6/2019 | 0 | 0 | 0 |
| 8/07/19 | 0 | 0 | 0 |
| 9/2/2019 | 0 | 0 | 300 |
| 6/21/20 | 0 | 0 | 0 |
| 6/28/20 | 0 | 0 | 5,000 |
| 7/23/20 | 0 | 0 | 0 |
| 9/10/20 | 0 | 0 | 3,000 |
| 7/9/21 | 0 | 0 | 0 |
| 9/2/21 | 0 | 0 | 0 |
| 11/12/21 | 0 | 0 | 10,000 |
| 8/5/22 | 0 | 0 | 0 |
| 8/7/22 | 0 | 0 | 0 |
| **Total** | **0** | **0** | **$42.06 M** |

Source: NOAA, National Centers for Environmental Information

### *CHANGING PRECIPITATION PATTERNS*

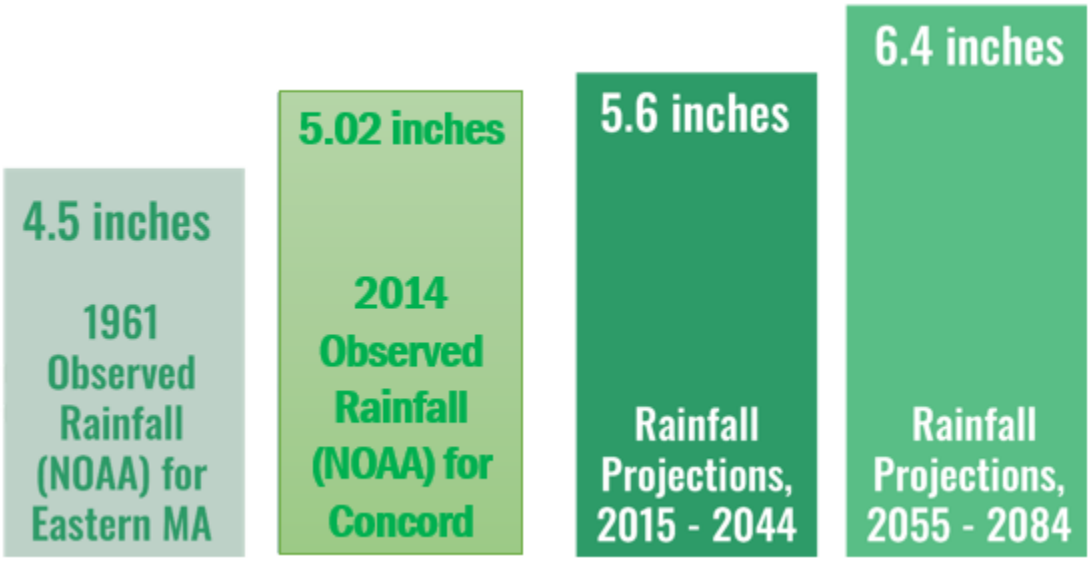
Precipitation frequency estimates, which are used to derive stormwater design standards, were published in 1961 by the U.S. Commerce Department in a document known as TP-40 (Technical Paper 40). The 10-year, 24-hour storm for eastern Massachusetts was calculated as a 4.5-inch

event. Recently the National Oceanic and Atmospheric Administration published updated estimates (NOAA Atlas 14), which increased this design storm by 0.6 inches to 5.14 inches for eastern Massachusetts.

In the future, based on projections developed for the City of Cambridge, the region will likely experience more frequent and intense precipitation events, including an increase in the standard "design storm" from historic levels of 4.5 inches to 6.4 inches by the late 21st century (Figure 8). According to data on ResilientMA.org, by mid- to late century, the region can anticipate 9-10 days with precipitation events with greater than one inch of rain, and an increase in total annual precipitation from 46 to 50 inches.

The March 2010 rainstorms fit the profile of a type of event expected to increase in frequency as the climate warms. That is, significant precipitation, falling in late winter as rain rather than snow, on frozen ground, and while vegetation is still dormant. The Blue Hill Observatory in Milton, MA recorded 17.7 inches of rain from three storms in the 19 days from March 13 to 31. The March 2010 storms were a federally declared disaster making federal assistance available to residents who did not carry flood insurance.

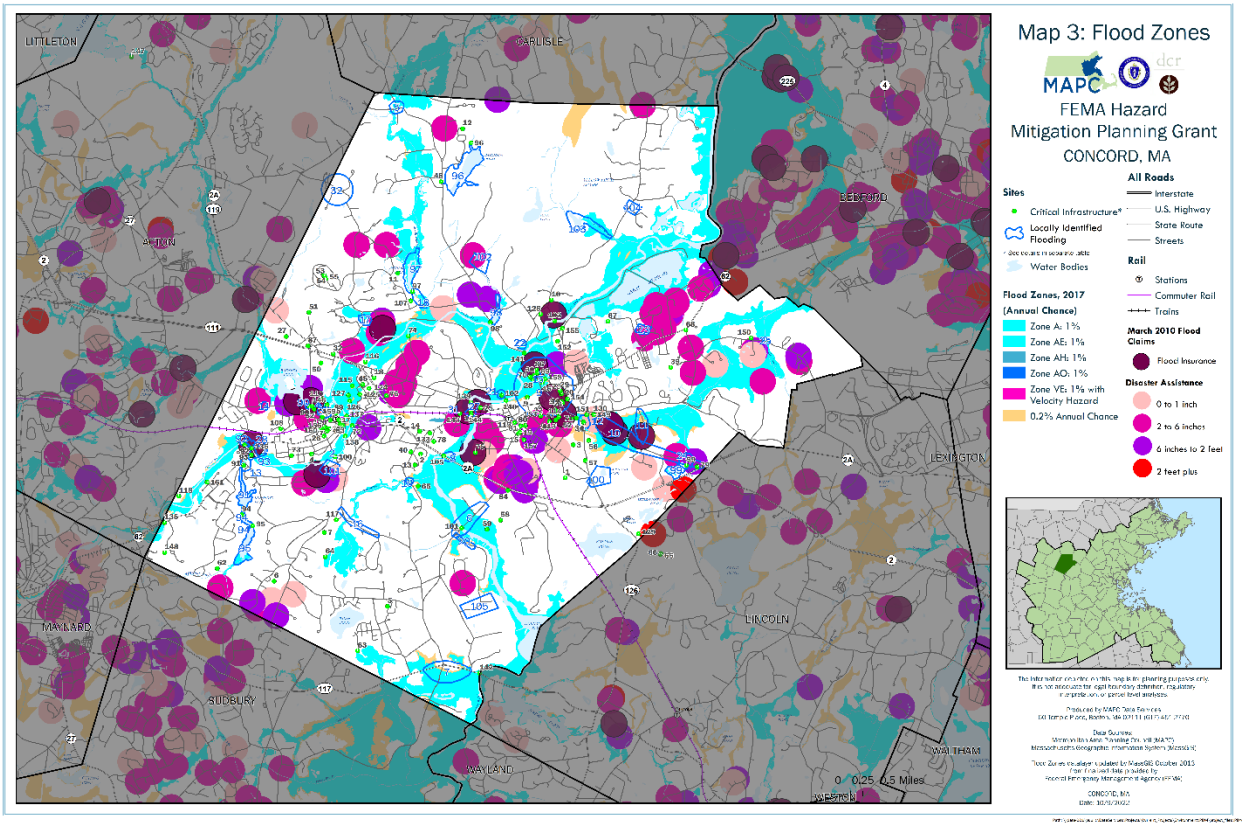
**Figure 8: Design Storm Trends and Projections for a 10-year, 24-hour Storm**




Source: NOAA; Cambridge Climate Vulnerability Assessment, 2017.

Figure 9 presents Concord's March 2010 flood insurance claims in relation to the FEMA's mapped 1% chance flood zone, highlighting the severity of stormwater flooding and the reality that much of the flooding in urban and suburban areas may also occur outside of the FEMA flood zones.

## Figure 9: March 2010 Flood Insurance Claims in Concord




### *DAM FAILURE OR OVERTOPPING*

Dams can fail because of structural problems or age, independent of any storm event. Earthquakes can be a cause of dam failure by causing structural damage. Dams can also fail structurally because of flooding arising from a storm, or they can overtop due to flooding. 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 structures 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 path of the dam's floodwaters. A concern for dams in Massachusetts is that many were built in the 19th century without the benefits of modern engineering or construction oversight. In addition, some dams have not been properly maintained.

The increasing intensity of precipitation is the primary climate concern related to dams, as they were most likely designed based on historic weather patterns. The SHMCAP indicates that changing precipitation patterns may increase the likelihood of overflow events. Dam failure is a highly infrequent occurrence, but a severe incident could result in loss of lives and significant property damage. According to the Office of Dam Safety, three dams have failed in Massachusetts since 1984, one of which resulted in a death.

**DCR Dam Hazard Classification**

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

There has not been any record of dam breaches or failures in Concord to date. Table 8 below lists all the dams located in Concord and their hazard classification provided by DCR Office of Dam Safety in 2018. With the exception of Warner's Pond Dam and Dakin Brook Dam, which are municipally owned, the majority of dams in Concord of privately owned.

**Table 8: Inventory of Dams in Concord**

| Dam | River | Owner | Hazard Classification |
|---|---|---|---|
| Warner's Pond Dam | Nashoba Brook | Municipality | Significant |
| Kennedy's Pond Dam | Second Division Brook | Private | N/A |
| Bateman's Pond Dam | Dakin Brook | Private | N/A |
| Barretts Mill Road Dam | Spencer Brook | Private | Low |
| Upper Musquetaquid Pond Dam | Second Division Brook | Private | Low |
| Lower Musquetaquid Pond Dam | Second Division Brook | Private | N/A |
| Crosby Pond Dam | Mill Brook | Private | Significant |
| Dakin Brook Dam | Tributary of Assabet River | Municipality | N/A |
| Damondale Dam | Assabet River | Private | Significant |
| Estabrook Farm Pond Dam | Dakin Brook | Private | Low |

Source: DCR Office of Dam Safety.

The Town frequently inspected all of its dams and dikes and submitted reports to the DCR Office of Dam Safety as required.

### *ICE JAM*

The U.S. Army Corps of Engineers' Ice Jam Database does not list any ice jams in Concord from the earliest records since 1796. In addition, the Fire Chief confirmed that the town is not subject to this hazard, as such ice jams are not included in this local plan update.

***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.

Average annual precipitation in Massachusetts is 44 inches per year, with approximately three to four-inch average amounts for each month of the year. In Massachusetts, droughts are caused by the prevalence of dry northern continental air and a decrease in coastal- and tropical-cyclone activity. In the driest year (1965), the statewide precipitation total of 30 inches was only 68% of the average total. Although Massachusetts is relatively small, it has several distinct regions that experience significantly different weather patterns and react differently to the amounts of precipitation they receive. The 2019 Massachusetts Drought Management Plan divides the state into seven regions: Western, Central, Connecticut River Valley, Northeast, Southeast, and Cape Cod and the Islands. Drought levels are declared on a regional basis for each of the seven regions in Massachusetts. County by county or watershed-specific determinations may also be made. Concord is in the Northeast region, and drought is considered a town-wide hazard.

As dry conditions can have a range of different impacts, 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. 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.

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 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.

Drought is considered a regional natural hazard, and therefore Concord does not collect local data on drought conditions. This plan references state data as the best available data for drought. The SHMCAP, using data collected since 1850, calculates that statewide there is a 1% chance of being in a drought emergency in any given month. For drought warning and watch levels, the chance is 2% and 8% respectively in any given month (Table 9).

**Table 9: Frequency of Massachusetts Drought Levels**

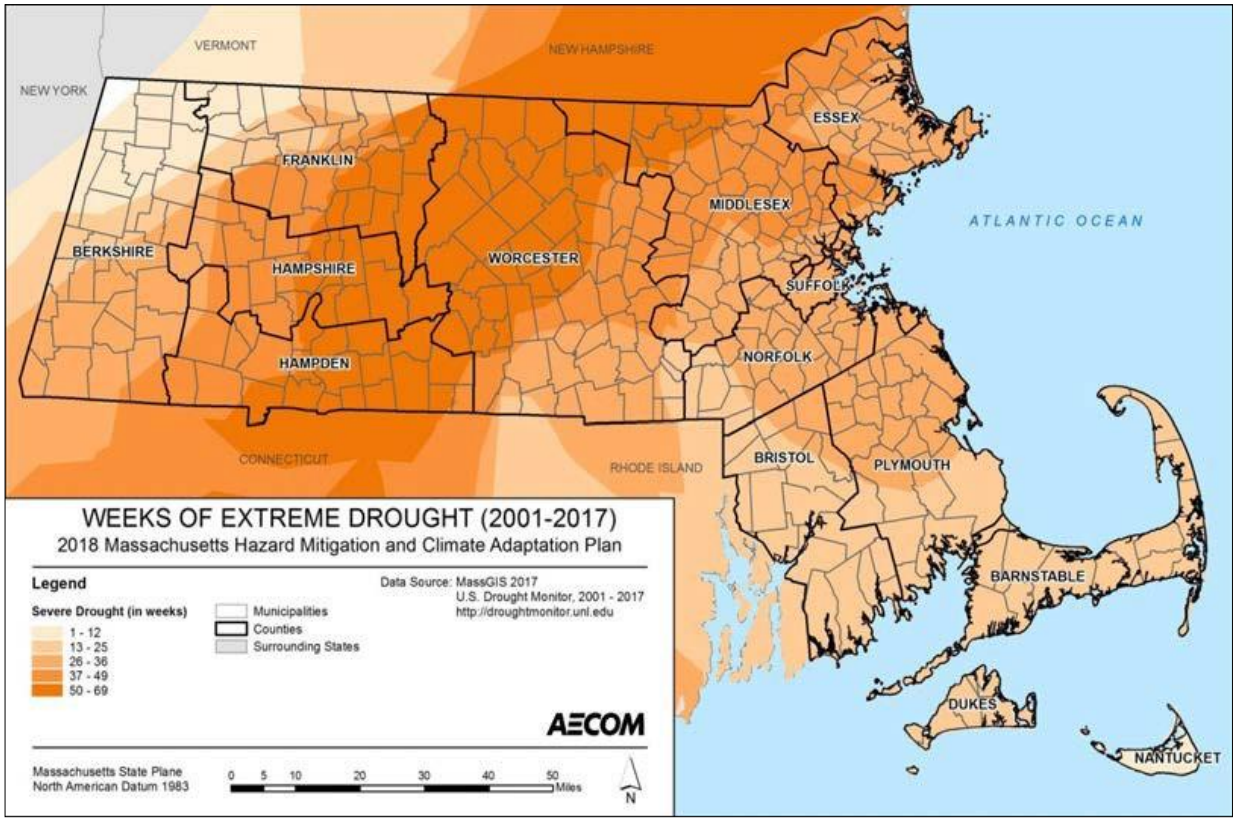
| Drought Level | Frequency Since 1850 | Probability of Occurrence in a Given Month |
|---|---|---|
| Drought Emergency | 5 occurrences | 1% chance |
| Drought Warning | 5 occurrences | 2% chance |
| Drought Watch | 46 occurrences | 8% chance |

Source: SHMCAP

Drought emergencies have been reached infrequently, with five events occurring between 1850 and 2012: 1883, 1911, 1941, 1957, and 1965 to 1966. Due to its long duration, the drought from 1965 to 1966 is viewed as the most severe drought to have occurred in Massachusetts in modern times. The drought that extended from July 2016 to April 2017 reached the Drought Warning level. 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 the potential for forest fires.

The U.S. Drought Monitor characterizes droughts as moderate, severe, extreme, or exceptional. Severe drought is characterized by likely crop and pasture losses, water shortages, and water restrictions. As shown in Figure 10, the Town of Concord experienced between 26 and 36 weeks of severe drought between 2001 and 2017.

**Figure 10: Weeks of Severe Drought (2001-2017)**




Source: SHMCAP

Since the 2017 Concord Hazard Mitigation Plan, Massachusetts experienced a severe drought and another moderate one in 2020 and 2021 respectively. In both cases, Concord was mildly impacted.

Droughts are projected to increase in frequency and intensity in the summer and fall as weather patterns change. Drought impacts can include reduced groundwater and surface water levels, affecting water quality and quantity, streamflow, and wetlands levels, and negatively impacting aquatic organisms that rely on riverine and wetland habitats. Drought also increases stress on plant communities, weakening trees, and increasing the likelihood of forest and brush fires. Potential damages of a severe drought include increased risk of wildfires. Extended drought could also cause losses of landscaped areas if outdoor watering is restricted for a long period, impacts to local agriculture, and potential loss of business revenues if water supplies were severely restricted for a prolonged period. Economic sectors impacted could potentially include commercial water users, recreation facilities, agriculture, landscaping, and forestry.

### *LANDSLIDES*

According to the U.S. Geological Survey, "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; earthquake created stresses that make weak slopes fail; excess weight from accumulation of rain or snow; and stockpiling of rock or ore from waste piles or man-made structures. In Massachusetts, according to the SHMCAP, the most common cause of landslides are geologic conditions combined with steep slopes and/or heavy rains. Landslides associated with heavy rains typically occur on steep slopes with permeable soil underlain by till or bedrock. There is no universally accepted measure of landslide extent, but it has been represented as a measure of destructiveness. Table 10 summarizes the estimated intensity for a range of landslides.

**Table 10: Landslide Volume and Velocity**

| Estimated Volume ($m^3$) | Expected Landslide Velocity | | |
|---|---|---|---|
| | **Fast moving (rock** | **Rapid moving (debris** | **Slow moving** |
| <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 |

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

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. More frequent extreme rain events may increase the chance of landslides as saturated soils are conducive to landslides. Drought may also increase the likelihood of landslides if loss of vegetation decreases soil stability. The SHMCAP, utilizing data from the MA Department of Transportation from 1986 to 2006, estimates that on average one to three known landslides have occurred each year. A slope stability map published by the MA Geological Survey and UMass-Amherst indicates that the most significant risk of landslide is in western Massachusetts. According to the SHMCAP, factors that influence landslide severity include soil properties, topographic position and slope, and historical incidence.

The western half of Concord is classified as low risk for landslides, while the eastern half is considered moderate risk. 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 damage 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, the town does not have records of any damage caused by landslides in Concord. As such 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 have a 1% to 2% chance of occurring each year. The Town has not made significant changes regarding landslide hazard mitigation plan since the 2017 Plan was adopted, aside from the Town's work on general public engagement and education on the effects of climate change but continues to enforce the MA State Building Code to as its primary source of landslide hazard mitigation.

***TSUNAMI***

The Town of Concord is not a coastal community subject to coastal hazards such as tsunamis. A tsunami is a surge of water typically caused by an offshore earthquake. Other causes may include volcanoes and landslides. Tsunamis can cause wave heights of 100 feet or more. According to the SHMCAP, Massachusetts has never experienced a significant tsunami, although two tsunamis have occurred with no deaths or damages recorded. Damage from a tsunami could be very significant, but it is a low likelihood event, having occurred approximately once every 39 years along the entire east coast. No tsunami has impacted Massachusetts since 1950. According to the SHMCAP, collapse of glaciers resulting from our warming climate could cause landslides that could generate tsunamis more powerful than those caused by earthquakes. The severity of a tsunami is related to its wave height at the shore, and the extent of runup. The extent of damage and impact from tsunami depends upon the source and severity of onset on the tide cycle.

## LOCALLY IDENTIFIED AREAS OF FLOODING

Information on potential flood hazard areas was taken from two sources. The first is the National Flood Insurance Rate Maps (FIRM). The FIRM flood zones are shown on Map 3 in Appendix B. The "Locally Identified Areas of Flooding" described below were identified by the Local HMP Team as areas where flooding is known to occur. These areas do not necessarily coincide with the flood zones on the FIRMs. Flood sources include inadequate drainage systems, high groundwater, coastal storms, or other local conditions that may not be within a Special Flood Hazard Area. The numbers listed below in Table 11 below correspond to the numbers on Map 8, "Local Hazard Areas" in Appendix B.

### Table 11: Locally Identified Areas of Flooding in Concord

| Map ID | Name | Description |
|---|---|---|
| 1 | Westvale Meadows Condominiums | Located downstream of several dams along the Assabet River and has experienced flooding of the property, but not of the buildings. If the dams were to breach, the buildings would likely be impacted. |
| 2 | 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. |
| 3 | Commonwealth Avenue at Warner's Pond Dam | This site at Commonwealth Avenue up to Maple Court has experienced flooding caused by Warner's Pond. |
| 4 | Pedestrian Bridge over Nashoba Brook | This pedestrian bridge downstream of 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. |
| 5 | Lowell Road - Spencer Brook Bridge | The bridge over Spencer Brook has experienced flooding due to upstream beaver dams. |
| 6 | 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. |
| 7 | Fitchburg Turnpike | 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. The state reconstructed a bridge over Cold Brook several years ago to raise it due to increased flooding concerns. |
| 9 | Concord Center | Concord Center is located within the floodplain of the Sudbury River and Mill Brook. 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 sections of the brook could greatly impact buildings, which is of great concern to the town. |
| 8 | Route 2 Bridge over Sudbury River | 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. |

| Map ID | Name | Description |
|---|---|---|
| 10 | 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 roadbed 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 recently completed a multi-year project to improve and raise a stretch of road along the Turnpike due to flooding concerns. |
| 11 | Hawthorne Lane | Hawthorne Lane is located in floodplain and seasonal floods, causing road closures and impacts to basements. One potential solution may be for residents to flood proof their homes. |
| 12 | Police/Fire Station | Mill Brook behind the Fire and Police Stations has caused some flooding on the property but not at the buildings. |
| 13 | Harrington Avenue | Harrington Avenue, near Kennedy's Pond Dam, has been identified by the town as a historical flooding site. |
| 14 | Laws Brook Road | This site has been identified by the town as a historical flooding area. |
| 15 | Lowell Road Sewer Pump Station | 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. |
| 16 | Williams Road | This site has been identified by the town as a historical flooding area. |
| 17 | Barrett's Mill Road | This site has been identified by the town as a historical flooding area. |
| 18 | Barrett's Mill Road & east of Strawberry Hill Road | This site, near Barrett's Mill Road Dam, has been identified by the town as a historical flooding area. |
| 19 | Old Road to Nine Acre Corner | This site has been identified by the town as a historical flooding area. |
| 20 | Heath's Bridge Road | This site has been identified by the town as a historical flooding area. |
| 21 | Nashawtuc Road (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. |
| 22 | Liberty Street | This site has been identified by the town as a historical flooding area. |
| 23 | Peter Spring Road | This site has been identified by the town as a historical flooding area. |
| 24 | Crosby's Pond | Crosby Pond and dam, located adjacent the Cambridge Turnpike, have flooded and exacerbated the flooding at Cambridge Turnpike. |

| Map ID | Name | Description |
|---|---|---|
| 25 | Virginia Road | This site has been identified by the town as a historical flooding area. |
| 27 | Main Street Bridge between Elm and Wood | This bridge is a concern due to its weight restrictions and inability to carry loads from Emergency Response Vehicles. |
| 28 | Damon Mill Properties (office buildings) | These office buildings are subject to flooding below Damondale dam. |
| 29 | Pail Factory Bridge | New locally flooded area identified since 2017 HMP |
| 30 | Route 2 Nashoba Brook Bridge | New locally flooded area identified since 2017 HMP |
| 31 | Main Street/MBTA Underpass | This is an area subject to heavy rain flash flooding, as water is trapped between the bridge walls. |
| 32 | Strawberry Hill Road (near Pope Road) | This area adjacent to wetlands, flooded in the March 2010 rainstorm. |
| 90 | Warner's Pond Dam | Area around Warner's Pond Dam |
| 91 | Kennedy's Pond Dam | Area around Kennedy's Pond Dam |
| 92 | Damonmill Dam | Area around Damonmill Dam |
| 93 | Harrington Pond Dam | Area around Harrington Pond Dam |
| 94 | Lower Musquetaquid Pond Dam | Area around Lower Musquetaquid Pond Dam |
| 95 | Upper Musquetaquid Pond Dam | Area around Upper Musquetaquid Pond Dam |
| 96 | Bateman's Pond Dam | Area around Bateman's Pond Dam |
| 97 | Barrett's Mill Road Dam | Area around Barretts Mill Road Dam |
| 98 | Dakin Brook Dam | Area around Dakin Brook Dam |
| 99 | Crosby Pond Dam | Area around Crosby Pond Dam. 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. |
| 101 | Harrington Ave @ Upland Road | New locally flooded area identified since 2017 HMP |
| 102 | Farmer's Cliff Road Culvert | New locally flooded area identified since 2017 HMP |
| 104 | Culvert at intersection of Monument Street and Buttrick's Hill Road | New locally flooded area identified since 2017 HMP |
| 105 | Valley Road @ #45 and #120 | New locally flooded area identified since 2017 HMP |

### *REPETITIVE LOSS STRUCTURES* [2]

As defined by FEMA, a repetitive loss property is any property which the National Flood Insurance Program (NFIP) has paid two or more flood claims of $1,000 or more in any given 10-year period since 1978. There are 5 repetitive loss structures in Concord—2 residential and 3 non-residential and/or commercial properties—as of September 2022, the latest data available from MA DCR. These repetitive loss properties had a total of 18 losses, with estimated aggregated building property losses of $140,289, contents losses of $101,280, or a total of $241,569 for total losses.

2 FEMA Repetitive Loss Data

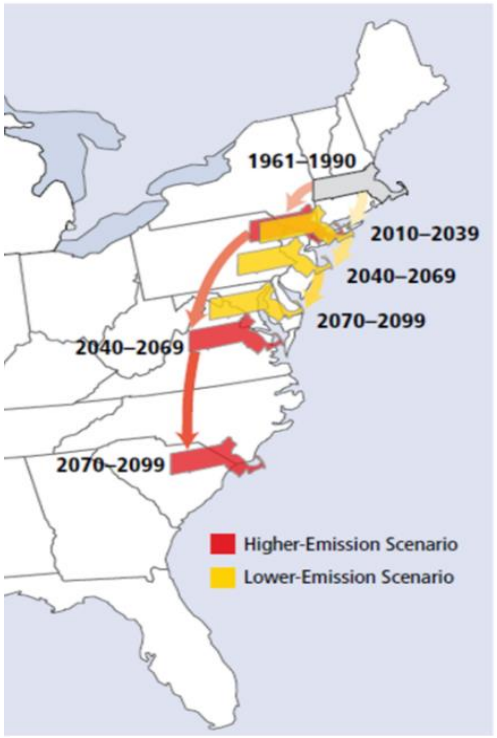
For more information on repetitive losses, visit:
https://www.fema.gov/txt/rebuild/repetitive_loss_faqs.txt and
https://www.fema.gov/repetitive-flood-claims-grant-program-fact-sheet.

## RISING TEMPERATURES

### *AVERAGE AND 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 where there is a long stretch of excessively hot or cold weather. Like the rest of New England, 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 that are far outside of the normal seasonal ranges for Massachusetts.

**Figure 11: Temperature Change Scenarios**




Source: Union of Concerned Scientists (2007)

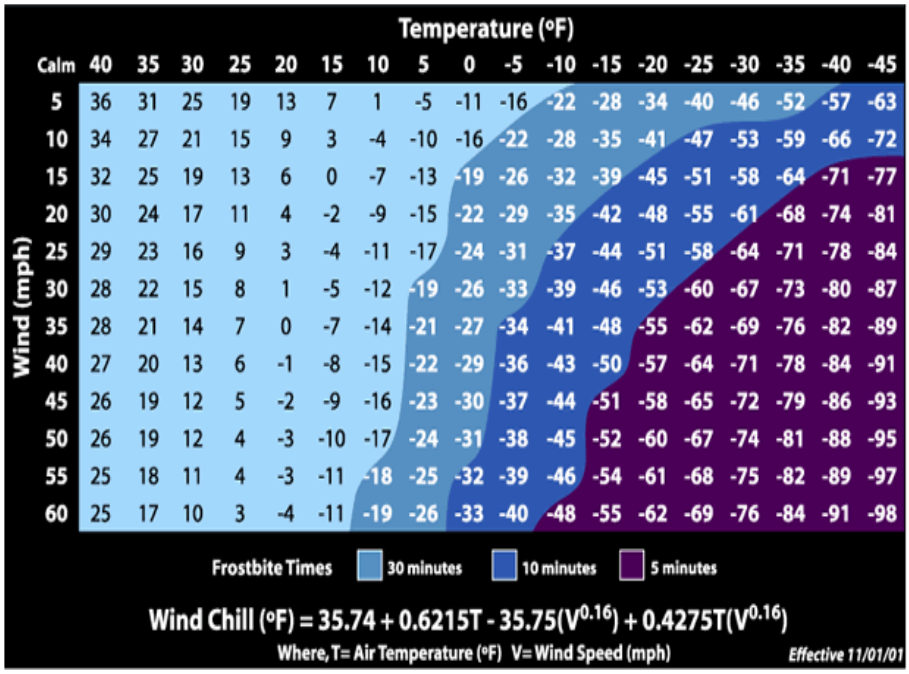
**Extreme Temperatures and Climate Change**

Average temperatures in Massachusetts are projected to increase by 3.8 to 10.8 degrees by the end of the century (SHMCAP). Over time our climate will become more similar to areas south of New England (see Figure 11). Impacts on natural resources include a longer growing season and northern migration of plants and animals, including invasive species. The SHMCAP identifies ecosystems that are expected to be particularly vulnerable to warming temperatures. These include cold-water fisheries, vernal pools, spruce-fir forests, northern hardwood forests (Maple, Beach, Birch), Hemlock forests, and urban forests (due to heat island impacts).

### *EXTREME COLD*

The severity of extreme cold temperature is typically measured using the Wind Chill Temperature Index, which is provided by the National Weather Service (NWS). The wind chill is the apparent temperature felt on exposed skin due to the combination of air temperature and wind speed. The index is provided in Figure 12. A Wind Chill warning is issued when the Wind Chill Index is forecast to fall below -25 degrees F for at least 3 hours. Extreme cold is a dangerous situation that can result in health emergencies for susceptible people, such as those without shelter, those who are stranded, or those who live in homes that are poorly insulated or without heat.

**Figure 12: Wind Chill Temperature Index and Frostbite Risk**




Source: National Weather Service

The Town of Concord does not collect data for previous occurrences of extreme cold. The best available local data is for Middlesex County, through the National Centers for Environmental Information (NCEI). There have been three extreme cold events in the past ten years, which caused no deaths, no injuries, or property damage. When it occurs, extreme cold can result in health emergencies, particularly for those without shelter, who are stranded, or those who live in homes that are poorly insulated or without heat. In Concord, approximately 25% of town residents are over age 65, and approximately 2% of town residents are seniors who are living below poverty level.

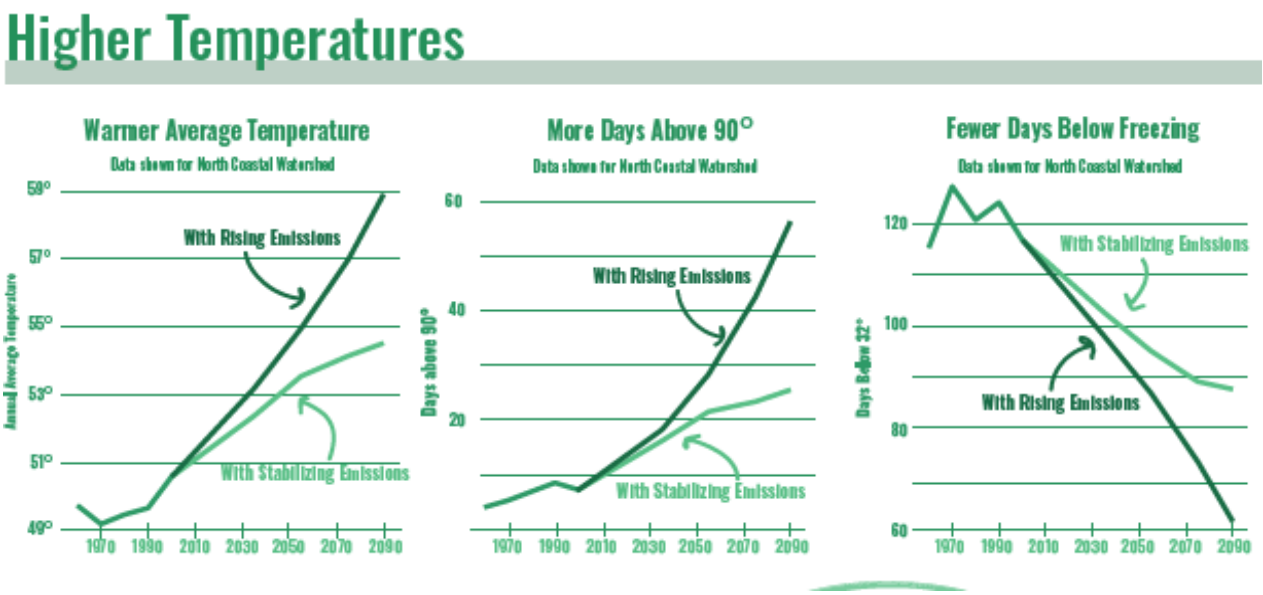
**Table 12: Middlesex County Extreme Cold and Wind Chill Occurrences**

| Date | Deaths | Injuries | Damages |
|---|---|---|---|
| 2/15/2015 | 0 | 0 | 0 |
| 2/16/2015 | 0 | 0 | 0 |
| 2/14/2016 | 0 | 0 | 0 |
| **TOTAL** | **0** | **0** | **0** |

Source: NOAA, National Centers for Environmental Information

Extreme cold events are predicted to decrease in the future, while extreme heat days as well as average temperatures are projected to increase (see Figure 13 below). Global temperatures have increased by nearly 2 degrees in the last century and even small changes in temperature have made widespread and significant changes to our climatic system. For example, the northeast has experienced a 10-day increase in the growing season since 1980. Extreme cold is still a community-wide hazard for Concord.

**Figure 13: Projected Temperatures for Climate Scenarios to 2100**




Source: ResilientMA.org

***EXTREME HEAT***

A heat wave in Massachusetts is defined as three or more consecutive days above 90°F. Another measure used for identifying extreme heat events relies on the Heat Index. According to the National Weather Service (NWS), the Heat Index is a measure of how hot it really feels relative humidity is factored in with the actual air temperature. The NWS issues an advisory when the heat index (Figure 14) is forecast to exceed 100°F for two or more hours; an excessive heat advisory is issued if the forecast predicts the temperature will rise above 105°F.

### Figure 14: Heat Index Chart

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

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

Source: National Weather Service

The best available local data on past occurrences of extreme heat in Concord is for Middlesex County, through the National Centers for Environmental Information (NCEI). In the last decade, there have been two excessive heat events recorded, with one reported death, no injuries, and no property damage (see Table 13).

### Table 13: Middlesex County Extreme Heat Occurrences 2010-2020

| Date | Deaths | Injuries | Damage |
|---|---|---|---|
| 7/6/2010 | 0 | 0 | 0 |
| 7/5/2013 | 1 | 0 | 0 |
| **TOTAL** | **1** | **0** | **0** |

Source: NOAA, National Centers for Environmental Information

The projected increase in extreme heat and heat waves is the source of one of the key health concerns related to climate change. Prolonged exposure to high temperatures can cause heat-related illnesses, such as heat cramps, heat exhaustion, heat stroke, and death. Heat exhaustion is the most common heat-related illness and if untreated, it may progress to heat stroke. People who perform manual labor, particularly those who work outdoors, are at increased risk for heat-related illnesses. Prolonged heat exposure and the poor air quality and high humidity that often accompany heat waves can also exacerbate pre-existing conditions, including respiratory illnesses, cardiovascular disease, and mental illnesses.

Older adults are often at elevated risk due to a high prevalence of pre-existing and chronic conditions; in Concord, approximately 25% of the population is over age 65. People who live in older housing stock and in housing without air conditioning have increased vulnerability to heat-related illnesses. Areas with less shade and darker surfaces (pavement and roofs) will experience even hotter temperatures; these surfaces absorb heat during the day and release it in the evening, keeping nighttime temperatures warmer as well. Map 9 in Appendix B displays areas that are among the hottest 5% of land in the MAPC region based on land surface temperature derived from satellite imagery on July 13, 2016, when the high temperature at Logan Airport was 92°F. There are a few hot spots spread across West and South Concord areas.

Power failures are more likely to occur during heat waves, affecting the ability of residents to remain cool during extreme heat. Individuals with pre-existing conditions and those who require electric medical equipment may be at increased risk during a power outage.

***WILDFIRE***

Wildfire is a non-structure fire occurring in a forested, shrub or grassland areas. In the Boston Metro region these fires rarely grow to the size of a wildfire, as seen more typically in the western U.S. A more likely occurrence is brush fires that typically burn no more than the underbrush of a forested area. There are three different classes of wildfires:

- 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

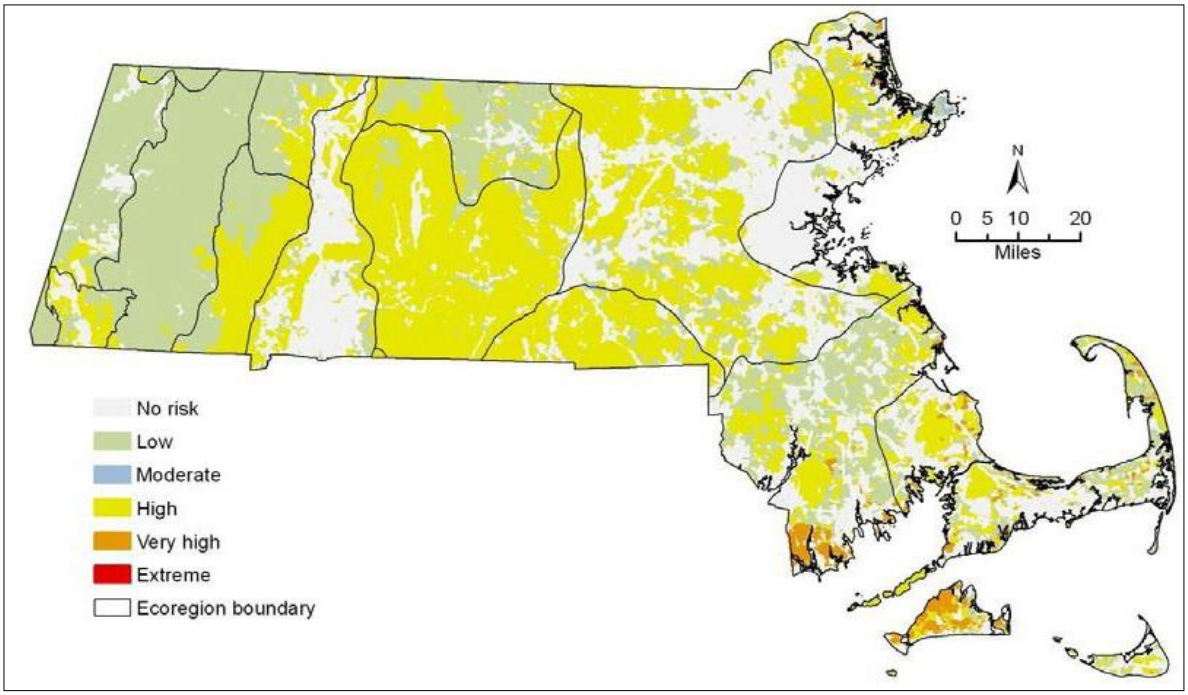
A wildfire differs greatly from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to unexpectedly change direction, and its ability to jump gaps such as roads, rivers, and fire breaks. Wildfire season can begin in March and usually ends in late November. 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. As the climate warms, drought and warmer temperatures may increase the risk of wildfire as vegetation dries out and becomes more flammable. The National Wildfire Coordinating Group classifies the severity of wildfires based on their acreage.

These fires can present a hazard where there is the potential to spread into developed or inhabited areas, particularly residential areas where sufficient fuel materials might exist to allow the fire to spread into homes. Protecting structures from fire poses special problems and can stretch firefighting resources to the limit. If heavy rains follow a fire, other natural disasters can occur, including landslides, mudflows, and floods. If the wildfire destroys the ground cover, then erosion becomes one of several potential problems.

## POTENTIAL BRUSHFIRE HAZARD AREAS

The SCHMCAP depicts statewide fire risk incorporating three risk components: fuel, wildland-urban interface, and topography (Figure 15). The wildland-urban interface reflects communities where housing and vegetation intermingle, and fire can spread from structures to vegetated areas. The most susceptible fuels are pitch pine, scrub oak and oak forests. Topography can affect the behavior of fires, as fire spreads more easily uphill. Concord is shown in the "high" wildfire risk area. The most common cause of wildfires is the careless disposal of smoking materials and untended campfires.

**Figure 15: Wildfire Risk Areas**




Source: SHMCAP

Table 14 below summarizes areas of Concord that were identified as having the highest potential for brush fires. The ID numbers correspond to the numbers on Map 8, "Hazard Areas" in Appendix B.

**Table 14: Locally Identified Areas of Brushfire Risk**

| Map ID | Name |
|---|---|
| 106 | Hapgood Wright Town Forest @ Walden Street |
| 107 | Wright Woods/Fairhaven Bay |
| 108 | Old Rifle Range/Old Marlboro Road |
| 109 | Annursnac Hill |
| 110 | Concord-Bedford Line |
| 111 | Lowell Road, near Monument Street |

### *INVASIVE SPECIES*

The 2018 SHMCAP includes invasive species as a natural hazard for the first time. They are defined as "non-native species that cause or are likely to cause harm to ecosystems, economies, and/or public health". In new habitats invasive species displace native species because they have competitive advantages including no biological controls from their native habitat. Some of the more recognizable invasive plant species noted in the SHMCAP include Norway maple, garlic mustard, Japanese barberry, black swallowwort, buckthorn, purple loosestrife, water milfoil, Japanese knotweed, and phragmites. Invasive pests include emerald ash borer, hemlock wooly adelgid, and the Asian long-horned beetle. The Massachusetts Invasive Plant Advisory Group categorizes invasive severity as either limited prevalence in Massachusetts, partial containment potential, or public health threat.

According to Concord's Open Space and Recreation Plan (2015), Concord is home to a diversity of wetland communities and plant associations, several of which are classified by the Natural Heritage and Endangered Species Program (NHESP) as priority natural communities that are imperiled or vulnerable. It includes stretches of small river floodplain forest along its three rivers, alluvial red maple swamp (at Great Meadows), level and kettlehole level bogs (most notably Gowing's Swamp, Bose's Meadow, and Jenny Dugan Kames bog), and acidic fens (the Andromeda Ponds and Heyward Meadow, west and southwest of Walden Pond). Common invasive plants in Concord include buckthorn, burning bush, Asiatic bittersweet, Japanese knotweed, garlic mustard, porcelain berry, water chestnut, and swallowwort. Since 2005, Concord has been participating in regional invasive species control efforts including the establishment of the Cooperative Invasive Species Management Area (CISMA) in 2009 - a group of partnering organizations that work together to manage and control invasive species in the Sudbury-Assabet-Concord (SuAsCo) Watershed.

## EXTREME WEATHER

### *HURRICANES AND TROPICAL STORMS*

A hurricane is a violent wind and rainstorm with wind speeds of 74 to 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 land. A tropical storm has similar characteristics, but wind speeds are between 34 and 73 miles per hour. Climate models suggest that hurricanes and tropical storms will become more intense as warmer ocean waters provide more fuel for the storms. In addition, rainfall amounts associated with hurricanes are predicted to increase because warmer air can hold more water vapor. 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. Like its neighboring communities in the region, the Town of Concord is vulnerable to hurricanes, which occur between June and November. Table 15 presents hurricane records for Massachusetts since 1938.

**Table 15: Hurricane Records for Massachusetts, 1938 to 2018**

| 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 potential. These are combined to estimate potential damage. Table 16 provides an overview of the wind speeds, surges, and range of damage caused by different hurricane categories.

**Table 16: Saffir/Simpson Scale**

| Scale No. (Category) | Winds (mph) | 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. Total damages in Concord are estimated at $19.1 million for a 100-year hurricane (equivalent to Category 2), and about $246.1 million for a 500-year hurricane (Category 4).

### *SEVERE WINTER STORM/NOR'EASTER*

A northeast storm, known as a nor'easter, is typically a large counterclockwise 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 rain or snow, depending on temperatures. 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 February 2013, January 2015, and in March 2018 were large nor'easters that caused significant snowfall amounts.

Frequently, nor'easters are coastal events for Massachusetts. For inland communities, Concord can be impacted by high winds. 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. Nor'easters are also a cause of coastal flooding.

A blizzard is a winter snowstorm with sustained or frequent wind gusts to 35 mph or more, accompanied by falling or blowing snow which reduces visibility to or below ¼ mile. These conditions must be the predominant conditions over a three-hour period. Extremely cold temperatures are often associated with blizzard conditions but are not a formal part of the definition. The hazard related to the combination of snow, wind, and low visibility significantly increases when temperatures drop below 20 degrees.

The Regional Snowfall Index (RSI) characterizes and ranks the severity of northeast snowstorms. RSI has five categories: Extreme, Crippling, Major, Significant, and Notable. RSI 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 RSI values result from storms producing heavy snowfall over large areas that include major metropolitan centers. The RSI categories are summarized below:

**Table 17: Regional Snowfall Index**

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

Source: SHMCAP

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 serious property damage, injuries, or deaths. However, periodically, a storm will occur which is a true disaster, and necessitates intense large-scale emergency response. The impacts of winter storms are often related to the weight of snow and ice, which can cause roof collapses and causes tree limbs to fall. This in turn can cause property damage and potential injuries. Power outages may also result from fallen trees and

utility lines. Winter storms are a community-wide hazard in Concord. Map 6 in Appendix B illustrates the average annual average snowfall in Concord, which is between 48 to 72 inches. A number of public safety issues can arise during snowstorms. Impassible streets are a challenge for emergency vehicles and affect residents and employers. Snow-covered sidewalks force people to walk in streets, which are already less safe due to snow, slush, puddles, and ice. Large piles of snow can also block sight lines for drivers, particularly at intersections. Refreezing of melting snow can cause dangerous roadway conditions. In addition, transit operations may be impacted, as they were in the 2015 blizzards which caused the closure of the MBTA system for one day and limited services on the commuter rail for several weeks. As with hurricanes, warmer ocean water and air will provide more fuel for winter storms. According to the SHMCAP it appears that Atlantic coast nor'easters are increasing in frequency and intensity. Further, the SHMCAP notes that research suggests that warmer weather in the Artic is producing changes to atmospheric circulation patterns that favor the development of winter storms in the Eastern United States.

Data for Middlesex County is the best available data to help understand previous occurrences and impacts of heavy snow events. According to National Centers for Environmental Information (NCEI) records, from 2010 to 2022, Middlesex County experienced nearly 40 days with heavy snowfall events, resulting in no injuries, deaths, and property damage of $142,000.

**Table 18: Heavy Snow Events and Impacts in Middlesex County, 2010 to 2022**

| Date | Deaths | Injuries | Property Damage ($) |
|---|---|---|---|
| 1/18/2010 | 0 | 0 | 0 |
| 2/16/2010 | 0 | 0 | 15,000 |
| 2/23/2010 | 0 | 0 | 8,000 |
| 1/12/2011 | 0 | 0 | 0 |
| 1/26/2011 | 0 | 0 | 0 |
| 10/29/2011 | 0 | 0 | 30,000 |
| 12/29/2012 | 0 | 0 | 0 |
| 2/8/2013 | 0 | 0 | 0 |
| 2/8/2013 | 0 | 0 | 0 |
| 2/23/2013 | 0 | 0 | 0 |
| 3/7/2013 | 0 | 0 | 0 |
| 3/18/2013 | 0 | 0 | 0 |
| 12/14/2013 | 0 | 0 | 0 |
| 12/17/2013 | 0 | 0 | 0 |
| 1/2/2014 | 0 | 0 | 0 |
| 1/18/2014 | 0 | 0 | 0 |
| 2/5/2014 | 0 | 0 | 0 |
| 2/13/2014 | 0 | 0 | 0 |
| 2/18/2014 | 0 | 0 | 0 |
| 11/26/2014 | 0 | 0 | 10,000 |
| 1/24/2015 | 0 | 0 | 0 |
| 1/26/2015 | 0 | 0 | 0 |
| 2/2/2015 | 0 | 0 | 0 |
| 2/8/2015 | 0 | 0 | 0 |
| 2/14/2015 | 0 | 0 | 0 |

| Date | Deaths | Injuries | Property Damage ($) |
|---|---|---|---|
| 2/5/2016 | 0 | 0 | 75,000 |
| 3/21/2016 | 0 | 0 | 0 |
| 4/4/2016 | 0 | 0 | 0 |
| 12/29/2016 | 0 | 0 | 0 |
| 3/14/2017 | 0 | 0 | 0 |
| 11/15/2018 | 0 | 0 | 0 |
| 12/1/2019 | 0 | 0 | 4,000 |
| 1/18/20 | 0 | 0 | 0 |
| 3/23/20 | 0 | 0 | 0 |
| 10/30/20 | 0 | 0 | 500 |
| 12/05/20 | 0 | 0 | 0 |
| 12/16/20 | 0 | 0 | 0 |
| 2/1/21 | 0 | 0 | 0 |
| 1/28/22 | 0 | 0 | 0 |
| **TOTAL** | **0** | **0** | **$142,500** |

Source: NOAA, National Climatic Data Center

In Eastern Massachusetts, blizzards and severe winter storms have occurred in the following years:

**Table 19: Severe Weather Major Disaster Declarations in Eastern MA**

| Storm Event | Date |
|---|---|
| Severe Winter Storm and Snowstorm | March 2018 |
| Severe Winter Storm, Snowstorm, and Flooding | January 2015 |
| Severe Winter Storm, Snowstorm, and Flooding | February 2013 |
| Hurricane Sandy | October/November 2012 |
| Severe Storm and Snowstorm | October 2011 |
| Tropical Storm Irene | August 2011 |
| Severe Winter Storm and Snowstorm | January 2011 |
| Severe Winter Storm and Flooding | December 2008 |
| Severe Storms and Inland and Coastal Flooding | April 2007 |
| Severe Storm and Flooding | October 2005 |
| Severe Storms & Flooding | March 2001 |
| Blizzard | January 1966 |
| Winter Coastal Storm | December 1992 |
| Severe Coastal Storm | October 1991 |
| Hurricane Bob | August 1991 |
| Hurricane Gloria | September 1985 |

| | |
|---|---|
| Coastal Storm, Flood, Ice, Snow | February 1978 |
| Hurricane, floods | August 1955 |
| Hurricanes | September 1954 |

Source: FEMA

The most significant winter storm was the "Blizzard of 1978," which resulted in over three feet of snowfall and multiple day closures of roadways, businesses, and schools.

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

The best available local data is for Middlesex County through NOAA's Centers for Environmental Information. Middlesex County experienced two ice storm events since 2000. No deaths or injuries were reported and the total reported property damage in the county was estimated at $6.5 million. There is some indication that if winters warm, temperatures may be more likely to produce icing conditions.

Sleet and hail are other forms of frozen precipitation. Sleet occurs when raindrops fall into subfreezing air thick enough that the raindrops refreeze into ice before hitting the ground. The difference between sleet and hail is that sleet is a wintertime phenomenon whereas hail falls from convective clouds (usually thunderstorms), often during the warm spring and summer months. Hail size typically refers to the diameter of the hailstones. Warnings and reports may report hail size through comparisons with real-world objects that correspond to certain diameters:

**Table 20: Hail Size Comparisons**

| 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 |

| | |
|---|---|
| Teacup | 3.00 |
| Grapefruit | 4.00 |
| Softball | 4.50 |

Source: NOAA

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.

Compared to ice storms, hail events are much more frequent in Middlesex County. Records show that Middlesex County experienced 26 hail events since 2010 with no recorded property damage, injuries, or deaths (Table 21).

**Table 21: Hail Events in Middlesex County, 2010-2022**

| Date | Magnitude | Deaths | Injuries | Property Damage ($) |
|---|---|---|---|---|
| 5/4/2010 | 0.75 | 0 | 0 | 0 |
| 5/7/2011 | 0.75 | 0 | 0 | 0 |
| 6/1/2011 | 0.75 | 0 | 0 | 0 |
| 8/2/2011 | 0.75 | 0 | 0 | 0 |
| 8/19/2011 | 0.75 | 0 | 0 | 0 |
| 3/13/2012 | 1.25 | 0 | 0 | 0 |
| 3/14/2012 | 1 | 0 | 0 | 0 |
| 6/23/2012 | 0.75 | 0 | 0 | 0 |
| 7/18/2012 | 1 | 0 | 0 | 0 |
| 10/30/2012 | 1 | 0 | 0 | 0 |
| 6/17/2013 | 0.75 | 0 | 0 | 0 |
| 5/25/2014 | 0.75 | 0 | 0 | 0 |
| 7/3/2014 | 1 | 0 | 0 | 0 |
| 8/7/2014 | 0.75 | 0 | 0 | 0 |
| 9/6/2014 | 0.88 | 0 | 0 | 0 |
| 8/4/2015 | 1 | 0 | 0 | 0 |
| 8/15/2015 | 0.75 | 0 | 0 | 0 |
| 7/23/2016 | .75 | 0 | 0 | 0 |
| 6/27/2017 | 1.00 | 0 | 0 | 0 |
| 8/2/2017 | .75 | 0 | 0 | 0 |
| 6/29/19 | .75 | 0 | 0 | 0 |
| 6/06/20 | 1.00 | 0 | 0 | 0 |
| 6/28/20 | 1.00 | 0 | 0 | 0 |
| 7/30/20 | .75 | 0 | 0 | 0 |
| 8/23/20 | 1.00 | 0 | 0 | 0 |
| **TOTAL** | | **0** | **0** | **0** |

Magnitude refers to diameter of hail stones in inches.

Source: NOAA, Centers for Environmental Information

### *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 Enhanced Fujita scale, which is based on the amount of damage created. As of February 1, 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 (Table 22).

The frequency of tornados 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). Recent tornado events in Massachusetts resulted in significant damage in Springfield in 2011 and in Revere in 2014. The Springfield tornado caused significant damage and resulted in four deaths in June of 2011. The Revere tornado touched down in Chelsea just south of Route 16, 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 damage and 13 homes and businesses were rendered uninhabitable. And on August 22, 2016, an F1 tornado passed through part of Concord. It impacted an area 0.85 miles long by 400 yards wide. According to the report from the National Centers for Environmental Information:

> *"This tornado touched down near the Cambridge Turnpike and headed northeast. Most of the damage was concentrated in an area beginning near the intersection of Lexington Road and Alcott Road and continuing up to the neighborhood of Alcott and Independence Roads. Numerous trees were uprooted or had the tops sheared off. These subsequently blocked roads, damaged homes, and downed power lines, cutting off power to the neighborhood. In addition, utility poles were downed either from the wind or from the downed power lines. Thirty-nine houses in this area were damaged to some degree. Only one house suffered significant structural damage. The tornado continued for a short distance beyond this neighborhood before lifting. The historical home of Louisa May Alcott and her family was right next to the tornado path but was not damaged."*

### Table 22: Enhanced Fujita Scale

| Scale | Wind speed | | Relative frequency | Potential damage | |
|---|---|---|---|---|---|
| | mph | km/h | | | |
| EF0 | 65–85 | 105–137 | 53.5% | Minor damage.<br>Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.<br>Confirmed tornadoes with no reported damage (i.e., those that remain in open fields) are always rated EF0. |  |
| EF1 | 86–110 | 138–178 | 31.6% | Moderate damage.<br>Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken. |  |
| EF2 | 111–135 | 179–218 | 10.7% | Considerable damage.<br>Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground. |  |
| EF3 | 136–165 | 219–266 | 3.4% | Severe damage.<br>Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance. |  |
| EF4 | 166–200 | 267–322 | 0.7% | Extreme damage to near-total destruction.<br>Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated. |  |
| EF5 | >200 | >322 | <0.1% | Massive Damage.<br>Strong frame houses leveled off foundations and swept away; steel-reinforced concrete structures critically damaged; high-rise buildings have severe structural deformation. Incredible phenomena will occur. |  |

Source: SHMCAP 2018

Since 1955, there have been 18 tornados in Middlesex County recorded by the NCEI. Two tornados were F3, four were F2, ten were F1and two were F0. These tornados resulted in one fatality, six injuries, and an estimated $4.88 million in property damage, as summarized in Table 23 below.

### Table 23: Tornado Records for Middlesex County

| Date | Fujita Scale | Fatalities | Injuries | Property Damage $ | Length (mile) | Width (yard) |
|---|---|---|---|---|---|---|
| 10/24/1955 | 1 | 0 | 0 | 2.50K | 10 | 0.1 |
| 6/19/1957 | 1 | 0 | 0 | 25.00K | 17 | 1 |
| 6/19/1957 | 1 | 0 | 0 | 0.25K | 100 | 0.5 |
| 7/11/1958 | 2 | 0 | 0 | 250.00K | 17 | 1.5 |
| 8/25/1958 | 2 | 0 | 0 | 2.50K | 50 | 1 |
| 7/3/1961 | 0 | 0 | 0 | 25.00K | 10 | 0.5 |
| 7/18/1963 | 1 | 0 | 0 | 25.00K | 50 | 1 |
| 8/28/1965 | 2 | 0 | 0 | 250.00K | 10 | 2 |
| 7/11/1970 | 1 | 0 | 0 | 25.00K | 50 | 0.1 |

| Date | Fujita Scale | Fatalities | Injuries | Property Damage $ | Length (mile) | Width (yard) |
|---|---|---|---|---|---|---|
| 10/3/1970 | 3 | 1 | 0 | 250.00K | 60 | 35.4 |
| 7/1/1971 | 1 | 0 | 1 | 25.00K | 10 | 25.2 |
| 11/7/1971 | 1 | 0 | 0 | 0.25K | 10 | 0.1 |
| 7/21/1972 | 2 | 0 | 4 | 2.500M | 37 | 7.6 |
| 9/29/1974 | 3 | 0 | 1 | 250.00K | 33 | 0.1 |
| 7/18/1983 | 0 | 0 | 0 | 0.25K | 20 | 0.4 |
| 9/27/1985 | 1 | 0 | 0 | 0.25K | 40 | 0.1 |
| 8/7/1986 | 1 | 0 | 0 | 250.00K | 73 | 4 |
| 8/22/2016 | 1 | 0 | 0 | 1.000M | 400 | .85 |
| **TOTAL** | | **1** | **6** | **4.88M** | | |

Source: NOAA

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.

Tornados are community-wide hazards in Concord. Tornados are most common in the summer, June through August and most form in the afternoon or evening. Tornados are associated with strong thunderstorms. Based on the record of previous occurrences since 1950, tornado events in Concord are a "very low" frequency event. According to the SHMCAP, it is possible that severe thunderstorms which can include tornadoes may increase in frequency and intensity. However, scientists have less confidence in the models that seek to project future changes in tornado activity. At this time, the Massachusetts State Building Code's provisions are the most cost-effective mitigation measure against tornados given the extremely low probability of occurrence.

## OTHER SEVERE WEATHER

### *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, 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 severity of thunderstorms ranges from commonplace and of short duration to intense storms that cause damage due to high winds, flooding, or lightning strikes.

The best available data on previous occurrences of thunderstorms in Concord is for Middlesex County through NOAA's National Centers for Environmental Information (NCEI). For the years 2010 to 2022, NCEI records show 84 thunderstorm wind events in Middlesex County (Table 24).

These storms resulted in an estimate of $3.47 million in property damage. There were seven injuries and no death reported.

**Table 24: Middlesex County Thunderstorm Wind Events, 2010 to 2022**

| DATE | MAGNITUDE (knots) | DEATHS | INJURIES | PROPERTY DAMAGE $ |
|---|---|---|---|---|
| 5/4/2010 | 50 | 0 | 0 | 30000 |
| 6/1/2010 | 50 | 0 | 0 | 5000 |
| 6/3/2010 | 50 | 0 | 0 | 20000 |
| 6/5/2010 | 50 | 0 | 0 | 40000 |
| 6/6/2010 | 50 | 0 | 1 | 100000 |
| 6/24/2010 | 50 | 0 | 0 | 30000 |
| 7/12/2010 | 50 | 0 | 0 | 50000 |
| 7/19/2010 | 50 | 0 | 0 | 25000 |
| 6/1/2011 | 50 | 0 | 0 | 5000 |
| 6/9/2011 | 50 | 0 | 0 | 15000 |
| 8/2/2011 | 50 | 0 | 0 | 1000 |
| 8/19/2011 | 50 | 0 | 0 | 15000 |
| 6/8/2012 | 50 | 0 | 0 | 25000 |
| 6/23/2012 | 45 | 0 | 0 | 5000 |
| 7/4/2012 | 50 | 0 | 0 | 10000 |
| 7/18/2012 | 70 | 0 | 0 | 350000 |
| 9/7/2012 | 50 | 0 | 0 | 10000 |
| 9/8/2012 | 40 | 0 | 0 | 3000 |
| 6/17/2013 | 50 | 0 | 0 | 25000 |
| 6/18/2013 | 45 | 0 | 0 | 10000 |
| 6/24/2013 | 45 | 0 | 0 | 3000 |
| 7/23/2013 | 50 | 0 | 0 | 20000 |
| 7/29/2013 | 50 | 0 | 0 | 5000 |
| 7/3/2014 | 50 | 0 | 0 | 75000 |
| 7/7/2014 | 87 | 0 | 0 | 100000 |
| 7/15/2014 | 50 | 0 | 0 | 25000 |
| 7/28/2014 | 50 | 0 | 0 | 50000 |
| 9/6/2014 | 50 | 0 | 1 | 15000 |
| 5/28/2015 | 45 | 0 | 0 | 5000 |
| 8/4/2015 | 50 | 0 | 0 | 40000 |
| 8/15/2015 | 50 | 0 | 0 | 25000 |
| 2/25/2016 | 50 | 0 | 0 | 30000 |
| 3/17/2016 | 45 | 0 | 0 | 5000 |
| 7/22/2016 | 50 | 0 | 0 | 14,000 |
| 7/23/2016 | 50 | 0 | 0 | 0 |
| 8/22/2016 | 50 | 0 | 0 | 0 |

| DATE | MAGNITUDE (knots) | DEATHS | INJURIES | PROPERTY DAMAGE $ |
|---|---|---|---|---|
| 9/11/2016 | 50 | 0 | 0 | 10,000 |
| 5/18/2017 | 50 | 0 | 0 | 0 |
| 6/13/2017 | 52 | 0 | 0 | 0 |
| 6/23/2017 | 52 | 0 | 0 | 1000 |
| 6/27/2017 | 50 | 0 | 0 | 0 |
| 7/12/2017 | 50 | 0 | 0 | 0 |
| 8/2/2017 | 50 | 0 | 0 | 0 |
| 9/6/2017 | 50 | 0 | 0 | 0 |
| 5/15/2018 | 40 | 0 | 0 | 0 |
| 6/18/2018 | 50 | 0 | 0 | 0 |
| 6/25/2018 | 43 | 0 | 0 | 0 |
| 7/17/2018 | 50 | 0 | 0 | 3000 |
| 7/26/2018 | 50 | 0 | 0 | 5000 |
| 8/7/2018 | 50 | 0 | 0 | 3000 |
| 8/17/2018 | 50 | 0 | 0 | 4000 |
| 9/6/2018 | 50 | 0 | 0 | 2000 |
| 10/23/2018 | 46 | 0 | 0 | 10,000 |
| 6/30/2019 | 50 | 0 | 0 | 800 |
| 7/17/2019 | 50 | 0 | 0 | 7250 |
| 7/31/2019 | 50 | 0 | 0 | 2500 |
| 8/7/2019 | 50 | 0 | 0 | 800 |
| 9/4/2019 | 55 | 0 | 0 | 26700 |
| 5/15/20 | 50 | 0 | 0 | 285,000 |
| 6/06/20 | 50 | 0 | 0 | 7000 |
| 6/21/20 | 50 | 0 | 0 | 38,200 |
| 6/28/20 | 55 | 0 | 0 | 6000 |
| 7/02/20 | 50 | 0 | 0 | 15300 |
| 7/05/20 | 50 | 0 | 0 | 12300 |
| 7/23/20 | 60 | 0 | 0 | 40600 |
| 7/30/20 | 50 | 0 | 0 | 3100 |
| 8/22/20 | 50 | 0 | 0 | 6000 |
| 8/23/20 | 50 | 0 | 0 | 25600 |
| 8/27/20 | 50 | 0 | 0 | 1600 |
| 10/07/20 | 61 | 0 | 5 | 6500 |
| 11/15/20 | 56 | 0 | 0 | 4000 |
| 5/6/21 | 50 | 0 | 0 | 800 |
| 6/30/21 | 50 | 0 | 0 | 500 |
| 7/6/21 | 50 | 0 | 0 | 18,500 |
| 7/7/21 | 55 | 0 | 0 | 7,600 |
| 7/27/21 | 52 | 0 | 0 | 33,800 |

| DATE | MAGNITUDE (knots) | DEATHS | INJURIES | PROPERTY DAMAGE $ |
|---|---|---|---|---|
| 8/19/21 | 50 | 0 | 0 | 1,300 |
| 9/13/21 | 50 | 0 | 0 | 400 |
| 3/7/22 | 56 | 0 | 0 | 19,000 |
| 7/2/22 | 50 | 0 | 0 | 800 |
| 7/21/22 | 50 | 0 | 0 | 500 |
| 8/5/22 | 50 | 0 | 0 | 9,900 |
| 8/7/22 | 60 | 0 | 0 | 30,300 |
| 8/26/22 | 50 | 0 | 0 | 7,800 |
| **TOTAL** | | **0** | **7** | **$3.47M** |

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

Severe thunderstorms are a community-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, thunderstorms in Concord are high frequency events; this hazard has occurred an average of three times per year in the past ten years. As noted previously, the intensity of rainfall events has increased significantly, and those trends are expected to continue. The SHMCAP does not specifically address whether climate will affect the intensity or frequency of thunderstorms.

## NON-CLIMATE INFLUENCED HAZARDS

### *EARTHQUAKES*

Earthquakes are the sole natural hazard for which there is no established correlation with climate impacts. Damages in an earthquake stem 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 known as the Richter scale to express the seismic energy released by each earthquake. The typical effects of earthquakes in various ranges are summarized below:

**Table 25: Richter Scale and Effects**

| Richter Magnitudes | Earthquake Effects |
|---|---|
| Less than 3.5 | Generally, not felt, but recorded |

| Richter Magnitudes | Earthquake Effects |
|---|---|
| 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

From 1668 to 2016, 408 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 in the distant past, 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. A 4.0 earthquake centered in Hollis, Maine in October 2012 was felt in the Boston area. Historic records of some of the more significant earthquakes in the region are shown in Table 26.

**Table 26: Historic Earthquakes in Massachusetts or Surrounding Area**

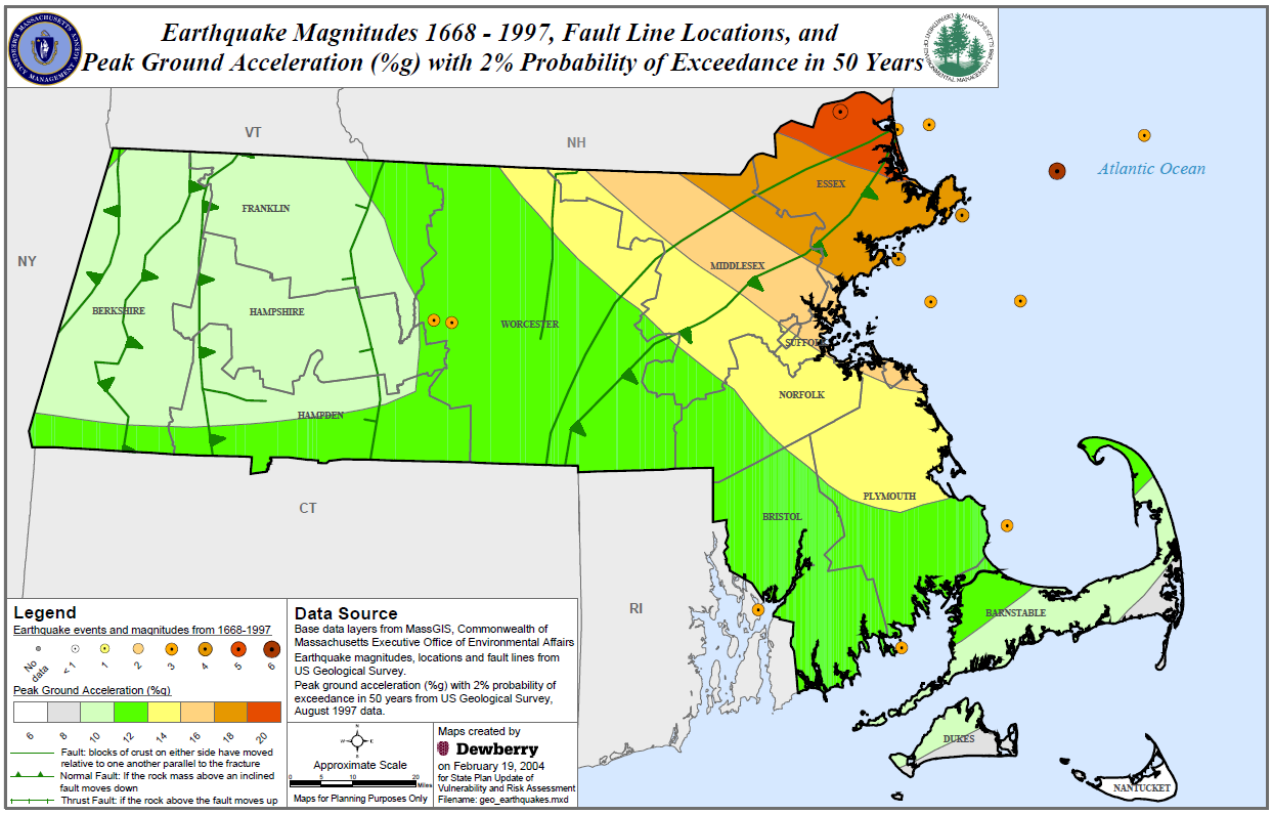
| Location | Date | Magnitude |
|---|---|---|
| MA - Cape Ann | 11/10/1727 | 5 |
| MA - Cape Ann | 12/29/1727 | NA |
| MA - Cape Ann | 2/10/1728 | NA |
| MA - Cape Ann | 3/30/1729 | NA |
| MA - Cape Ann | 12/9/1729 | NA |
| MA - Cape Ann | 2/20/1730 | NA |
| MA - Cape Ann | 3/9/1730 | NA |
| MA - Boston | 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 |

| Location | Date | Magnitude |
|---|---|---|
| MA - Nantucket | 10/25/1965 | NA |
| MA - Boston | 12/27/74 | 2.3 |
| 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 (%g). The range of peak ground acceleration in Massachusetts is from 10 %g to 20 %g, with a 2% probability of exceedance in 50 years. Concord is in the middle to upper part of the range for Massachusetts, at 16-18 %g, making it a relatively moderate high 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.

**Figure 16: State of Massachusetts Earthquake Probability Map**




Source: SHMCAP

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. The majority of 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 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. According to the SHMCAP there is a 10-15% chance of a magnitude 5 earthquake in a given ten-year period. Earthquakes are considered a community-wide hazard in Concord. Although new construction under the most recent building codes generally will be built to seismic standards, much of the development in the town pre-dates the most recent building code. Potential earthquake damage to Concord have been estimated using HAZUS-MH. Total building damages are estimated at $563.1 million for a 5.0 magnitude earthquake and $3.9 billion for a 7.0 magnitude earthquake. Other potential impacts of earthquakes such as sheltering and debris generation, are detailed in Table 32.

## LAND USE AND DEVELOPMENT TRENDS

### Existing Land Use

The most recent land use statistics available from the state are from aerial imagery completed in 2016. Some change has certainly occurred in Concord since then, but this data still provides the most detailed town-wide descriptions of land use available. Table 28 shows the acreage and percentage of land in Concord. If the primary residential categories are aggregated, residential uses make up about 35% of the area of the town. Commercial use makes up about 2%, and industrial less than 1%. Open land makes up a total of 4.7% of the land. The tax-exempt category represents about 37% of Concord's total land use area. Most of this land is additional impervious areas, open space, unconsolidated shore, wetlands, and water.

**Table 27: Town of Concord Land Use (2016)**

| Land Use Type | Acres | Approx. Percentage |
|---|---|---|
| Residential - single family | 5,047 | 30.53% |
| Residential - multi-family | 771 | 4.66% |
| Residential – other | 4 | 0.02% |
| Commercial | 319 | 1.93% |
| Mixed use – primarily residential | 3 | 0.02% |
| Mixed use – primarily commercial | 0 | 0 |
| Mixed use - other | 4 | 0.03% |
| Water | 337 | 2.04% |
| Industrial | 102 | 0.62% |
| Open land | 781 | 4.72% |

| Land Use Type | Acres | Approx. Percentage |
|---|---|---|
| Unknown | 15 | 0.09% |
| Right-of-way | 917 | 5.54% |
| Tax exempt | 6,141 | 37.15% |
| Forest | 485 | 2.94% |
| Agriculture | 779 | 4.71% |
| Recreation | 827 | 5% |
| **Total** | **16,533** | **100%** |

For more information on how the land use statistics were developed and the definitions of the categories, please go to https://docs.digital.mass.gov/dataset/massgis-data-land-use-2005.

**Economic Elements**

As of 2015, Concord's economy includes 960 businesses and accounts for approximately 11,800 jobs. Key business districts include Town Center (Mildham, Walden Street, and historic sites), West Concord Center, Concord Depot/Thoreau School/Sudbury Road, Baker Avenue, Old Road to Nine Acre Corner at Route 2, Virginia Road, and Forest Ridge. Retailers, professional services, finance, and real estate are the most common business types. Many of these businesses, especially in Concord Center, also depend on tourism and visitor spending to remain viable. Agriculture is another key component of Concord's economy, however, like other places in the state, this sector faces issues including labor availability, lack of housing for employees and transportation for seasonal workers, farm/agriculture economic viability, and ownership succession. [3]

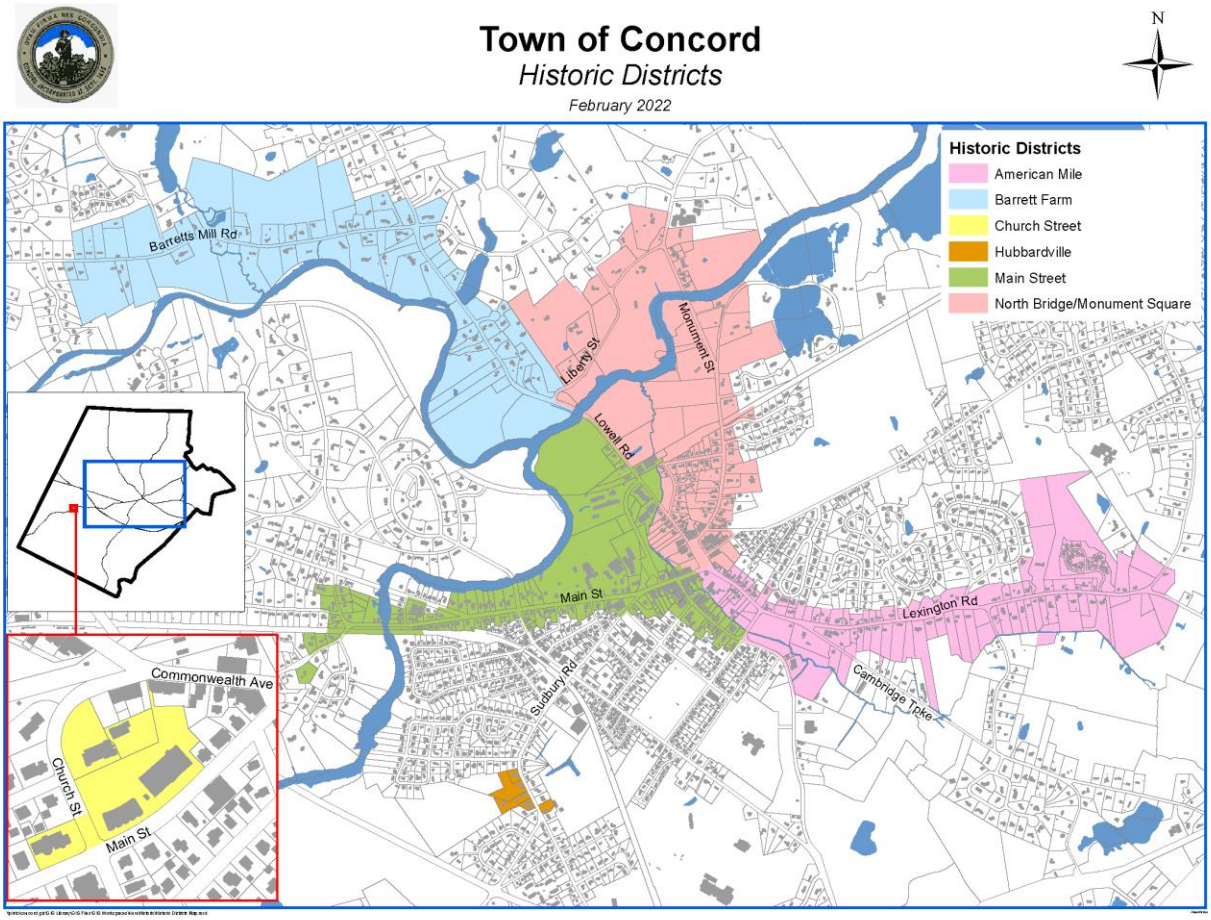
## NATURAL, CULTURAL, AND HISTORICAL RESOURCE AREAS

The Town of Concord has considerable natural, historic and cultural resources. Concord's topography includes rolling forested and open landscapes, extensive low-lying wetlands and floodplain, rivers, streams, and vernal pools. Its glacial history is seen in the drumlins and kettle ponds that dot the landscape. In 1999, Congress designated the three rivers – Concord, Sudbury, and Assabet – as Wild and Scenic Rivers – for their "outstanding ecology, history, scenery, recreation values, and place in American literature." The confluence of the Sudbury and Assabet Rivers to form the Concord River falls within the center of Concord. From this confluence, the Concord River flows to the Merrimac River. Much of the town is mapped by the Natural Heritage and Endangered Species Program as Estimated Habitat and Priority Habitat for rare flora and fauna. Significant protected open space includes the Great Meadows National Wildlife Refuge, the Minute Man National Historic Park, the Walden Pond State Reservation, and over 2,700 acres of locally conserved land.[4]

3 Envision Concord Comprehensive Long Range Plan (2018), Section 4.2 "Economic Vitality Plan Element," https://www.concordma.gov/DocumentCenter/View/15432/Section-42-Economic-Vitality-Plan-Element.

4 Envision Concord Comprehensive Long Range Plan (2018), Section 4.1 "Cultural Historic Plan Elements," https://www.concordma.gov/DocumentCenter/View/15431/Section-41-Cultural-Historic-Plan-Elements.

Concord's 2015 Open Space Plan has identified nine "Large Natural Areas" that provide ecosystem services and serve as areas with the highest conservation values. Great Meadows, Estabrook Woods, and White Pond are among these areas.[5] Approximately 20% of the town's buildings are surveyed, listed, or protected in some way. 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 theatres, music and arts organizations. Concord is home to 6 museums and houses open to the public, including the Concord Museum, the Concord Art Association, the Emerson and Orchard Houses, Old Manse and Wayside. Many of these sites have also been identified and included in this Plan's critical infrastructure and assets.




Source: https://concordma.gov/1528/Map-of-Historic-Districts

5 Open Space and Recreation Plan (2015), https://www.concordma.gov/DocumentCenter/View/27974/2015-Open-Space-and-Recreation-Plan.

## DEVELOPMENT TRENDS

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 more than 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 largely infill development and redevelopment. Development trends throughout the metropolitan region are tracked by MassBuilds, 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 planning and/or construction. The database includes 71 developments in the Town of Concord, of which 8 have been completed since 2017, and 3 are currently planned or under construction.

**Table 28: Summary of Concord's Developments (2017-2022)**

| Name | Status | Year | Project Type | Housing Units | Commercial SF |
|---|---|---|---|---|---|
| **Black Horse Place PRD** | Completed | 2018 | Residential | 16 single-family<br>3 duplexes | 0 |
| **Concord Academy Bradford Hall** | Completed | 2018 | Institutional | 0 | 8,000 |
| **Millbrook Tarry** | Completed | 2018 | Commercial | 0 | 15,000 |
| **506 Old Bedford Road** | Completed | 2018 | Residential | 8 single family units, 1 at 80% affordable | 0 |
| **Concord Museum Expansion** | Completed | 2019 | Institutional | 0 | 13,000 |
| **Black Birch Phase II** | Completed | 2020 | Residential | 16 single-family | 0 |
| **Fenn School** | Completed | 2020 | Institutional | 0 | 16,030 |
| **1440 Main Street Planned Residential Development (PRD)** | PRD was not approved, and the proposed Subdivision Plan decision has been appealed. Future residential development is not defined yet. | N/A | Residential | TBD | 0 |
| **13B Commonwealth Avenue** | Planning | 2020 | Commercial | 0 | 6,000 |
| **McCaller Lane Subdivision** | Planning | 2022 | Residential | 5 multi-family | 0 |

## POTENTIAL FUTURE DEVELOPMENT

The Town of Concord's Department of Planning and Land Management has identified the following potential future development projects in the next five years, as listed in Table 29 below. These potential future land uses are expected to take place on redevelopment sites. As new development and redevelopment occurs, it will be subject to the latest building code requirements and zoning regulations pertaining to the Town's identified natural hazards, including wind, earthquakes, and flooding.

**Table 29: Summary of Concord's Potential Future Developments for the Next Five Years**

| Name | Status | Year | Project Type | Housing Units | Commercial SF |
|---|---|---|---|---|---|
| **Concord Academy Centennial Arts Center** | Planning | 2023 | Institutional | 0 | 36,826 |
| **Concord Art Association - addition** | Planning | 2023 | Institutional | 0 | 2,593 |
| **48Y Fitchburg Turnpike PRD** | Planning | 2023 | Residential | 6 | |
| **406 Old Marlboro Road/Assabet River Bluff** | Planning | 2024/25 | Residential | 3 | |
| **Junction Village** | Planning | 2027 | Residential | TBD | |

To characterize potential 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 indicated two (2) sites partially located in AE zone (1% Annual Chance of Flooding): Junction Village and 48Y Fitchburg Turnpike PRD. Parcels that are partially in a flood zone typically include a portion of the site that is not built on. All these potential development sites have "Low Incidence" landslide risk. Other hazards such as wind speed and snowfall rates do not vary across Concord. Overall, Concord's potential future development would not significantly increase the Town's vulnerability if existing regulations were adhered to.

## CRITICAL FACILITIES & INFRASTRUCTURE IN HAZARD AREAS

Critical facilities and infrastructure include facilities that are important for disaster response and evacuation (such as emergency operations centers, fire stations, water pump stations, communications, and electricity) and facilities where additional assistance might be needed during an emergency (such as nursing homes, elderly housing, day care centers, etc.). There are **142 critical facilities** identified throughout the Town of Concord. These are listed in Table 30 and are shown in Figures 17, as well as on the maps in Appendix B.

**Explanation of Columns in Table 30**

- ***Column 1: ID #:*** The first column in Table 30 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.
- ***Column 3: Type*:** The third column indicates what type of site it is.
- ***Column 4: FEMA Flood Zone*:** The fourth 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. as follows:
  - **Zone A** Areas subject to inundation by the 1-percent-annual-chance flood event. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
  - **Zone AE** (1% annual chance) Areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. Base Flood Elevations (BFEs) are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply. Zones AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the FIS by detailed methods. Mandatory flood insurance purchase requirements apply
  - **Zone AH** Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are 1–3 feet. BFEs derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements and floodplain management standards apply.
  - **Zone X** (0.2% annual chance) Moderate risk areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent-annual-chance flood by a levee. No BFEs or base flood depths are shown within these zones. (formerly Zone B)
  - **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.
- ***Column 5: Locally Identified Area of Flooding*:** The fifth column indicates the risk of flooding in local hazard areas. If there is an entry in this column, it indicates the local hazard area.
- ***Column 6:*** Hot spots indicates areas that are within the 5% of hottest areas in the MAPC region based on satellite data from 2016.
- ***Column 7:*** The seventh column indicates the risk of brushfire. If there is an entry in this column, it indicates the local hazard area.
- ***Column 8:*** This column indicates locations subject to inundation at Mean Higher High Water with 3 feet of sea level rise.

### Table 30: Critical Facilities and Relationship to Hazard Areas

| ID | NAME | TYPE | FEMA Flood Zone | Locally Identified Flood Area | Hot Spot | Brushfire Risk |
|---|---|---|---|---|---|---|
| 1. | Pine Hill Reservoir | Reservoir | | | | |
| 2. | Concord Carlisle Regional High School | School | | | x | |
| 3. | Emerson Hospital | Hospital | | | | |
| 4. | Alcott School | School | | | | |
| 5. | Thoreau School | School | | | | |
| 6. | Willard School | School | | | | |
| 7. | Peabody Middle School | School | | | | |
| 8. | Sanborn Middle School | School | | | | |
| 9. | Concord Academy | School | | x | | |
| 10. | Fenn School | School | | | | |
| 11. | Nashoba Brooks School | School | | | | |
| 12. | Middlesex School | School | | | | |
| 13. | Rivercrest Deaconess/Newbury Court | Nursing Home | | | | |
| 14. | Walden Rehabilitation and Nursing Center | Nursing Home | | | | |
| 15. | CVS | Pharmacy | | | | |
| 16. | Rite Aid | Pharmacy | X: 0.2% Annual Chance of Flooding | x | | |
| 17. | West Concord Pharmacy | Pharmacy | | | x | |
| 18. | Congregation Kerem Shalom | Place of Assembly | | | | |
| 19. | Redeemer Presbyterian Church | Place of Assembly | | | x | |
| 20. | First Church of Christ | Place of Assembly | | x | | |
| 21. | First Parish in Concord | Place of Assembly | | x | | |
| 22. | New Life Community Church | Place of Assembly | | | | |
| 23. | Holy Family Parish | Place of Assembly | | x | | |
| 24. | Trinitarian Congregational Church | Place of Assembly | | x | | |
| 25. | Trinity Episcopal Church | Place of Assembly | | | | |
| 26. | West Concord Union Church | Place of Assembly | | | | |
| 27. | Concord Municipal Light Plant | Municipal | | | | |
| 28. | Concord Public Works | Municipal | AE: 1% Annual Chance of Flooding; with BFE | x | | |
| 29. | Concord Town House | Municipal | x | x | | |
| 30. | Concord Planning & Land Management | Municipal | AE: 1% Annual Chance of Flooding; with BFE | x | | |
| 31. | Concord Police Department | Police Station | | x | | |
| 32. | State Police Concord | Police Station | | | | |

| ID | NAME | TYPE | FEMA Flood Zone | Locally Identified Flood Area | Hot Spot | Brushfire Risk |
|---|---|---|---|---|---|---|
| 33. | Concord Fire Department #1 | Fire Station | | | | |
| 34. | Concord Fire Department #2 | Fire Station | | x | | |
| 35. | Hunt Recreation Center | Daycare | | | | |
| 36. | Concord Carousel Day Care | Daycare | | | | |
| 37. | Concord Children's Center | Daycare | | | | |
| 38. | Concord Children's Center | Daycare | | | | |
| 39. | Concord Recreation | Daycare | | | | |
| 40. | Milldam Nursery School | Daycare | | x | | |
| 41. | Minuteman ARC | Daycare | | | x | |
| 42. | The Barn Coop Nursery School | Daycare | | x | | |
| 43. | The Children's Meetinghouse Day Care | Daycare | | | | |
| 44. | MCI - Concord | Correctional Facility | | | x | |
| 45. | Northeastern Correctional Center | Correctional Facility | | | x | |
| 46. | Walden Street School | Residential Board | | | | |
| 47. | Annursnac Hill Tower | Communication Tower | | | | |
| 48. | Annursnac Hill Repeater Tower | Communication Tower | | | | |
| 49. | Annursnac Hill Reservoir | Water Storage Tank / Reservoir | | | | |
| 50. | Concord District Court | Court House | | | | |
| 51. | Hugh Cargill Water Pump Station | Water Pump Station | | | | |
| 52. | Robinson Water Pump Station | Water Pump Station | | | | |
| 53. | Robinson Public Well | Well | AE: 1% Annual Chance of Flooding; with BFE | | | |
| 54. | Second Division Water Pump Station | Water Pump Station | No | | | |
| 55. | White Pond Water Pump Station | Water Pump Station | No | | | |
| 56. | Jennie Duggan Water Treatment Plant | Water Pump Station | AE: 1% Annual Chance of Flooding; with BFE | | | |
| 57. | Deaconess Water Pump Station | Water Pump Station | X: 0.2% Annual Chance of Flooding | | | |
| 58. | Concord Wastewater Treatment | Wastewater Treatment | No | | | |
| 59. | Bedford Street Sewer Pump Station | Sewer Pump Station | No | | | |
| 60. | Lowell Road Sewer Pump Station | Sewer Pump Station | AE: 1% Annual Chance of Flooding; with BFE | x | | |

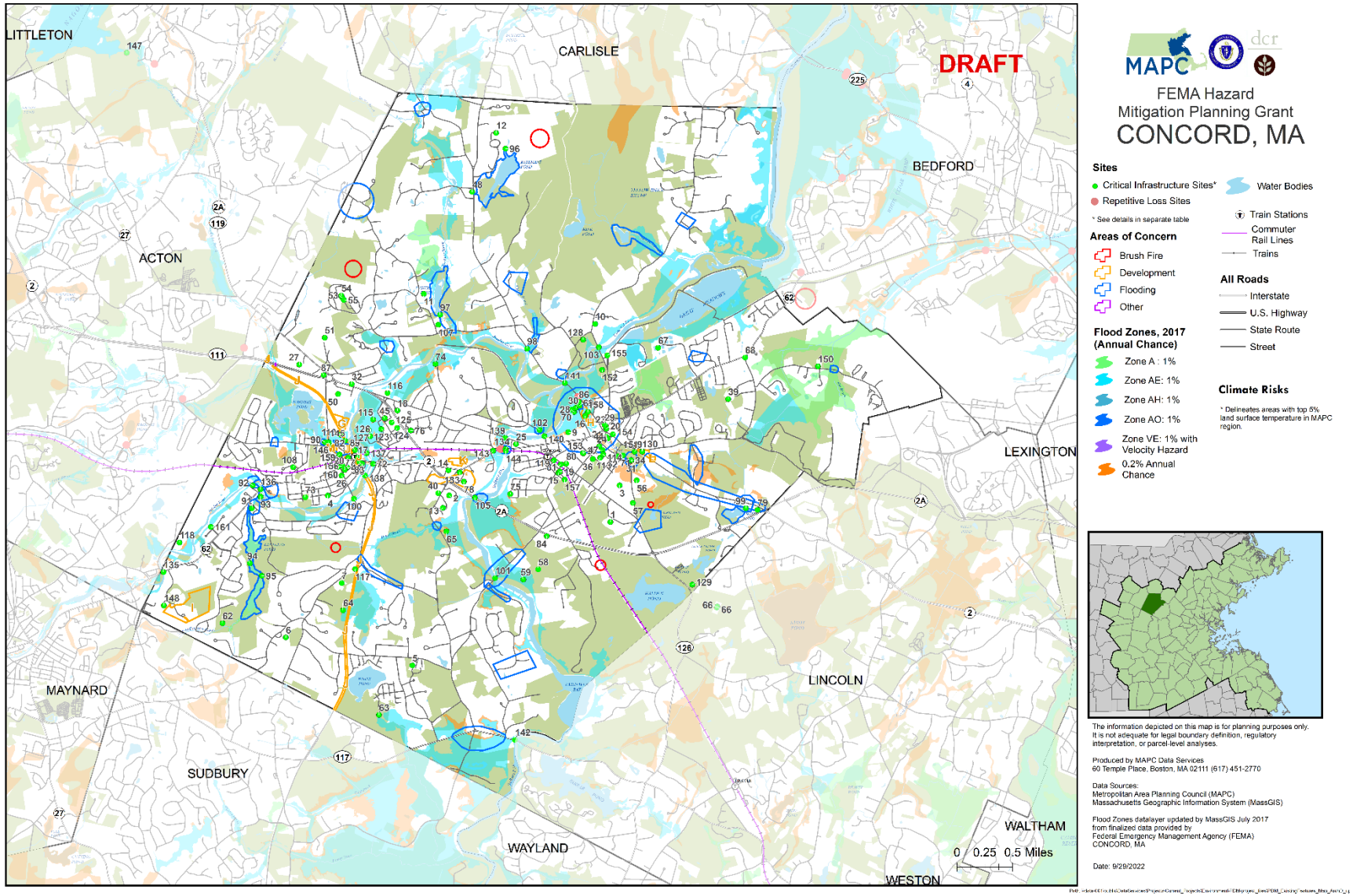
| ID | NAME | TYPE | FEMA Flood Zone | Locally Identified Flood Area | Hot Spot | Brushfire Risk |
|---|---|---|---|---|---|---|
| 61. | Concord Water/Sewer/Hiway Department | Municipal | AE: 1% Annual Chance of Flooding; with BFE | x | | |
| 62. | Laurel Street Sewer Pump Station | Sewer Pump Station | X: 0.2% Annual Chance of Flooding | | | |
| 63. | Assabett Sewer Pump Station | Sewer Pump Station | AE: 1% Annual Chance of Flooding; with BFE | | | |
| 64. | Cousins Park Sewer Pump Station | Sewer Pump Station | No | | | |
| 65. | Park Lane Sewer Pump Station | Sewer Pump Station | AE: 1% Annual Chance of Flooding; with BFE | | | |
| 66. | Pilgrim Road Sewer Pump Station | Sewer Pump Station | | | | |
| 67. | Gifford Land Sewer Pump Station | Sewer Pump Station | | | | |
| 68. | Harvey Wheeler Community Center | Place of Assembly | | | | |
| 69. | Concord Health Care | Nursing Home | | | x | |
| 70. | Mobil Gas Station | Hazardous Material Site | | x | | |
| 71. | Sudbury Road Mobil Gas Station | Hazardous Material Site | | | | |
| 72. | Cumberland Farm Gas Station | Hazardous Material Site | | | x | |
| 73. | Commonwealth Avenue Gulf Gas Station | Hazardous Material Site | | | | |
| 74. | Colonial Motors Gas Station | Hazardous Material Site | | | | |
| 75. | Route 2 Gas Station | Hazardous Material Site | | | | |
| 76. | Concord Oil Company | Hazardous Material Site | AE: 1% Annual Chance of Flooding; with BFE | x | | |
| 77. | Exxon Gas Station (Rotary) | Hazardous Material Site | | | | |
| 78. | Concord Park Assisted Living | Assisted Living | | | | |
| 79. | Warner's Pond Dam | Dam | AE: Regulatory Floodway | x | | |
| 80. | Kennedy's Pond Dam | Dam | A: 1% Annual Chance of Flooding; no BFE | x | | |
| 81. | Damondale Dam | Dam | AE: Regulatory Floodway | x | | |
| 82. | Harrington Ave Dam | Dam | AE: 1% Annual Chance of Flooding; with BFE | x | | |

| ID | NAME | TYPE | FEMA Flood Zone | Locally Identified Flood Area | Hot Spot | Brushfire Risk |
|---|---|---|---|---|---|---|
| 83. | Lower Musquetaquid Pond Dam | Dam | A: 1% Annual Chance of Flooding; no BFE | x | | |
| 84. | Upper Musquetaquid Pond Dam | Dam | A: 1% Annual Chance of Flooding; no BFE | x | | |
| 85. | Bateman's Farm Pond Dam | Dam | | | | |
| 86. | Barretts Mill Road Dam | Dam | | x | | |
| 87. | Dakin Brook Dam / Macone Pond Dam | Dam | AE: 1% Annual Chance of Flooding; with BFE | | | |
| 88. | Crosby Pond Dam | Dam | AE: Regulatory Floodway | x | | |
| 89. | Pine Street Bridge | Bridge | AE: Regulatory Floodway | x | | |
| 90. | Heath's Bridge | Bridge | AE: Regulatory Floodway | x | | |
| 91. | Nashawtuc Road – Nashawtuc Bridge | Bridge | AE: 1% Annual Chance of Flooding; with BFE | x | | |
| 92. | Flint Bridge | Bridge | AE: Regulatory Floodway | | | |
| 93. | Route 2 Bridge over Sudbury River / Concord Turnpike Bridge | Bridge | AE: Regulatory Floodway | x | | |
| 94. | Pine Hill Reservoir | Water Storage Tank / Reservoir | | | | |
| 95. | Little Sprouts Day Care Center | Daycare | | | | |
| 96. | Concord Montessori | School | | | | |
| 97. | Dialysis Clinic Inc. | Medical Facility | X: 0.2% Annual Chance of Flooding | | | |
| 98. | Concord Housing Authority/Peter Bulkeley | Housing Authority | | | | |
| 99. | Concord Housing Authority/Everett Gardens | Housing Authority | | | | |
| 100. | Marriott Extended Stay | Hotel | AE: 1% Annual Chance of Flooding; with BFE | | x | |
| 101. | Best Western | Hotel | | | | |
| 102. | Fiber Node Point (Substation 479) | Utility | | | | |
| 103. | Public School Bus Depot | Transportation Facility | | | | |
| 104. | West Concord MBTA Station | Transportation Facility | | | x | |
| 105. | Concord MBTA Station | Transportation Facility | | | x | |

| ID | NAME | TYPE | FEMA Flood Zone | Locally Identified Flood Area | Hot Spot | Brushfire Risk |
|---|---|---|---|---|---|---|
| 106. | Harvard Vanguard | Medical Facility | AE: 1% Annual Chance of Flooding; with BFE | | x | |
| 107. | Emerson Specialty Care | Medical Facility | | | x | |
| 108. | Emerson Specialty Care | Medical Facility | | | x | |
| 109. | 300 Baker Ave Offices | Office | AE: 1% Annual Chance of Flooding; with BFE | | x | |
| 110. | Emerson Hospital PT/Labs | Medical Facility | AE: 1% Annual Chance of Flooding; with BFE | | x | |
| 111. | Minuteman National Park Headquarters | Park Headquarters | | | | |
| 112. | Walden Pond Reservation Hdq./State Police Mounted Unit | Park Headquarters | | | | |
| 113. | Concord Museum | Museum | | | | |
| 114. | Fiber Node Point (Substation 223) | Utility | | | | |
| 115. | Main Street at South Bridge Boathouse (Sudbury River) | Bridge | AE: Regulatory Floodway | x | | |
| 116. | Rt 62 near Knox Trail at Acton Town Line (Assabet River) (bridge) | Bridge | AE: Regulatory Floodway | | | |
| 117. | Rt 62 at Damon Mill (Assabet River) | Bridge | AE: Regulatory Floodway | | | |
| 118. | MBTA Commuter Rail Bridge (Assabet River) | Bridge | AE: Regulatory Floodway | | | |
| 119. | Bruce Freeman Rail Trail (Assabet River) | Bridge | AE: Regulatory Floodway | | | |
| 120. | Elm Street Bridge (Sudbury River) | Bridge | AE: Regulatory Floodway | | | |
| 121. | Nashawtuc Rd (Sudbury River) | Bridge | AE: 1% Annual Chance of Flooding; with BFE | | | |
| 122. | Lowell Rd (Concord River) | Bridge | AE: Regulatory Floodway | | | |
| 123. | Rt 117 at Lincoln Town Line (Sudbury River) | Bridge | AE: Regulatory Floodway | | | |
| 124. | MBTA Commuter Rail Bridge over Rt 62 | Bridge | | x | | |
| 125. | MBTA Commuter Rail Bridge (Sudbury River) | Bridge | AE: Regulatory Floodway | x | | |
| 126. | Bruce Freeman Trail (Nashoba Brook) | Bridge | AE: Regulatory Floodway | | | |
| 127. | Pail Factory Bridge / Commonwealth Ave (Nashoba Brook) | Bridge | AE: 1% Annual Chance of Flooding; with BFE | | | |

| ID | NAME | TYPE | FEMA Flood Zone | Locally Identified Flood Area | Hot Spot | Brushfire Risk |
|---|---|---|---|---|---|---|
| 128. | Nagog Pond Treatment Plant | Water Treatment Plant | | | | |
| 129. | Substation 219 | CMLP | | | | |
| 130. | Concord Museum | Cultural Resources | | | | |
| 131. | Thoreau Farm | Cultural Resources | | | | |
| 132. | Ralph Waldo Emerson House | Cultural Resources | | | | |
| 133. | The Old Manse | Cultural Resources | | | | |
| 134. | The Umbrella Arts Center | Cultural Resources | | | | |
| 135. | Concord Art Association | Cultural Resources | | x | | |
| 136. | The Robbins House | Cultural Resources | | | | |
| 137. | Concord Youth Theatre | Cultural Resources | | | | |
| 138. | Crosby's Marketplace | Grocery Store | | | | |
| 139. | The Concord Market | Grocery Store | X: 0.2% Annual Chance of Flooding | x | | |
| 140. | Debra's Natural Gourmet | Grocery Store | | | x | |
| 141. | Social Services | Municipal | | | | |
| 142. | Knox Trail | Municipal | | | | |

## Figure 17: Identified Critical Infrastructure and Facilities in Concord



## VULNERABILITY ASSESSMENT

The purpose of the vulnerability assessment is to estimate the extent of potential damage from natural hazards of varying types and intensities. A vulnerability assessment and estimation of damages was performed for hurricanes, earthquakes, and flooding through the HAZUS-MH software.

### 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 https://www.fema.gov/hazus/

> *"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 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 damage due to certain types of natural disasters and to allow for a comparison between different types of disasters. Therefore, this analysis should be considered a starting point for understanding potential damage from the hazards.

## ESTIMATED DAMAGES FROM HURRICANES

The HAZUS software was used to model potential damages to the community from a 100-year and 500-year hurricane event; storms that are 1% and 0.2% likely to happen in a given year, and roughly equivalent to a Category 2 and Category 4 hurricane. The damage 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 31: HAZUS Estimated Damages from Hurricanes**

| | Category 2 (100-yr) | Category 4 (500-yr) |
|---|---|---|
| **Building Characteristics** | | |
| Estimated total number of buildings | 6,555 | |
| Estimated total building replacement value (2014 $) | $3,750,174,000 | |
| | | |
| **Building Damages** | | |
| # of buildings sustaining minor damage | 128 | 837 |
| # 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 | 3 |
| # of people seeking public shelter | 0 | 0 |
| | | |
| **Debris** | | |
| Building debris generated (tons) | 2,506 | 7,891 |
| Tree debris generated (tons) | 5,594 | 13,753 |
| # of truckloads to clear building debris (25 tons/truck) | 22 | 118 |
| | | |
| **Value of Damages** | | |
| Total property damage (buildings and content) | $19,118,230 | $246,111,000 |
| Total losses due to business interruption | $442,880 | $26,551,660 |

## ESTIMATED DAMAGES FROM EARTHQUAKES

The HAZUS earthquake module allows users to define an earthquake magnitude and model the potential damages caused by that earthquake as if its epicenter had been at the geographic center of the study area. For the purposes of this plan, two earthquakes were selected: magnitude

5.0 and magnitude 7.0. Historically, major earthquakes are rare in New England, though a magnitude 5.0 event occurred in 1963.

**Table 32: HAZUS Estimated Damages from Earthquakes**

| | Magnitude 5.0 | Magnitude 7.0 |
|---|---|---|
| **Building Characteristics** | | |
| Estimated total number of buildings | 6,555 | |
| Estimated total building replacement value (2014 $) | $9,206,000,000 | |
| | | |
| **Building Damages** | | |
| # of buildings sustaining slight damage | 1,904 | 200 |
| # of buildings sustaining moderate damage | 1,045 | 1,338 |
| # of buildings sustaining extensive damage | 298 | 1,857 |
| # of buildings completely damaged | 78 | 3,146 |
| | | |
| **Population Needs** | | |
| # of households displaced | 239 | 3,539 |
| # of people seeking public shelter | 121 | 1,798 |
| | | |
| **Debris** | | |
| Building debris generated (tons) | 79,000 | 608,000 |
| # of truckloads to clear debris (@ 25 tons/truck) | 3,160 | 24,320 |
| | | |
| **Value of Damages** | | |
| Total property damage | $563,160,000 | $3,955,620,000 |
| Total losses due to business interruption | $101,368,800 | $514,230,600 |

**ESTIMATED DAMAGES FROM FLOODING**

The HAZUS flooding module allows users to model the potential damage caused by a 100-year flood event and a 500-year flood event.

**Table 33: HAZUS Estimated Damages from Flooding**

| | 100-Year Flood | 500-Year Flood |
|---|---|---|
| **Building Characteristics** | | |
| Estimated total number of buildings | 6,555 | |
| Estimated total building replacement value (2014 $) | $3,750,000,000 | |
| | | |
| **Building Damages** | | |
| # of buildings sustaining limited damage | 228 | 286 |
| # of buildings sustaining moderate damage | 133 | 209 |
| # of buildings sustaining extensive damage | 5 | 20 |
| # of buildings substantially damaged | 0 | 0 |
| | | |

| | 100-Year Flood | 500-Year Flood |
|---|---|---|
| **Population Needs** | | |
| # of households displaced | 534 | 730 |
| # of people seeking public shelter | 50 | 91 |
| | | |
| **Value of Damages** | | |
| Total property damage | $92,310,000 | $135,070,000 |
| Total losses due to business interruption | $160,760,000 | $207,240,000 |

## IMPACTS ON PEOPLE

As some areas of Concord will be more vulnerable than others, it is also true that climate change and natural hazards will not affect all residents equally. As noted in Concord's 2019 Municipal Vulnerability Preparedness (MVP) Planning Report, confined populations (in schools and hospitals), seniors, people with disabilities and/or with pre-existing health conditions, and lower-income households were consistently identified as populations in community who are most vulnerable to extreme heat, poor air quality, and isolation.

Individuals with physical mobility constraints may need additional assistance with emergency responses. Older adults are often at elevated risk due to a high prevalence of pre-existing and chronic conditions. People who live in substandard housing and in housing without air conditioning have increased vulnerability to heat-related illnesses. Low-income households are often more susceptible to financial shocks, which can occur after extreme weather, and which can impact financial security and the ability to secure safe shelter and meet medical needs. Approximately 2.7% of Concord residents live below poverty level; and 2% of the senior population are below poverty level. [6]

Social isolation can also influence vulnerability, as it limits access to critical information, municipal resources, and social support systems. In the absence of strong social support networks and translation services, people living alone and those with limited English language proficiency may experience social isolation. Certain occupations, particularly those who work outdoors, or in unregulated temperatures, are at increased risk for heat-related illnesses.

In developing mitigation measures the Town of Concord will consider the different needs of all residents.

6 American Community Survey, 2019

## RISK ASSESSMENT SUMMARY

| CLIMATE CHANGE | NATURAL HAZARD | PRIORITY (H/M/L) | KEY CONCERNS SOCIETY | KEY CONCERNS BUILT ENVIRONMENT | KEY CONCERNS NATURAL RESOURCES |
|---|---|---|---|---|---|
| **Changes in Precipitation**  | Inland Flooding | H | • Damage to buildings/homes in historic districts<br>• Inland flooding could lead to the potential loss of historic artifacts or historic items that can't be replaced<br>• List public health and economic damages to the town when an extreme event occurs | • Flooding of major arteries, emergency routes, key facilities, bridges (ex: South Bridge; policy/fire departments in floodplain)<br>• Residential basements<br>• Concord has about 150 culverts all over town. Had a recent failure of a culvert that was significant - impacted travel and were close to more serious impacts to gas mains, water mains, and other infrastructure. Generally, it would also impact significant historic buildings in Concord Center if the Mill Dam Culvert fails.<br>• Dam failures could result in downstream loss of life and property damage<br>• Flooding also introduces the risk of infiltration of wastewater into the water system<br>• Uprooted trees may cause culvert and bridge blockages | • Sedimentation and erosion, leading to degraded habitats, clogged rivers and streams, and adverse effects to aquatic organisms<br>• Contaminated floodwaters can pollute rivers and streams<br>• Uprooted trees along rivers may destroy or degrade riparian wildlife corridors |

| CLIMATE CHANGE | NATURAL HAZARD | PRIORITY (H/M/L) | KEY CONCERNS SOCIETY | KEY CONCERNS BUILT ENVIRONMENT | KEY CONCERNS NATURAL RESOURCES |
|---|---|---|---|---|---|
| | Drought | H | • Increased risk of water supply shortage<br>• Impact to farm operations, plant nursery, etc. (water use restriction) | • Infrastructure – turbines can't operate if they're exposed because of low water levels | • Stress on surface and groundwater supplies<br>• Stress on terrestrial and aquatic ecosystems due to reduced stream baseflows and drying wetlands, which all fisheries and wildlife rely on<br>• Stress on agricultural crop production from reduced soil moisture, and water supplies → Concord enacted water use restrictions annually<br>• Loss of plant life, reduced habitat quality and biodiversity<br>• Less natural resistance to brushfires |
| | Landslide | M/L | | • Potentially buildings built on expansive soil could be impacted.<br>• There are 2 underground transmission lines that service the entire town. | • Potential filling of wetlands and rivers; loss of wildlife habitat |
| **Rising Temperatures**  | Average and Extreme Temperatures | | • Heat related illness and deaths – particularly high risk for seniors and those who are medically vulnerable.<br>• Increase energy costs | • Increase energy demand – stress on infrastructure → aging conduits for service and without redundancy | • Loss of livestock and crops |

| CLIMATE CHANGE | NATURAL HAZARD | PRIORITY (H/M/L) | KEY CONCERNS SOCIETY | KEY CONCERNS BUILT ENVIRONMENT | KEY CONCERNS NATURAL RESOURCES |
|---|---|---|---|---|---|
| | Wildfires | M/L | • Smoke from fires could result in poor air quality → health risk for those with pre-existing conditions and/or respiratory illnesses. | | • Brushfire hazard areas have historically been the same places – Hapgood Wright Town Forest, Spencer Brook Valley, places on Old Marlborough Rd near Sudbury line. The absence of brushfires over time can lead to larger wildfires in future. |
| | Invasive species | M/H | • Rising temperatures will mean an increase in invasive species.<br>• Shift in climate also creates more favorable habitat for ticks and mosquitos and disease vectors (EEE). Concord is especially concerned about ticks, because it's happening already. | | • Introduction of exotic pests (e.g., Asian long-horned beetle, emerald ash-borer, and hemlock wooly adelgid) can severely impact the composition of Concord's forests and woodlands<br>• Increased presence of invasive species alters habitats, reduce native plant populations, and reduce biodiversity<br>• Invasives that outcompete native species can result in species extinction, particularly to vulnerable, rare species |
| **Extreme Weather** | Hurricanes / Tropical Storms<br><br>Severe Winter Storms | H | • Disruption to the movement of goods, which hinders local economy<br>• Dependence on energy to power life-sustaining machines, access critical | • Downed trees and snow-packed or icy roads disrupt emergency management systems, delay commutes, etc.<br>• Concord Municipal Light Plant's systems vulnerable to intense storms | |

| CLIMATE CHANGE | NATURAL HAZARD | PRIORITY (H/M/L) | KEY CONCERNS SOCIETY | KEY CONCERNS BUILT ENVIRONMENT | KEY CONCERNS NATURAL RESOURCES |
|---|---|---|---|---|---|
| | | | information databases (prescription), keep the heat on during winter, communicate with emergency management and family (losing cell phone charge), etc.<br>• Damage to buildings/homes in historic districts | • Increased frequency of power outages<br>• Damage infrastructure like roads, bridges, and private property | |
| | Tornadoes | M/H | • Significant property damage and household displacement<br>• Destruction of historical and cultural resources in Concord. | • In 2016, EF-1 tornado 1 mile from downtown – it was short lived but did a lot of damage. If it went down Main Street, it would have wiped out the historic downtown. | |
| | Other (Wind/ Thunderstorms) | H | • Damage to buildings and homes in historic districts | | • Risk to 23,000 public shade trees in town. They're aging. This town prides itself on the urban forest and wants to maintain the tree canopy. |
| **Non-Climate Hazard** | Earthquake | L | • Significant property damage and household displacement | • Damage to utility infrastructure (especially underground) | |

# SECTION 5: HAZARD MITIGATION GOALS

The Local Hazard Mitigation Planning Team reviewed and discussed the goals from the 2017 Hazard Mitigation Plan for the Town of Concord. All the goals are considered critical for the town, and they are not listed in order of importance. Prior to the Hazard Mitigation Plan update process, the Town of Concord has also developed a climate action and adaptation planning process as part of the state Municipal Vulnerability Preparedness (MVP) program. The Local HMP Team decided to incorporate climate considerations as noted in Goals 4, 5, and 9.

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

**Goal 2:** Identify and seek funding for measures to mitigate or eliminate each known significant 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 and resources resulting from all hazards, especially the critical services for climate vulnerable populations.

**Goal 5:** Work with business community, major institutions, and non-profits to develop, review and implement the hazard mitigation plan that ensures prompt recovery and continuity of operations during and post emergency events or disasters.

**Goal 6:** Work with surrounding communities, state, regional and federal agencies to ensure regional cooperation, communications, 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 communicate and educate Town staff and the public about hazard mitigation.

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

# SECTION 6: 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 execute and complete some of these.

The Town's existing mitigation measures, which were included in the 2017 Plan, are listed by hazard type here and are summarized in Table 34 below. Many upgrades to existing measures have occurred and are noted in the following sections.

## EXISTING TOWN-WIDE MITIGATION FOR FLOOD-RELATED HAZARDS

It is an ongoing effort for Concord to address and 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 National Flood Insurance Program (NFIP) with 106 policies in force. 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. FEMA maintains a database on flood insurance policies and claims. The following information is provided for the Town of Concord, provided by MEMA on September 6, 2022:

| | |
|---|---|
| Flood insurance policies in force | 106 |
| Coverage amount of flood insurance policies | $35,239,700 |
| Closed losses (Losses that have been paid) | 61 |
| Total payments (Total amount paid on losses) | $372,956 |

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.

***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***

Concord 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. Since 2017, six projects including 10 culvert replacements have been completed.

***Beaver Management***

The Town manages for beavers on a case-by-case basis, when there is a threat to public health or safety. Options include trapping, beaver dam breaching or removal, or installation of a water flow device. A permit for trapping is required by state law through the local Board of Health, and dam breach/removals, as well as installation of water flow devices, require a permit from the Natural Resources Commission. Water flow devices (beaver deceivers or pond levelers) have been installed at several locations in Town (Hutchins Pond, Fairyland Pond, and Westford Road). The Town uses an interdepartmental approach to manage beavers.

***Wetlands Protection Act and Concord Wetlands Bylaw***

The state and local wetland law and bylaw require approval and compensation for activities within the floodplain.

***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.

***Cluster Development***

Residential Developments that provide open space protections 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 and Recreation Plan, Long-Range Plan, and Community Preservation Plan are comprehensive and identify key parcels for purchase or protection.
- The Natural Resources Commission, Concord Land Conservation Trust, and other conservation organizations acquire and manage conservation lands in town. Since the 2017 HMP, an additional 140 acres in town has been protected.
- The town adopted the Community Preservation Act with a 1.5% surcharge in 2004. The Community Preservation Committee helps administer the Community Preservation Act, and developed a Community Preservation Plan in 2008.
- Low-lying wetlands and floodplains provide significant flood storage from the town's rivers.
- Flood plain has been preserved and is effective at minimizing flooding.

***NPDES stormwater***

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

### *ONGOING FLOOD MITIGATION FOR SPECIFIC SITES*

*Cambridge Turnpike*

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 roadbed, 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 beaver activity in the area. Improvements to the Crosby Dam 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 roadbed. Work commenced in 2017, has been completed and under the supervision of the MA Office of Dam Safety.

*Crosby's Pond*
Crosby's Pond and dam located adjacent the Cambridge Turnpike previously 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. Flood management efforts at Crosby's Pond have been ongoing and under the supervision of the MA Office of Dam Safety.

Previous flood mitigation efforts mentioned in the 2017 Plan and have since been completed included: Pine Street Bridge, Sudbury Road/Heath's Bridge, Concord Center, Nashawtuc Road/Bridge, Monument Street/Flint's Bridge.

### *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.

Specific sites:

- Warner's Pond Dam, located in West Concord tributary to the Assabet River, has been reconstructed to mitigate flooding of downstream properties.
- Crosby's Pond and dam, located adjacent to the Cambridge Turnpike have flooded and exacerbated the flooding at Cambridge Turnpike. As of the 2023 update to this plan, the property owner has lowered pond levels, and the length of the dam that is privately-owned is in the process of upgrading. This mitigation effort is ongoing and under supervision of the MA Office of Dam Safety.

## EXISTING TOWN-WIDE MITIGATION FOR WIND-RELATED HAZARDS

#### *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 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 damage would be extremely high.

#### *Tree-trimming Program*
The Public Works Department has an effective tree trimming program 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 trees 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 are required to install buried utilities. The town currently has 40% of its wires installed underground and is retroactively burying wires where street work is underway for other purposes.

## EXISTING TOWN-WIDE MITIGATION FOR WINTER-RELATED HAZARDS

***Snow Disposal***

Regular plowing and snow/ice removal. Calcium chloride is used primarily for road treatments. Sand is very rarely used as it creates siltation and cleans up problems. The CPW works to clear roads as requested or in an emergency for the Fire and Police Departments.

***Parking***

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

***Snow and Ice Disposal Bylaw***

The Town of Concord prohibits disposal of snow or ice in any public place or upon any part of a public street or sidewalk. Snow is stored in the Keyes Road lot.

***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 social media, listservs, and email. In addition, new codes are more stringent to better guard against roof collapses

## EXISTING TOWN-WIDE MITIGATION FOR FIRE-RELATED HAZARDS

***Burn Permits***

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.

## EXISTING TOWN-WIDE MITIGATION FOR GEOLOGIC HAZARDS

### *EARTHQUAKES*

***Massachusetts State Building Code***
The State Building Code contains a section on designing for earthquake loads (780 CMR 1612.0). Section 1612.1 states that the purpose of 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 a 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 and Sewer Division is proactive in isolating portions of the water system and identifying alternative firefighting water supply sources.

***Evacuation Plan***
The Town has an evacuation plan as specified in its Comprehensive Emergency Management Plan (CEMP).

### *LANDSLIDES*

***Maximum slope requirements***
The subdivision regulations has maximum slope requirements for new roads.

***Earth Removal Bylaw***
The Town has an Earth Removal Bylaw.

### *BRIDGE WEIGHT RESTRICTIONS*

Concord has many bridges that cross the numerous waterways throughout 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 has to plan for alternate routes around these bridges to reach an emergency 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.

As of this 2023 Plan update, two of the three bridges of greatest concern have been upgraded, and detours are no longer required. They are Pine Street Bridge and Flint's Bridge on Monument Street. There is yet to be a plan for upgrading the Main Street Bridge between Elm and Wood Streets; this bridge has a 7-ton rating and adds a 2-mile detour, which happens several times per week.

## EXISTING TOWN-WIDE MITIGATION FOR MULTIPLE HAZARDS

### *Multi-department Review of Developments*

Multiple departments, including 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, hurricanes, tornadoes, dam failures, earthquakes, and winter storms. Therefore, the CEMP is a mitigation measure that is relevant to all of the hazards discussed in this plan. The CEMP is available online through secure access for town personnel.

### *Enforcement of the State's 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, Concord, Lincoln, Sudbury, Wayland, and Weston.

### *Emergency Preparedness*

Public education is available on the town's website. Concord establishes a reverse 911 system and names can be added to the database via the town's website. The Concord/Carlisle High School and Harvey Wheeler Community Center are the designated community shelter sites. The Police and Fire Stations have a backup generator, but it runs on natural gas and would be inoperable if 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 helicopters 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 for the elderly during extreme heat.

## PREPARING FOR CLIMATE CHANGE IMPACTS

Concord established the Climate Action Advisory Board (CAAB) to advise and provide strategic direction to the Town on how to meet its climate goals. The purpose, charge, and membership are intentionally broad. Addressing climate change in Concord will require both reducing GHG emissions and ensuring community members are resilient to impacts due to climate change.

In 2019, Concord participated in the state's Municipal Vulnerability Preparedness (MVP) Planning program, conducting community workshops to assess the community's climate vulnerabilities and priority actions to adapt and enhance resilience of the town's social, environmental, and infrastructural assets. In becoming an MVP community, Concord is eligible to pursue Action grants to implement the identified priority actions.

In June 2020, Concord published *Sustainable Concord: Climate Action and Resilience Plan*[7], which lays out a roadmap for how Concord will take action in the next 5 years to make progress toward our climate goals.

## COMPILATION OF EXISTING MITIGATION

Table 34 summarizes the many existing natural hazard mitigation measures already in place in Concord when the last Hazard Mitigation Plan was developed in 2017. Because of the number of entities, public and private, involved in natural hazard mitigation, it is likely that this list is a starting point for a more comprehensive inventory of all measures.

7 Sustainable Concord: Climate Action and Resilience Plan, June 2020. https://concordma.gov/DocumentCenter/View/25318/Sustainable-Concord-Climate-Action-and-Resilience-Plan-2020

### Table 34: Existing Natural Hazard Mitigation Measures in Concord

| HAZARD | AREA | MITIGATION MEASURE | EFFECTIVE Y/N | UPDATES SINCE 2017 |
|---|---|---|---|---|
| **Flood-Related** | Town-Wide | The town participates in the National Flood Insurance Program and has adopted FIRM maps. | Y | None. The town actively enforces the floodplain regulations. |
| | | The Town enforces the Massachusetts Building Code | Y | None. |
| | | Stormwater system is mapped in GIS | Y | None. |
| | | Annual catch basin cleaning and street sweeping | Y | None. |
| | | Drainage system maintenance | Y | None. |
| | | Long-term stormwater plan and funding, and ongoing system improvements | Y | Completed replacing 10 culverts. |
| | | Beaver mitigation | Y | None. |
| | | State Wetlands Protection Act and local Wetlands Bylaw | Y | None |
| | | Flood Plain Conservancy District | Y | None. |
| | | Wetlands Conservancy District | Y | None. |
| | | Massachusetts Stormwater Policy | Y | None |
| | | Stormwater Requirements in Subdivision Regulations and Site Plan Review | Y | None. |
| | | Open Space Residential Developments | Y | None. |
| | | Groundwater Conservancy District | Y | None. |
| | | Protected open space and proactive land preservation programs | Y | An additional 140 acres of protected land. |
| | | Public Education on stormwater through the NPDES Phase II program | Y | None |
| | Pine Street Bridge | Reconstruction by the state for structural upgrades, not necessarily to improve water flow | Y | Complete. |

| HAZARD | AREA | MITIGATION MEASURE | EFFECTIVE Y/N | UPDATES SINCE 2017 |
|---|---|---|---|---|
| | Commonwealth Ave at Warner's Pond | Reconstruct Warner's Pond Dam to alleviate flooding at this location. | Y | Complete. |
| | Pedestrian Bridge at Nashoba Brook | Reconstruct Warner's Pond Dam to alleviate flooding at this location. | Y | Complete. |
| | Sudbury Road – Heath's Bridge | Reconstruction by the state | Y | Complete. |
| | Concord Center | Rehabilitate the Mill Dam culvert under Main Street is currently being rehabilitated. | Y | Complete. |
| | Cambridge Turnpike | Cambridge Turnpike reconstruction | Y | Complete. |
| | Cambridge Turnpike | Improvements to Crosby Dam (private owner) to alleviate some flooding at the Cambridge Turnpike. | N/A | On-going, under the supervision of the Office of Dam Safety |
| | Nashawtuc Road-Nashawtuc Bridge | Jersey barriers were installed to maintain the side walls. | Y | Complete. |
| | Crosby Pond | Lowered pond levels in anticipation of flooding. The owner is currently in the process of upgrading the dam. | N/A | On-going, under the supervision of the Office of Dam Safety |
| | Monument Street – Flint's Bridge (26) | Upgraded by the state. | Y | Complete. |
| **Dams** | Town-Wide | DCR Dam Safety Regulations | Y | None. |
| | Warner's Pond Dam | Reconstruction needed. | Y | Complete. |
| | Crosby's Pond Dam | Lowered pond levels in anticipation of flooding. Upgrading the dam (by owner). | N/A | On-going, under the supervision of the Office of Dam Safety |
| **Wind-Related** | Town-Wide | Enforcement of the Massachusetts Building Code. | Y | None. |
| | | Tree Maintenance Program by Public Works and by Concord Municipal Light. | Y | None. |

| HAZARD | AREA | MITIGATION MEASURE | EFFECTIVE Y/N | UPDATES SINCE 2017 |
|---|---|---|---|---|
| | | Requirement for new developments to install underground utilities. Town continually removing existing overhead wires and installing them underground | Y | None. |
| **Winter-Related** | Town-Wide | A) Standard snow operations, restricted salt<br>B) Overnight parking ban November – April<br>C) Public Education on snow operations and winter maintenance is on the town website<br>D) Snow and Ice Disposal Bylaw<br>E) Public Education on how to prevent roof collapses from snow loads<br>F) Sufficient space for municipal snow storage | Y | None. |
| **Fire-Related** | Town-Wide | A) Open burning permits required<br>B) Fire Department reviews all development plans<br>C) Fire Department provides public education on its website<br>D) Fire Department is trained for protecting the Federal Wildlife Preserve and National Park<br>E) Fire department obtained new brush fire vehicle in 2006<br>F) Town provides public education on drought watches | Y | None. |
| **Geologic - *Earthquake*** | Town-Wide | Shelters and backup facilities available (see multi-hazard mitigation below) | Y | Addition shelter has been designated. |
| | | Water Department able to isolate portion of the water system and identify alternate firefighting supply sources | Y | None. |
| | | Evacuation plan in CEMP | Y | None. |

| HAZARD | AREA | MITIGATION MEASURE | EFFECTIVE Y/N | UPDATES SINCE 2017 |
|---|---|---|---|---|
| **Geologic - *Landslides*** | Town-Wide | Maximum slopes for subdivision roads | Y | None. |
| | | Earth Removal Bylaw | Y | None. |
| **Other – Bridge Weight Restrictions** | Pine Street Bridge (2) | Upgraded by the state | Y | Complete. |
| | Flint's Bridge on Monument Street (26) | Scheduled for upgrades by the state | Y | Complete. |
| | Main Street Bridge b/t Elm and Wood | No planned upgrades underway | N | Not done. |
| **Multi-Hazard** | Town-Wide | A) Multi-department review of developments<br>B) Comprehensive Emergency Management Plan (CEMP)<br>C) Enforcement of State Building Code<br>D) Local Emergency Management Planning Committee (LEPC) and CrossRoads Regional Emergency Management Committee (REPC)<br>E) Emergency Preparedness public education on the town website<br>F) Reverse 911<br>G) Concord/Carlisle High School is designated as a community shelter (although it has no generator)<br>H) Police and Fire Stations have backup generators (although they are on natural gas or are limited diesel)<br>I) Citizen Emergency Response Team (CERT)<br>J) Medical Reserve Corps<br>K) El Paso Tenneco Energy company monitors its gas line<br>L) Sheltering available for elderly during extreme heat | Y | G) Harvey Wheeler Community Center is new shelter |

# EXISTING MITIGATION CAPABILITIES AND LOCAL CAPACITY FOR IMPLEMENTATION

**Town Plans and Policies**

Under the Massachusetts system of "Home Rule," the Town of Concord is authorized to adopt and from time to time amend 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.

**Town Staff and Commissions**

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 relevant updates to the Comprehensive Plan and implementation of the Zoning Bylaw, Floodplain District, and Subdivision Rules and Regulations. The Natural Resources Commission will oversee implementation of the Wetlands Bylaw and the Open Space Plan. Public Works together with the Planning Board and Natural Resources Commission will coordinate drafting and adoption of the Stormwater Bylaw.

The Town can improve its hazard mitigation capabilities with the following measures:

- Adopt Low Impact Development (LID) best practices and/or incorporating LID requirements more formally into a bylaw to ensure it becomes widely adopted in new developments and redevelopments
- Adopt a Stormwater Utility or stormwater user fee to provide a dedicated, predictable revenue stream to finance upgrades to the stormwater infrastructure.
- Incorporate climate resilience in the local wetlands bylaws and regulations.
- Continue analyzing future threats to critical infrastructure, facilities, and residences based on projections of sea level rise and increasing storms.

**Financial Capabilities**

In addition to pursuing state and federal funding sources, Concord will continue identifying potential local funding sources to implement hazard mitigation activities, such as data analysis or outreach efforts, which may require little to no costs other than staff time and existing operating budgets. Additional financial assistance in the form of grant funding will likely be required to implement the larger proposed mitigation actions.

# SECTION 7: MITIGATION MEASURES FROM PREVIOUS PLAN

## IMPLEMENTATION PROGRESS ON THE PREVIOUS PLAN

The Local HMP Team reviewed the mitigation measures identified in the 2017 Concord Hazard Mitigation Plan and determined whether each measure had been implemented or deferred. Of those measures that had been deferred, the team evaluated whether the measure should be deleted or carried forward into this 2023 Plan Update. The decision on whether to delete or retain a particular measure was based on the HMP Local Team'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 act on the measure. Table 35 summarizes the status of mitigation measures from the 2017 Plan.

### Table 35: Mitigation Measures from the 2017 Plan

| **Mitigation Action (from 2017 HMP)** *Note: Measures retained from 2010 Plan are marked with (*)* | **Priority** | **Current Status** | **Include in 2023 HMP** |
|---|---|---|---|
| *Drainage improvement to the Cambridge Turnpike | High | COMPLETED: Construction complete. | No |
| Conduct alternatives analysis for flood protection at Lowell Road wastewater pump station | High | COMPLETED: The facility has been refurbished. Rehabilitated completed in 2022. | No |
| *Continuation of Open Space Protection and Land Acquisition | High | This is now ongoing mitigation program. Some locations have been identified but not approved. | No |
| Provide improved elevation resolution in GIS | High/Medium | NOT COMPLETED: MassGIS has provided a more detailed view of groundwater without structures. Have better base data but still need to analyze – need additional staff capacity to lead this effort and expand analysis to include community-wide flooding capacity and vulnerability. | Yes |
| Continue culvert replacement projects | High | NOT COMPLETED: Sawmill Brook culvert repaired. A consultant is conducting a full inventory of bridges and culverts and preparing a capital spending plan on priority needs. | Yes |

| | | | |
|---|---|---|---|
| | | Beaver dams caused severe flooding that the town will need to keep monitoring. | |
| Continue to monitor status of private dams for flood risk. | Medium/High | This is now an ongoing program. | No |
| Town wide shade tree inventory and management plan | High | NOT COMPLETED: This action needs to be done every 5 years or so. Completed a shade tree inventory in 2017 – there are more than 2,300 trees in the inventory. Currently looking for funding to conduct an inventory update.<br><br>The Town has a Public Shade Tree Planting Policy to ensure standard operating procedures for public tree planting and replacement. | Yes |
| Maintain debris stockpile location at the Composting Facility, identify back-up location | High | This is now an ongoing maintenance program. | No |
| Tree management at Annursnac Reservoir | High | COMPLETED. | No |
| Clear/create fire roads to brush fire risk areas | High | This is now an ongoing program. | No |
| Maintain snow storage at the Composting Facility; secure replacement for West Concord location | High | This is now an ongoing program. Have a MOU with DOC to get approved every year for snow storage. | No |
| Investigate technology for better monitoring of roadway conditions during storms | Medium | NOT COMPLETED: Made improvements, continue to look for new technology as it's always improving. Always opportunities to expand this. | Yes |
| Optimize use of space for salt storage | High | NOT COMPLETED: Was a "Medium" priority in 2017 Plan | Yes |
| Research options for additional back-up fuel storage capacity | High | NOT COMPLETED. | Yes |
| Provide public information on the risks of extreme temperatures | High | NOT COMPLETED: Was a "Medium" priority in 2017 Plan | Yes |
| Add treatment for Nagog Pond's water supply | High | This is an ongoing mitigation program. | No |

| | | | |
|---|---|---|---|
| Institute drought management plan | High | NOT COMPLETED.<br>But also recognizing that the State has advanced its drought management plan, so the Town will dovetail on that. Need to evaluate long range supply needs, potential for regionalization. | Yes |
| *Review status of historic buildings relative to earthquake resistance | Medium/Low | NOT COMPLETED: review in progress | Yes |
| *Upgrades to Main St. and Pail Factory bridges (bridge weight restrictions) | High | NOT COMPLETED: No actions have been taken because the State is responsible for these, and the town has no say in it. The Town will continue coordinating with state agency to address the issue. | Yes |
| *Identify alternate option for community sheltering | High | NOT COMPLETED: In progress. Looking at sheltering at high school and Harvey community center. Middle school is an option. Have ID alternative places. Nursing homes alternative sheltering is ongoing. How to shelter and evacuate nursing homes. | Yes |
| Outfit back-up emergency operations center | High | NOT COMPLETED: In progress. | Yes |
| Include sustainability in planning efforts | High | NOT COMPLETED: In progress – Need to develop an adaptation plan. Make recommendations more actionable. | Yes |
| Include climate change impacts in Comprehensive Long-Range Plan and Open Space and Recreation Plan | High | NOT COMPLETED: In progress. | Yes |

As indicated in Table 35 above, the Town has made progress implementing mitigation measures identified in the 2010 as well as 2017 HMPs. Since 2017, medium and high priority projects that were completed include drainage upgrades in various locations in town; conducting town-wide shade tree inventory and management planning; improving communications and monitoring during winter storms; and integrating sustainability in planning efforts.

Many of the mitigation measures are also in progress or continue as ongoing operations and maintenance programs and community outreach efforts. Overall, many of the "in progress" or "ongoing" mitigation measures from the 2017 plan will be continued in this plan update. Most retain the same priority in this 2023 Update; a couple measures previously indicated as "Medium" will be elevated to "High" priority in this 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.

# SECTION 8: 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

According to FEMA Local Multi-Hazard Mitigation Planning Guidance, identified 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, wetland and stream corridor restoration, watershed management, forest and vegetation management, and wildlife habitat 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.

## REGIONAL AND INTER-COMMUNITY CONSIDERATIONS

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 developed urban and suburban communities such as the metropolitan Boston area, mitigating natural hazards, particularly flooding, is more than a local issue. The drainage systems that serve these communities are complex systems of storm drains, roadway drainage structures, pump stations and other facilities owned and operated by a wide array of agencies including the Town, the Department of Conservation and Recreation (DCR), the Massachusetts Department of Transportation (MassDOT) and the Massachusetts Bay Transportation Authority (MBTA). The planning, construction, operation, and maintenance of these structures are integral to the flood 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 they must make decisions about numerous competing priorities.

The following section is a brief overview of regional facilities found in Concord and a discussion of inter-municipal mitigation efforts.

## OVERVIEW OF REGIONAL FACILITIES WITHIN CONCORD

Major facilities owned, operated, and maintained by federal, state, regional or private entities include:

- Great Meadows National Wildlife Refuge (US Fish and Wildlife)
- Minute Man National Historical Park (U.S. National Park Service)
- Walden Pond State Reservation (MA DCR)
- Hanscom Air Force Base (U.S. Air force)
- Hanscom Field Regional Airport (Massport)
- Commuter Rail Fitchburg Line with stations in Concord and West Concord (MBTA)
- 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
- Tenneco Gas Line (El Paso Energy Company)

- Army Corps of Engineers (ACOE) Regional Headquarters
- Routes 2, 2A, and 119 (MassDOT).

## INTER-COMMUNITY CONSIDERATIONS

The Town of Concord will continue engaging with neighboring communities on the following efforts:

**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.

**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. Beaver management will always occur on a case-by-case basis. In many instances beavers can live harmoniously with humans, in others, active management is necessary.

**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 correctional facilities.

**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 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 Natural Resources 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. Concord's Town Meeting has voted to approve a fossil-fuel ban on new construction and substantial renovations. After the Commonwealth approved legislation allowing certain Towns to participate in a pilot program, Concord is waiting to hear from the Department of Energy Resources whether it will be selected as one of the ten pilot communities for this effort.

## 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 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 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 road closures occurred and what impact closures had on delivery of emergency services and the local economy, 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 36 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 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 $25,000 to $100,000 |
| Low | Estimated costs less than $25,000 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 |

## INTRODUCTION TO MITIGATION MEASURES TABLE

Description of the Mitigation Measure – Each mitigation measure is provided with a brief description, and cost information is given if available from the community. The cost data represents 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 36, 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 (Social, Technical, Administrative, Legal, Economic, and Environmental) analysis.

Implementation Responsibility – based on a general knowledge of what each municipal department is responsible for; coordination with state agencies should also be considered. Most mitigation measures may require coordination of multiple departments, and assigning staff is the sole responsibility of the governing body of each community.

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

Potential Funding Sources – The information on potential funding sources in this table is preliminary and varies depending on a number of factors. These factors include whether 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. Individual grant programs and agencies also have specific eligibility requirements to be considered. In most instances, the measure may require different funding sources. Identification of a potential funding source 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)* provides assistance for different project types including shoreline/streambank protection, flood damage reduction, flood plain management services and planning services. Website: http://www.nae.usace.army.mil/.
- *Massachusetts Emergency Management Agency (MEMA)* provides information and guidance for the various Hazard Mitigation Assistance Program. Website: https://www.mass.gov/hazard-mitigation-assistance-grant-programs.

### Table 36: Mitigation Measures Prioritization

| CLIMATE CHANGE | ACTION | GEOGRAPHIC COVERAGE | LEAD | IMP.TIME FRAME | EST. BENEFIT | EST. COST | FUNDING SOURCE | PRIORITY |
|---|---|---|---|---|---|---|---|---|
| Changes in Precipitation  | **INLAND FLOODING** | | | | | | | |
| | 1. Promote and increase implementation of green infrastructure, Low Impact Development (LID), and climate change resilience solutions. | Town-wide | Planning<br>Natural Resources<br>CPW<br>Sustainability | 1-2 years | High | Medium/ High | State (MVP)<br>Federal (BRIC) | High |
| | 2. Rehabilitate or replace bridges to account for latest flood projections. | Town-wide | CPW | 4+ years | High | High | State (MassDOT)<br>Federal (BRIC) | High |
| | 3. Evaluate opportunities for dam removal. | Town-wide | CPW<br>Natural Resources | 2-4 years | High | High | Federal (FEMA NDSP) | High |
| | 4. Continue efforts to protect land in floodplain. | Town-wide | Planning<br>Natural Resources | 2-4 years | High | High | Local<br>State (EEA LWCF) | High |
| | 5. Expand GIS elevation analysis to better understand flooding capacity and vulnerability. | Town-wide | Planning<br>Sustainability<br>Data/GIS | 1-2 years | High | Medium | State (MVP) | High |
| | 6. Develop and calibrate hydrologic model with the latest climate change scenarios and considerations. | Town-wide | Sustainability<br>CPW<br>Data/GIS | 1-2 years | High | Medium | State (MVP) | High |
| | 7. Coordinate with the MA Office of Dam Safety on outreach to owners of private dams for potential dam failure and flood risk. | Site-specific | CPW | 1-2 years | Medium | Low | State (EOPSS)<br>Federal (FEMA NDSP) | Medium |
| | 8. Conduct a vulnerability assessment and identify resilience measures for the potential relocation of the Police/Fire/DPW facilities. | Site-specific | Sustainability<br>Fire<br>Police<br>CPW | 1-2 years | High | Low/ Medium | Local (Sustainability & Fire budgets) | High |

| CLIMATE CHANGE | ACTION | GEOGRAPHIC COVERAGE | LEAD | IMP.TIME FRAME | EST. BENEFIT | EST. COST | FUNDING SOURCE | PRIORITY |
|---|---|---|---|---|---|---|---|---|
| | 9. Evaluate all Town-owned culverts and develop plan for replacement, repair, and routine maintenance. | Town-wide | CPW | 1-2 years | High | Medium/ High | Local (CPW) State (DER CRM) | High |
| | **DROUGHT** | | | | | | | |
| | 10. Establish policies and programs to increase water efficiency and minimize the use of fresh water for irrigation. | Town-wide | Sustainability CPW | 1-2 years | Medium | Low/ Medium | Local (Sustainability & CPW budgets) | High |
| | 11. Develop a drought management plan to protect town water supply, evaluate long-range supply needs, and coordinate with neighboring municipalities for potential regionalization. | Town-wide | CPW Sustainability | 1-2 years | Medium | Medium | State (MVP) | High |
| | 12. Plant trees that are resistant to drought and heat. | Town-wide | CPW Natural Resources Sustainability | 2-4 years | Medium | Medium | State (DFW MWCCRGO) Federal (USDA-FS, LSR) | High |
| | 13. Require drought resilient landscaping in development permits. | Town-wide | Planning | 1-2 years | Medium | Low | Local (Planning) | High |
| | 14. Promote residents to adopt use of rain barrels by revamping existing program. | Town-wide | CPW Sustainability | 1-2 years | Medium | Low | Local (Sustainability) | Medium |
| | **LANDSLIDE** | | | | | | | |
| | 15. Assess steep slopes that are potentially vulnerable to failure. | Site-specific | CPW | 2-4 years | Low | Low | State (EOPSS; EEA HMGP) | Low |
| Rising Temperatures  | **EXTREME HEAT AND HEAT WAVES** | | | | | | | |
| | 16. Conduct extreme heat and heatwave risk awareness activities. | Town-wide | Health | 1-2 years | High | Low | State (MVP) | High |
| | 17. Update town-wide shade tree inventory and management plan with latest climate change data and considerations incorporated. | Town-wide | CPW | 1-2 years | High | Medium | State (MVP) | High |
| | 18. Increase shade (trees and/or structures) in public & commercial areas (including parking lots, urbanized sites). | Site-specific | CPW | 2-4 years | High | Medium | State (EEA) | High |

| CLIMATE CHANGE | ACTION | GEOGRAPHIC COVERAGE | LEAD | IMP.TIME FRAME | EST. BENEFIT | EST. COST | FUNDING SOURCE | PRIORITY |
|---|---|---|---|---|---|---|---|---|
| | 19. Evaluate removal of impervious surface areas to reduce heat island effect. | Town-wide | CPW | 2-4 years | High | Low | State (MVP) | Medium |
| | 20. Evaluate and update local heat map regularly. | Town-wide | Sustainability | 1-2 years | High | Low | Local (Sustainability) State (MVP) | Medium |
| | **WILDFIRES** | | | | | | | |
| | 21. Develop public education program about preventing and eliminating combustible areas around the home to reduce risk. | Town-wide | Fire/EMS | 1-2 years | Medium | Low | State (DCR) Federal (FEMA, USDA-FS) | Medium |
| | **INVASIVE SPECIES** | | | | | | | |
| | 22. Include invasives management plan in permit requirements | Town-wide | Natural Resources | 1-2 years | High | Low | Federal (USDA-FS, USDA-NRCS) State (DFW MWHMGP) | High |
| | 23. Develop a management plan for wildlife hazards and invasive species, with latest climate change data and considerations incorporated | Town-wide | Natural Resources | 2-4 years | High | Medium | State (DCR) | Medium |
| | 24. Enhance surveillance for mosquito and ticks, vector-borne species | Town-wide | Health | 1-2 years | Medium | Medium | State (DCR) | High |
| | **SEVERE WEATHER (STRONG WINDS, THUNDERSTORMS, WINTER STORM/NOR'EASTER)** | | | | | | | |
| | 25. Research options for additional back-up fuel storage, battery storage, salt storage spaces, and electric vehicle charging stations. | Site-specific | Fire Municipal Light Plant | 2-4 years | Medium | Medium | State (DOER) | Medium |
| | 26. Evaluate critical facilities for ability to withstand snow loads, retrofit if needed. | Site-specific | Facilities Building | 2-4 years | Medium | Medium | State (EOPSS) | High |
| | 27. Assess pavement materials, characteristics with consideration of future climate change conditions. Investigate technology for monitoring of roadway conditions during storms. | Town-wide | CPW | 4+ years | Medium | Medium | State (MassDOT) | Low |
| | 28. Develop a plan for urban forestry management. Assess urban forest vulnerability. | Town-wide | CPW | 2-4 years | High | Medium | State (MVP) | High |

| CLIMATE CHANGE | ACTION | GEOGRAPHIC COVERAGE | LEAD | IMP.TIME FRAME | EST. BENEFIT | EST. COST | FUNDING SOURCE | PRIORITY |
|---|---|---|---|---|---|---|---|---|
| Multi-hazards | **MULTI-HAZARDS** | | | | | | | |
| | 29. Develop an integrated natural resource management plan. | Town-wide | Natural Resources | 2-4 years | Medium | Medium/ High | State (DCR) | Medium |
| | 30. Expand database and educational outreach to seniors and medically vulnerable to collect information on critical needs, including prescriptions | Town-wide | Health Council on Aging Fire/EMS | 1-2 years | High | Low | State (EOPSS, DHCD) | High |
| | 31. Inventory and develop a needs assessment for vulnerable populations to expand plans for emergency preparedness (including community sheltering. | Town-wide | Health Council on Aging | 1-2 years | High | Low | State (EOPSS, DHCD) | High |
| | 32. Review existing communication and preparedness plans (from businesses, schools, town departments, etc.) to ensure response protocols are aligned. | Town-wide | Health Council on Aging | 1-2 years | High | Low | State (EOPSS, DHCD) | High |
| | 33. Coordinate with state agency (MassDOT) to make upgrades to bridges (e.g., Main Street, Pail Factory bridge) to meet weight restrictions | Site-specific | CPW | 4+ years | High | Low | State (MassDOT) Federal (FEMA) | High |
| | 34. Develop a community-wide climate adaptation plan. And also include climate change considerations in Comprehensive Long-Range Plan and Open Space and Recreation Plan. | Town-wide | Sustainability | 2-4 years | High | Medium | State (MVP) | High |
| Non-Climate Hazard | **EARTHQUAKE** | | | | | | | |
| | 35. Develop educational and outreach program on earthquake risks. | Town-wide | Fire/EMS | 4+ years | Low | Low | State (EOPSS) | Low |
| | 36. Assess vulnerability of infrastructure and buildings, particularly historic buildings. | Town-wide | CPW | 4+ years | Low | Medium/ High | State (MassDOT) Federal (FEMA BRIC) | Medium |

## DESCRIPTION OF MITIGATION MEASURES

### CHANGES IN PRECIPITATION

*Inland Flooding*

Promote and increase **implementation of green infrastructure, Low Impact Development (LID), and climate change resilience** solutions. For example, the Town will review and adopt resilience-focused policies to ensure future developments incorporate green infrastructure, LID, and other relevant climate resilience measures (floodproofing, strategic placement of utilities and systems in floodplain area, etc.). The Town will also prepare and develop education materials to promote best practices.

**Rehabilitate or replace bridges** to account for latest flood projections, starting with South Bridge.

**Evaluate opportunities for dam removal** to enhance public safety and prevent flood damage to roads, bridges, and other downstream built environment/infrastructure in the event of dam failure. In addition, dam removal can have positive environmental and ecological impacts such as improving water quality, restoring natural river flows, and potentially allowing reconnection of river habitats that benefit fish and wildlife.

**Continue efforts to protect land in floodplain.** In addition to continue monitoring and better understanding the intensity of precipitation projections (including consideration of 0.2% storm scenario that are anticipated to occur more frequently in the future), the Town can also consider requiring 2x compensatory flood storage capacity.

Expand GIS elevation analysis to **better understand flooding capacity and vulnerability**.

**Develop and calibrate hydrologic model** to exam overland riverine flooding as well as water supply based on predicted groundwater and surface water levels for selected climate change scenarios and considerations.

Coordinate with the MA Office of Dam Safety on **outreach to owners of private dams** to plan for potential dam failure and flood risk.

**Conduct a vulnerability assessment and identify resilience measures for the potential relocation of the Police/Fire/CPW facilities**, which are currently in a floodplain.

**Evaluate all Town-owned culverts** and develop a plan for replacement, repair, and routine maintenance.

*Drought*

**Establish policies and programs to increase water efficiency and minimize the use of fresh water.** The Town should include educational materials to help residents rethink water usage for landscaping, farm irrigation, etc. For example, consider gray water usage.

**Develop a drought management plan** to protect town water supply, evaluate long-range supply needs, and coordinate with neighboring municipalities for potential regionalization.

**Require drought resilient landscaping in development permits** – Examples include incorporating drought tolerant native species into development landscape regulations; and using permeable driveways and surfaces to promote groundwater infiltration and reduce stormwater runoff.

**Plant trees that are resistant to drought and heat,** particularly in identified "hot spots" in Concord.

**Encourage residents to adopt the use of rain barrels** to harvest rainwater for later use such as on lawns, gardens, or indoor plants. This will also contribute to the Town's water conservation efforts.

*Landslide*

**Assess steep slopes that are potentially vulnerable to failure** – The Town will review and identify potential landslide risk locations.

## RISING TEMPERATURES

*Extreme Heat and Heatwaves*

**Conduct extreme heat and heatwave risk awareness activities.** Similar to how New Englanders are well-prepared for snowstorms, the Town can help familiarize residents with preparation and procedures in dealing with more frequent heat days and heatwaves.

Continue exploring funding opportunities to **increase shade in public and commercial areas,** including parking lots and urbanized sites across town.

**Evaluate removal of impervious surface areas to reduce heat island impacts.**

**Evaluate and update local heat map** to inform priority emergency responses, strategic planning to reduce heat island impacts, etc.

*Wildfires*

**Continue promoting brush fire and fire prevention education.** The Fire Department participates in community events providing targeted outreach and informational brochures. The Fire Department maintains a web page with fire prevention materials. Additional focus should include prevention and elimination of combustible areas around homes.

*Invasive Species*

**Include invasives management in permit requirements**.

**Develop a management plan for wildlife hazards and invasive species.** Consider including the latest climate change data and impacts.

**Enhance surveillance for vector-borne species** and associated diseases, especially from mosquitoes and ticks.

**EXTREME WEATHER**

**Research options for additional back-up fuel storage, battery storage, and electric vehicle charging stations.** Consider renewable energy sources for back-up fuel storage.

**Evaluate critical facilities and their ability to withstand snow loads** and develop a plan to retrofit facilities that do not pass the criteria.

**Assess pavement materials and characteristics** with consideration of future climate change conditions.

**Update town-wide shade tree inventory and management plan** with latest climate change data and considerations incorporated.

**Develop an urban forestry management plan** – this plan will serve as a roadmap to manage and protect the Town's urban forest. It will include goals and priorities to enhance and expand the Town's tree canopy in the future.

**MULTI-HAZARDS**

**Develop an integrated natural resource management plan.** Develop a comprehensive plan for natural resource conservation and management (e.g., fish and wildlife, forestry, land management, outdoor recreation) in Concord.

**Expand database and education outreach to seniors and medically vulnerable** to collect information on critical needs, including provision of equipment, gathering points or shelters, prescriptions, healthcare services, etc. during extreme weather-related events

Review existing communications and plans from businesses, schools, town departments, etc. to **ensure alignment in preparedness and response protocols**.

**Develop a community-wide climate adaptation plan** to ensure the town and its residents are prepared for future climate change impacts. The plan can be built on the findings from the Municipal Vulnerability Preparedness planning efforts in 2019.

**NON-CLIMATE HAZARD**

*Earthquake*

**Conduct a seismic study to assess vulnerability of infrastructure and buildings.**

**Develop educational materials and outreach activities to raise awareness on earthquake risks** and prepare residents for potential incidents in the future.

# SECTION 9: PLAN ADOPTION & MAINTENANCE

## PLAN ADOPTION

The Concord Hazard Mitigation Plan 2023 Update was adopted by the Concord Select Board on April 3, 2023. See Appendix D for documentation. The plan was approved by FEMA on *[DATE TBD]* for a five-year period that will expire on *[DATE TBD]*.

## PLAN MAINTENANCE

MAPC worked with the Concord Local Hazard Mitigation Planning Team to prepare this plan. This group will continue to meet on an as-needed basis to coordinate the implementation and maintenance of this plan. The Town of Concord's Sustainability Director and Fire Chief will co-lead the implementation and maintenance efforts for the plan. Additional members could also be added to the local 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 Team, these will be placed on the Town's web site, and any meetings of the Hazard Mitigation Team will be publicly noticed in accordance with the town and state open meeting laws.

## IMPLEMENTATION AND EVALUATION SCHEDULE

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

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 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.

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 Team may decide to undertake the update themselves, contract with MAPC to update the plan or to hire another consultant. When the

Hazard Mitigation Implementation Team decides to update the plan, the Town will need to review the current FEMA hazard mitigation plan guidelines for any changes in requirements for hazard mitigation plans since the previous plan. Once the next plan update is prepared, the Town will submit it to MEMA and FEMA for review and approval and adopt the plan update in order to obtain formal FEMA approval of the plan.

## INTEGRATION OF THE PLANS WITH OTHER PLANNING INITIATIVES

Upon approval of the Concord Hazard Mitigation Plan 2023 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
- Police
- Engineering
- Water and Sewer
- Planning
- Natural Resources
- Recreation
- Health
- Building

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

The Town of Concord has taken steps to implement findings from the 2017 Hazard Mitigation Plan into policy, programmatic areas, and plans, including two planning efforts currently in progress: the Master Plan Update and the Open Space and Recreation Plan. In addition, hazard vulnerabilities and mitigation measures were also considered and aligned during the action prioritization of the MVP Community Resilience Building Workshop in 2019. The Hazard Mitigation Plan will also be integrated into other town plans and policies as they are updated and renewed, including the Community Comprehensive Plan, Emergency Management Plan, and Capital Investment Plan.

# SECTION 10: LIST OF REFERENCES


- Town of Concord, General Bylaws
- Town of Concord, Zoning Bylaw
- Town of Concord, Comprehensive Long-Range Plan "Envision Concord – Bridge to 2030," 2018
- Town of Concord Open Space Plan, 2015
- Town of Concord Water Quality Report, 2020
- Town of Concord Climate Action and Resilience Plan, 2020
- Town of Concord, Municipal Vulnerability Preparedness (MVP) Planning Report, 2019
- Blue Hill Observatory
- Boston HIRA
- FEMA, Flood Insurance Rate Maps for Middlesex County, MA, 2013
- FEMA, Hazards U.S. Multi-Hazard
- FEMA, Local Mitigation Plan Review Guide, October 2011
- Fourth National Climate Assessment, 2018
- Massachusetts Flood Hazard Management Program
- Massachusetts Office of Coastal Zone Management Shoreline Change Data
- Massachusetts Office of Dam Safety, Inventory of Massachusetts Dams 2018
- Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 2018
- Metropolitan Area Planning Council, GIS Lab, Regional Plans and Data
- National Weather Service
- Nevada Seismological Library
- New England Seismic Network, Boston College Weston Observatory, http://aki.bc.edu/index.htm
- NOAA National Climatic Data Center, http://www.ncdc.noaa.gov/
- Northeast Climate Adaptation Science Center
- Northeast States Emergency Consortium, http://www.nesec.org/
- Tornado History Project
- US Census, 2020 and American Community Survey 2020
- USGS, National Water Information System, http://nwis.waterdata.usgs.gov/usa/nwis
- USDA Forest Service, Wildfire Risk to Communities, www.wildfirerisk.org
- University of Massachusetts Boston, "Climate Change Impacts and Projections for the Greater Boston Area: Findings of the Greater Boston Research Advisory Group Report," 2022

# APPENDIX A: MEETING AGENDAS

## Concord Hazard Mitigation Plan - 2023 Update

### Local Hazard Mitigation Planning Team

**July 13, 2022**
**3:00 PM - 4:15 PM**
**Via Zoom Conference Call**
https://us06web.zoom.us/j/82033399241?pwd=Mm44b2d6TFIwWTdMQXBQQTJxRTZrdz09

### MEETING #1 - AGENDA

---

1. **Introductions** (5 minutes)

2. **Overview of Planning Process and Schedule** (10 minutes)

    a) Engagement process
    b) Stakeholder ID

3. **Overview of Climate Integration/MVP Review** (20 minutes)

    c) Review hazards & Identify key concerns

4. **Update local hazard areas** (20 minutes)

    d) Flooding
    e) Fires (brushfires/wildfires)
    f) Winter Storms
    g) Extreme Heat
    h) Others (geologic, wind related, etc.)

5. **Review Critical Infrastructure** (15 minutes)

6. **Conclusion & Next Steps** (5 minutes)

    a) Schedule Local Team Meeting #2

# Concord Hazard Mitigation Plan - 2023 Update

## Local Hazard Mitigation Planning Team

**August 25, 2022**
**10:00 PM - 11:30 PM**
**Hybrid: In-person at Concord Fire House (3rd Floor Conference Room)**
**and via Zoom Conference Call**
https://us06web.zoom.us/j/89564147851?pwd=R3AxZE9nS01oWWFMWms2cGV5eXA1QT09

## MEETING #2 - AGENDA

---

1. **Review and Confirm Critical Infrastructure** (30 minutes)

    i) Consider additional community and cultural assets to include on this list

2. **Review and Update Hazard Mitigation Goals** (5 minutes)

3. **Review and Update Status of 2017 Mitigation Measures** (45 minutes)

    a) Existing/Ongoing Mitigation Measures
    b) Proposed Mitigation Actions in 2017 HMP

4. **Prepare for Public Meeting** (8 minutes)

    a) Identify date, time, and location for Public Meeting #1
    b) Identify stakeholders for meeting outreach
    c) Consider: community-wide survey for feedback

5. **Conclusion & Next Steps** (2 minutes)

    b) Schedule Local Team Meeting #3

# Concord Hazard Mitigation Plan - 2023 Update

## Local Hazard Mitigation Planning Team

**November 8, 2022**

**3:00 PM - 4:00 PM**

**via Zoom Conference Call**

https://us06web.zoom.us/j/87205108447?pwd=NVJ4aUgxeHhaRVFHQmNEMG9aRzUyQT09

## MEETING #3 - AGENDA

---

1. **Develop New Mitigation Measures for 2023 Plan Update** (50 mins)
   d) Overview of mitigation table categories and evaluation criteria for prioritization (estimated benefits, costs, and overall priority)
   e) Review MVP Planning Report and determine priority actions to carry into the 2023 HMP Update

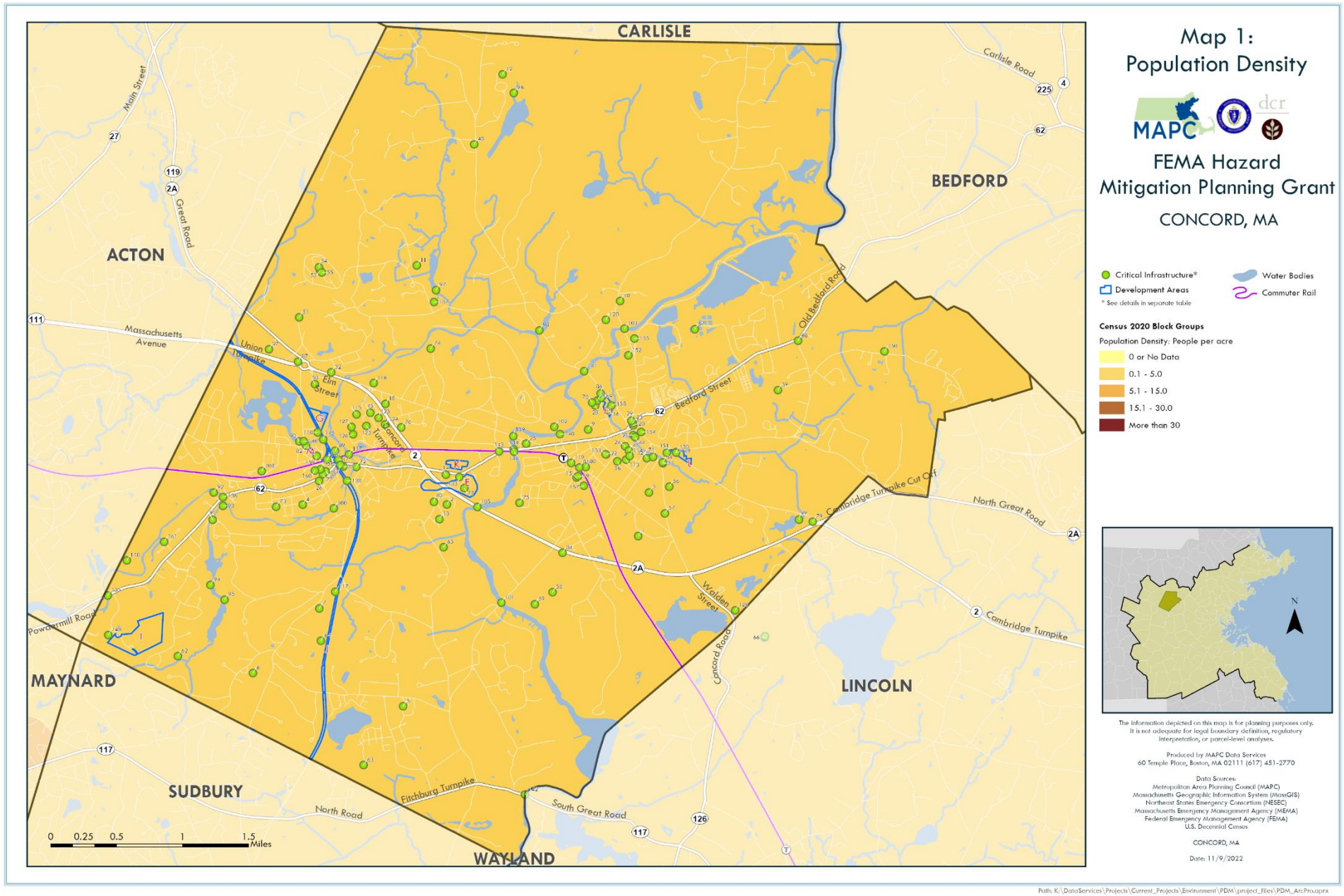
2. **Conclusion & Next Steps** (10 mins)

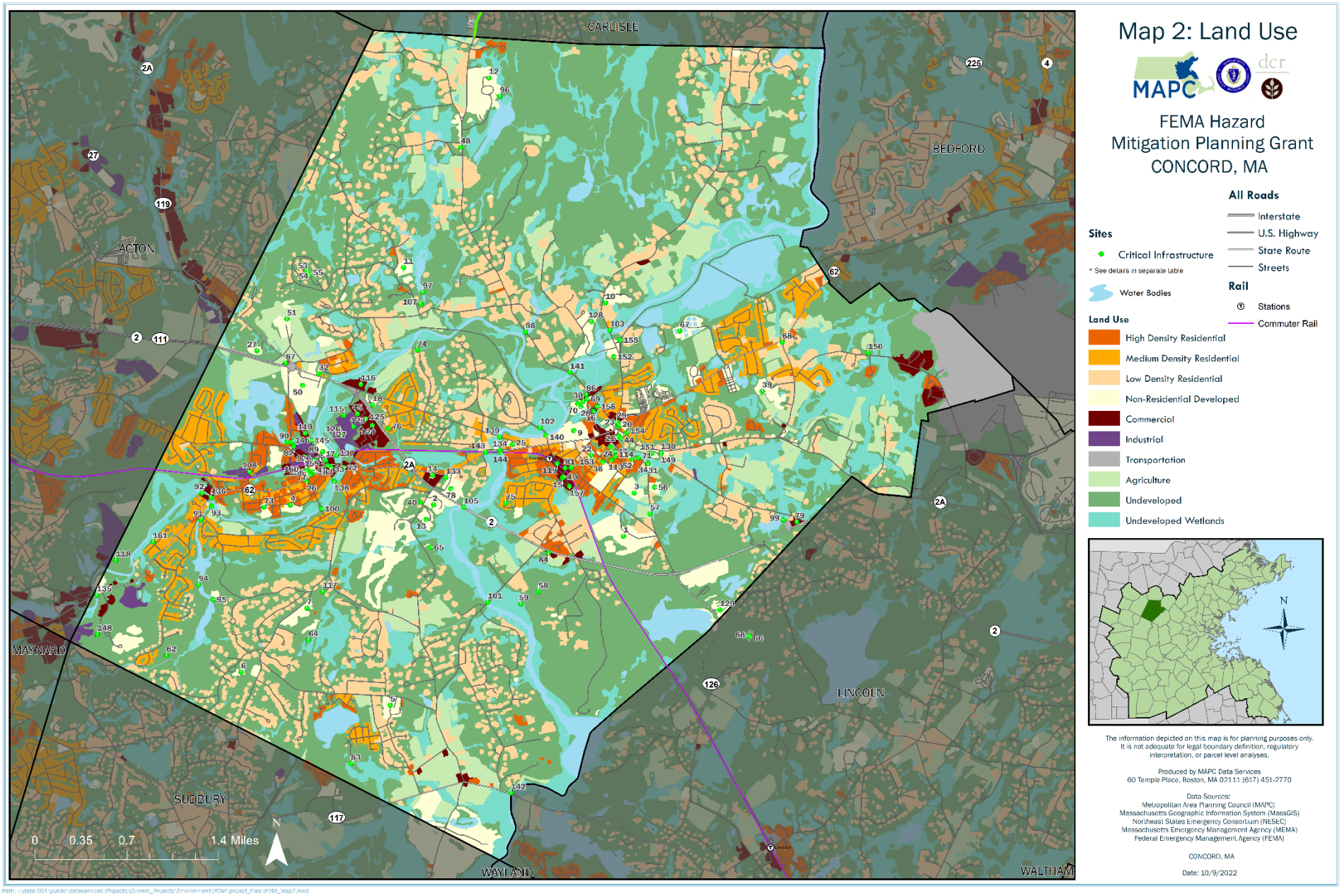
   c) Draft plan due to Local Team for review – by December 21
   d) Prepare for Public Meeting #2 – Week of December 5
      - Public Review – Dec 5 – Dec 16
      - Set up community-wide survey for final public input
   e) Deadline for submission to MEMA

# APPENDIX B: HAZARD MAPPING

**Maps:**

1. Population density
2. Land use
3. Flood zones
4. Earthquake/landslides
5. Hurricane/tornadoes
6. Average snowfall
7. Composite Natural Hazards
8. Local Hazard Areas
9. High Land Surface Temp


Map 1:
Population Density
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
CONCORD, MA
CARLISLE
BEDFORD
ACTON
MAYNARD
SUDBURY
WAYLAND
LINCOLN
Critical Infrastructure*
Development Areas
* See details in separate table
Water Bodies
Commuter Rail
Census 2020 Block Groups
Population Density: People per acre
0 or No Data
0.1 - 5.0
5.1 - 15.0
15.1 - 30.0
More than 30
0 0.25 0.5 1 1.5 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)
U.S. Decennial Census
CONCORD, MA
Date: 11/9/2022


Map 2: Land Use
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
CONCORD, MA
All Roads
Interstate
U.S. Highway
State Route
Streets
Sites
Critical Infrastructure
* See details in separate table
Water Bodies
Rail
Stations
Commuter Rail
Land Use
High Density Residential
Medium Density Residential
Low Density Residential
Non-Residential Developed
Commercial
Industrial
Transportation
Agriculture
Undeveloped
Undeveloped Wetlands
CARLISLE
BEDFORD
ACTON
MAYNARD
SUDBURY
WAYLAND
LINCOLN
WALTHAM
0 0.35 0.7 1.4 Miles
N
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.
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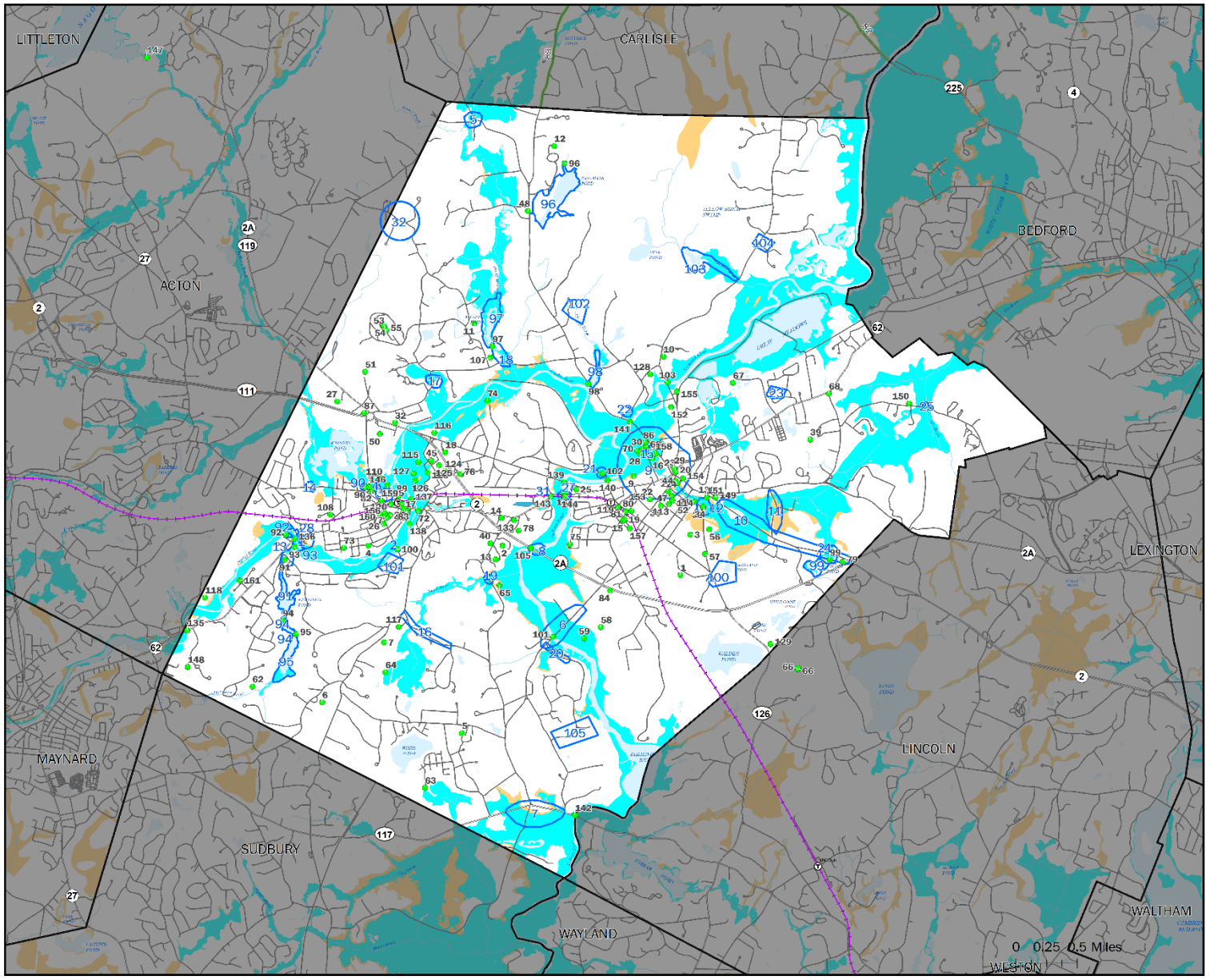
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
CONCORD, MA
Date: 10/9/2022




MAPC dcr

# FEMA Hazard Mitigation Planning Grant
## CONCORD, MA

Map 3: Flood Zones

Water Bodies

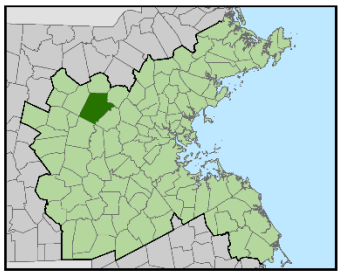
**Sites**
- Critical Infrastructure*
- Locally Identified Flooding

* See details in separate table

**Flood Zones, 2017 (Annual Chance)**
- Zone A: 1%
- Zone AE: 1%
- Zone AH: 1%
- Zone AO: 1%
- Zone VE: 1% with Velocity Hazard
- 0.2% Annual Chance

**All Roads**
- Interstate
- U.S. Highway
- State Route
- Streets

**Rail**
- Stations
- Commuter Rail
- Trains



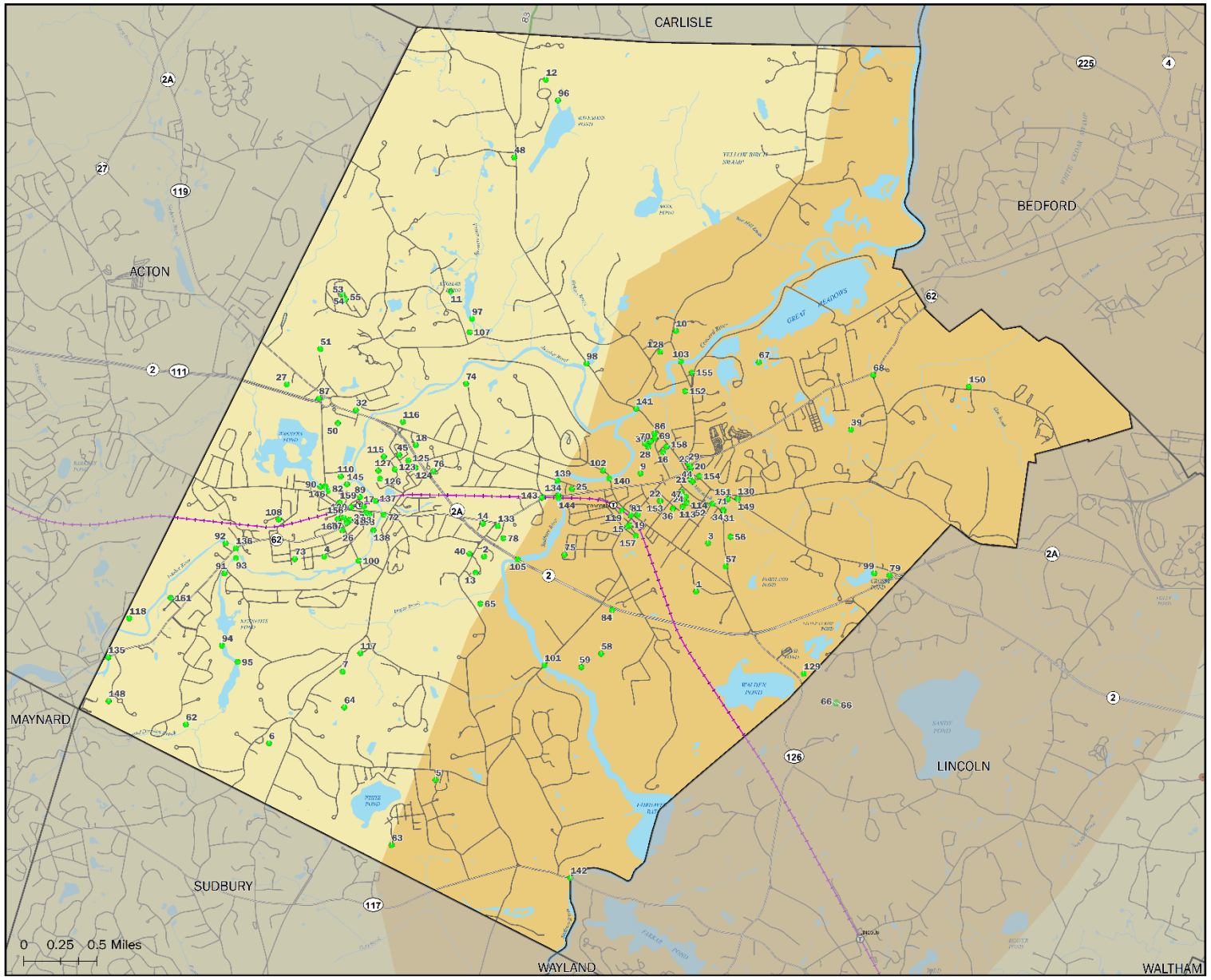


Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770

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
Date: 10/11/2022




# Map 4: Earthquakes / Landslides

MAPC

## FEMA Hazard Mitigation Planning Grant

CONCORD, MA

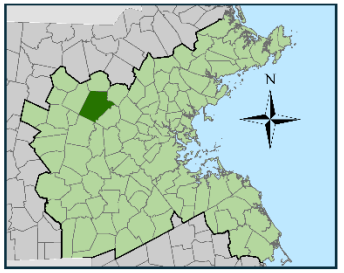
**Sites**
- Critical Infrastructure Sites*
- * See details in separate table

**All Roads**
- Interstate
- U.S. Highway
- State Route
- Street

- Train Stations
- Commuter Rail Lines
- Trains
- Water Bodies

**Earthquakes**
- Epicenters

**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

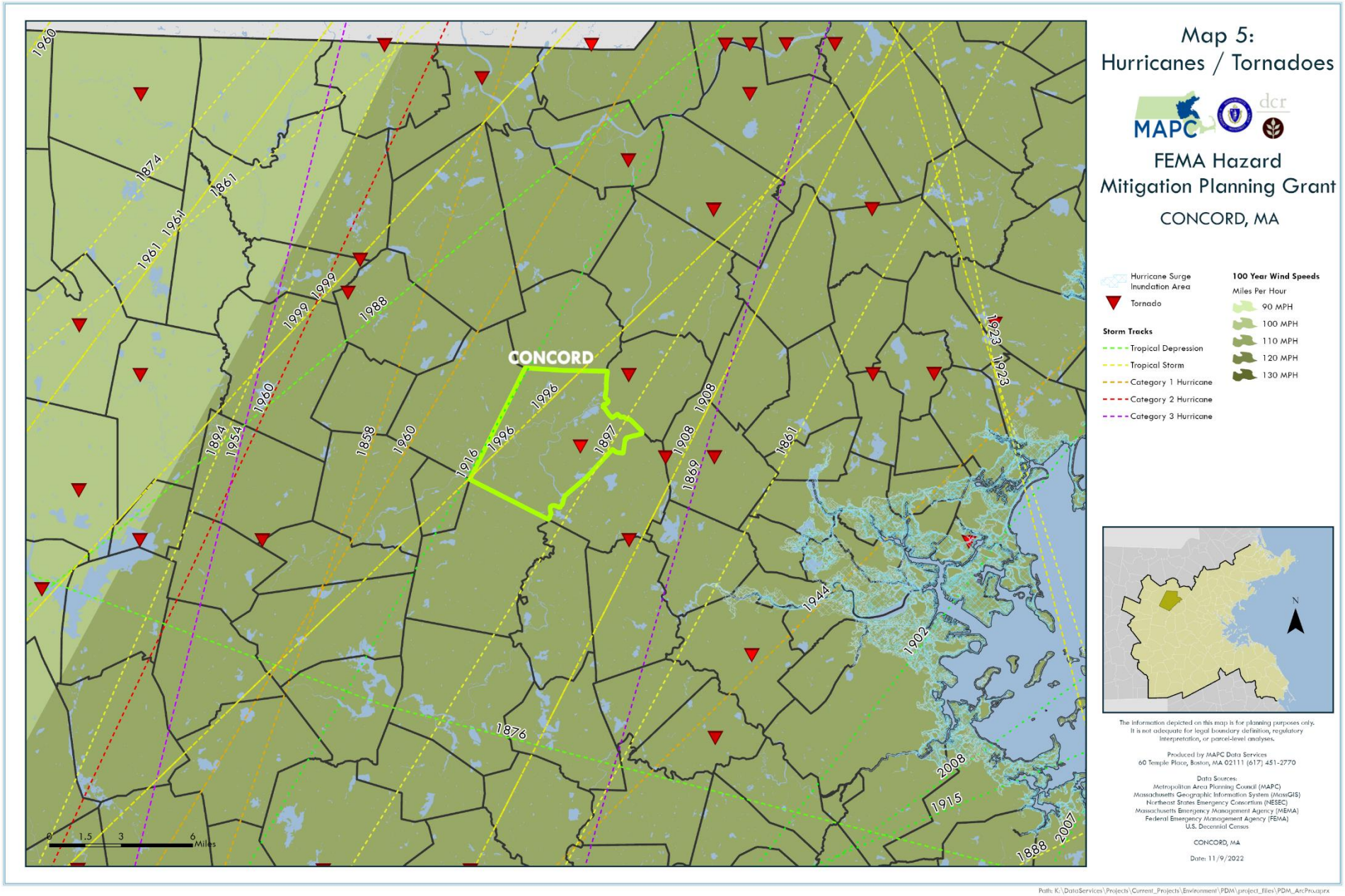



The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.

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)
U.S. Geological Survey (USGS)

Date: 10/9/2022
CONCORD, MA


Map 5:
Hurricanes / Tornadoes
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
CONCORD, MA
Hurricane Surge Inundation Area
Tornado
Storm Tracks
Tropical Depression
Tropical Storm
Category 1 Hurricane
Category 2 Hurricane
Category 3 Hurricane
100 Year Wind Speeds
Miles Per Hour
90 MPH
100 MPH
110 MPH
120 MPH
130 MPH
CONCORD
1960
1874
1861
1961
1961
1999
1999
1988
1960
1894
1954
1858
1960
1916
1996
1996
1897
1908
1908
1869
1861
1923
1923
1944
1902
1876
2008
1915
1888
2007
0 1.5 3 6 Miles
N
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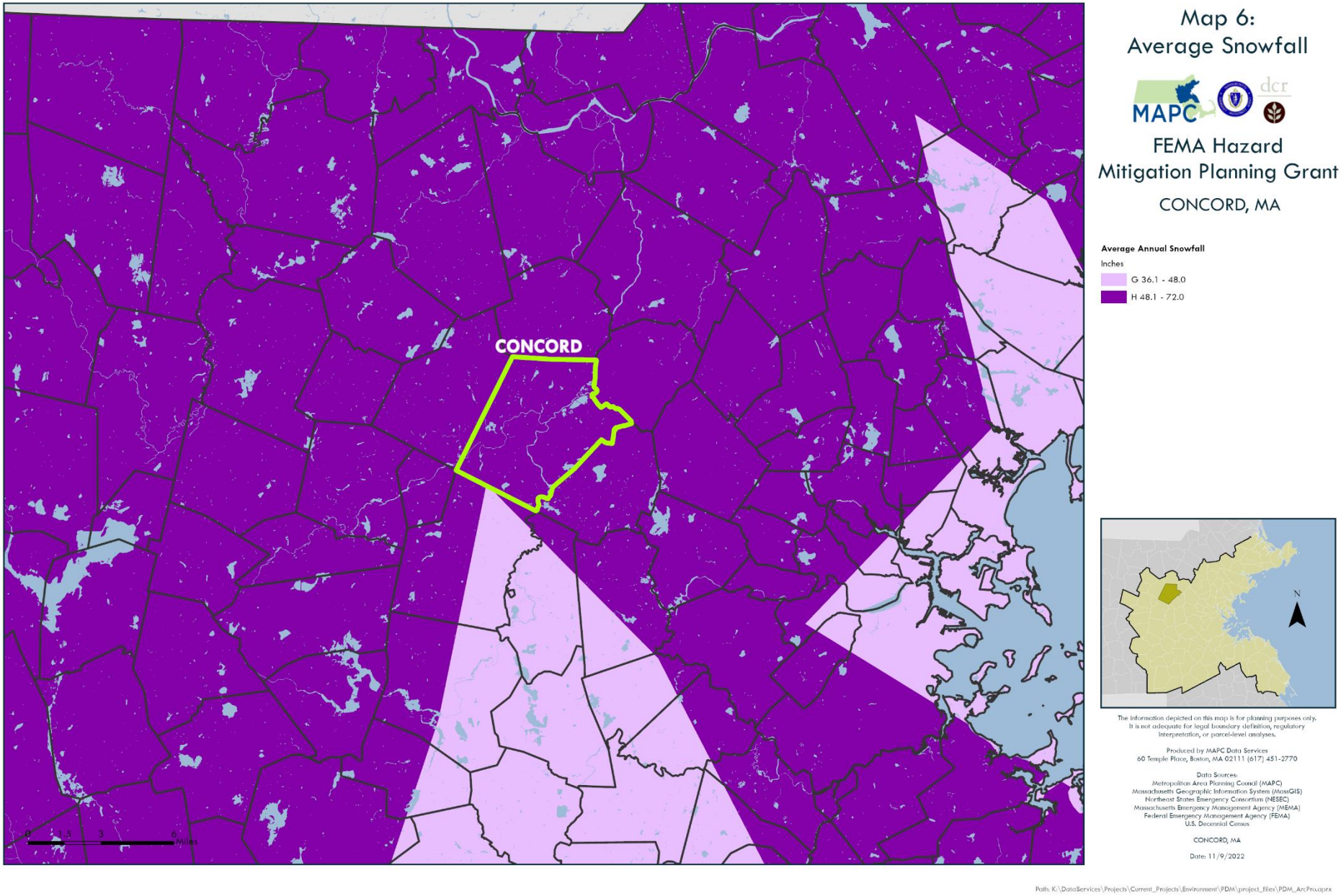
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
U.S. Decennial Census
CONCORD, MA
Date: 11/9/2022
Path: K:\DataServices\Projects\Current_Projects\Environment\PDM\project_files\PDM_ArcPro.aprx




# Map 6: Average Snowfall

MAPC dcr

FEMA Hazard Mitigation Planning Grant

CONCORD, MA

**Average Annual Snowfall**

Inches

G 36.1 - 48.0

H 48.1 - 72.0

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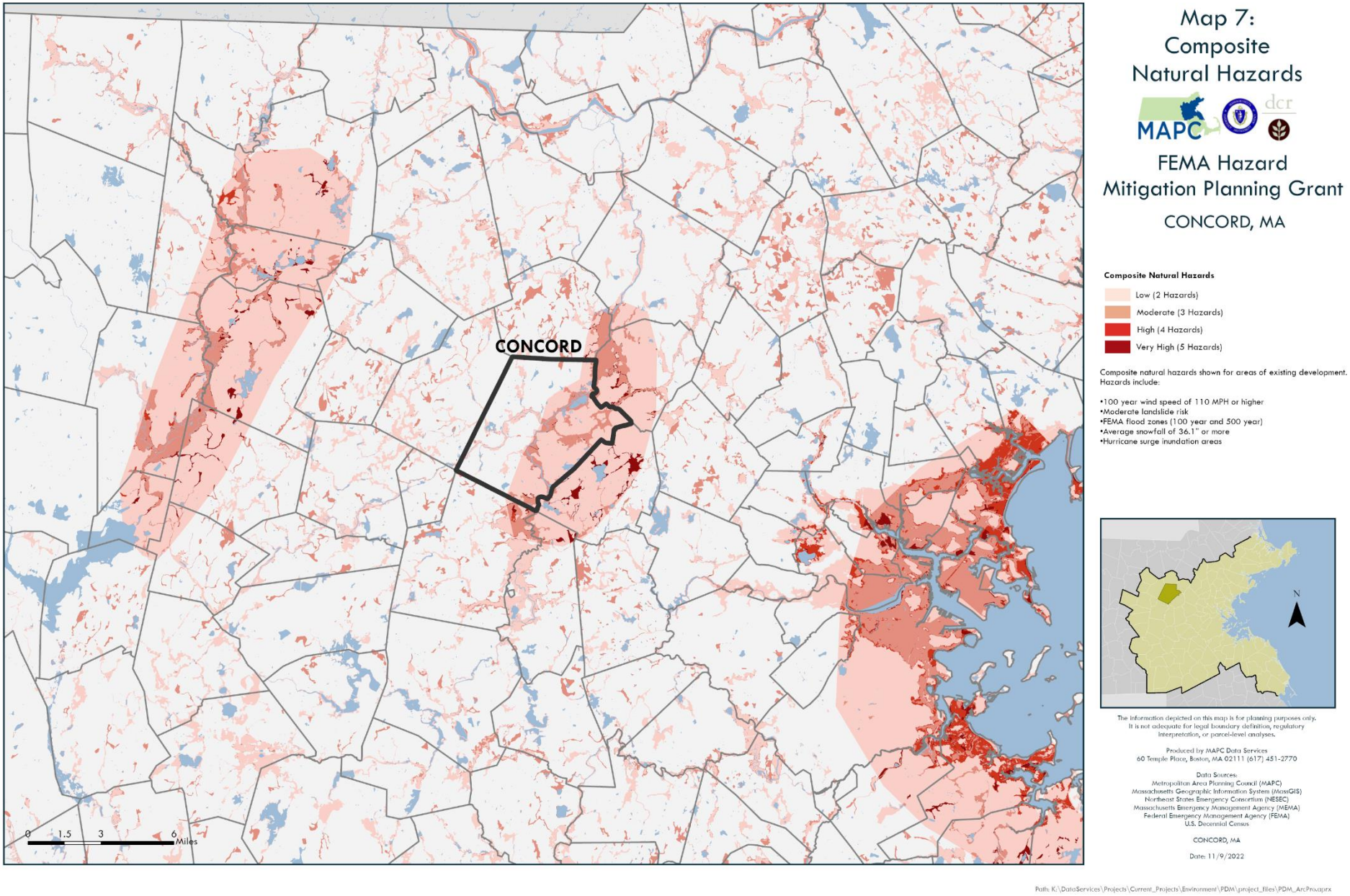
U.S. Decennial Census

CONCORD, MA

Date: 11/9/2022

Path: K:\DataServices\Projects\Current_Projects\Environment\PDM\project_files\PDM_ArcPro.aprx




# Map 7: Composite Natural Hazards

FEMA Hazard Mitigation Planning Grant

CONCORD, MA

**Composite Natural Hazards**

- Low (2 Hazards)
- Moderate (3 Hazards)
- High (4 Hazards)
- Very High (5 Hazards)

Composite natural hazards shown for areas of existing development. Hazards include:

- 100 year wind speed of 110 MPH or higher
- Moderate landslide risk
- FEMA flood zones (100 year and 500 year)
- Average snowfall of 36.1" or more
- Hurricane surge inundation areas

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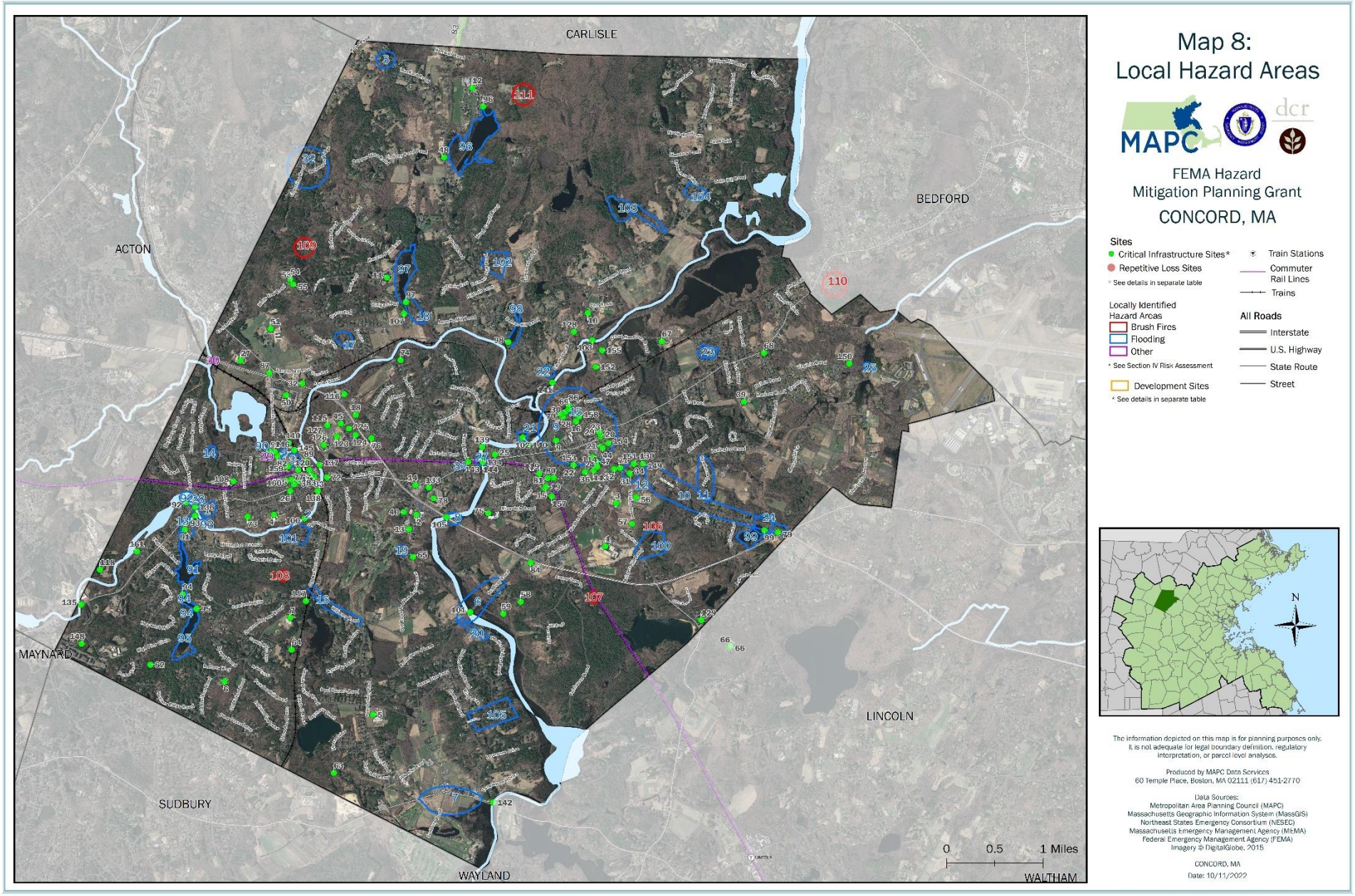
Federal Emergency Management Agency (FEMA)
U.S. Decennial Census

CONCORD, MA

Date: 11/9/2022

Path: K:\DataServices\Projects\Current_Projects\Environment\PDM\project_files\PDM_ArcPro.aprx


Map 8:
Local Hazard Areas
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
CONCORD, MA
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Train Stations
Commuter Rail Lines
Trains
Locally Identified Hazard Areas
Brush Fires
Flooding
Other
* See Section IV Risk Assessment
Development Sites
* See details in separate table
All Roads
Interstate
U.S. Highway
State Route
Street
CARLISLE
ACTON
BEDFORD
MAYNARD
SUDBURY
WAYLAND
LINCOLN
WALTHAM
0 0.5 1 Miles
N
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Data Sources:
Metropolitan Area Planning Council (MAPC)
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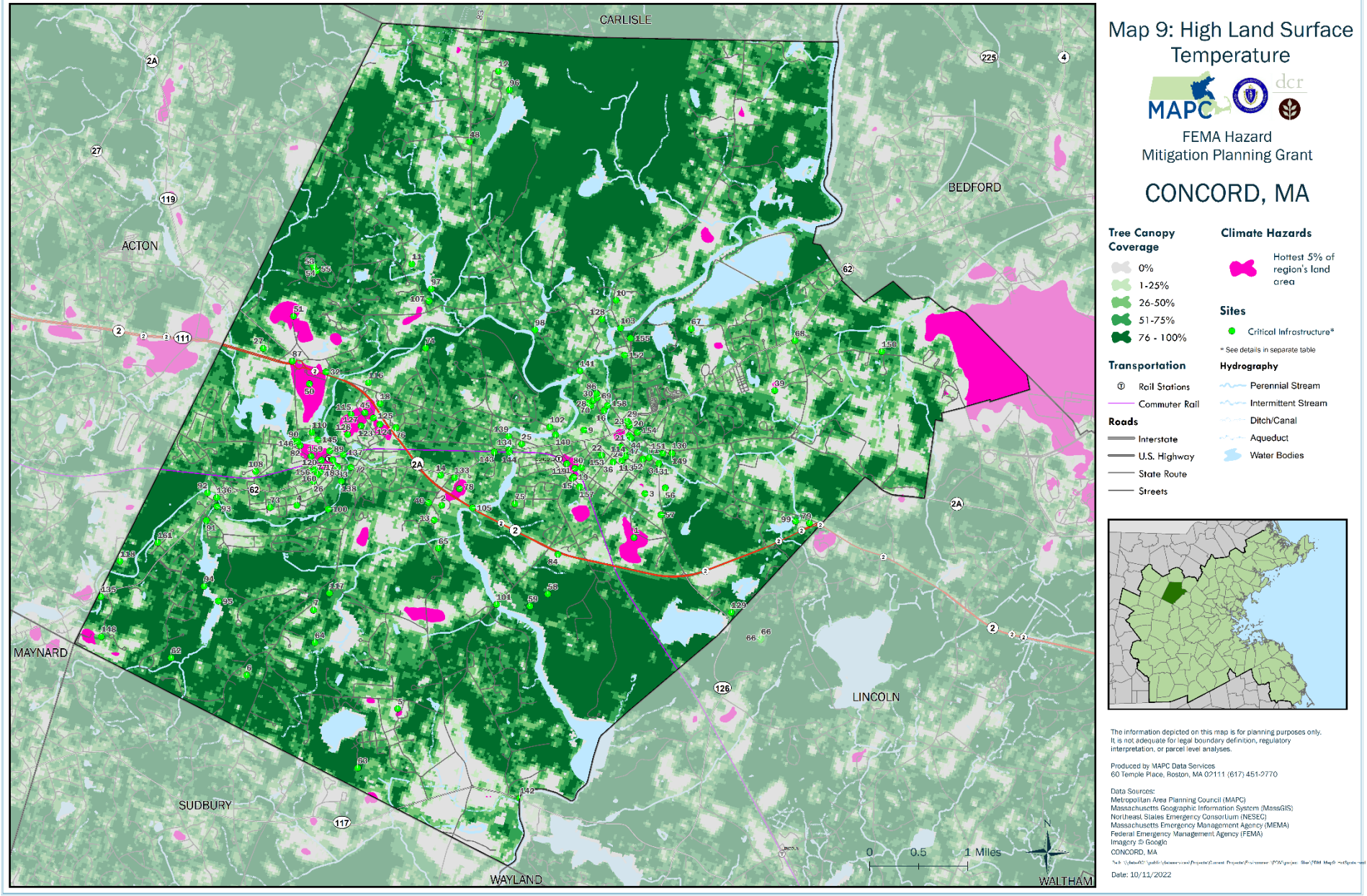
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Imagery © DigitalGlobe, 2015
CONCORD, MA
Date: 10/11/2022


Map 9: High Land Surface Temperature
MAPC
dcr
FEMA Hazard Mitigation Planning Grant
CONCORD, MA
Tree Canopy Coverage
0%
1-25%
26-50%
51-75%
76 - 100%
Climate Hazards
Hottest 5% of region's land area
Sites
Critical Infrastructure*
* See details in separate table
Transportation
Rail Stations
Commuter Rail
Roads
Interstate
U.S. Highway
State Route
Streets
Hydrography
Perennial Stream
Intermittent Stream
Ditch/Canal
Aqueduct
Water Bodies
CARLISLE
BEDFORD
ACTON
MAYNARD
LINCOLN
SUDBURY
WAYLAND
WALTHAM
0 0.5 1 Miles
N
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Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Imagery © Google
CONCORD, MA
Date: 10/11/2022

# Hazard Mitigation Plan
## Public Meeting

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



The Town of Concord is updating its Hazard Mitigation Plan to help assess its vulnerability to natural hazards such as flooding, hurricanes, and winter storms, and identifies strategies to mitigate impacts on community infrastructure and residents.

Please join us to learn more about Concord's climate and hazard preparations to date and provide your input for the plan!

**Date:** Wednesday, October 12, 2022

**Time:** 7:00 pm – 8:00 pm

**Location:** Zoom Meeting | Register in advance here: **https://mapc.ma/3QV9Dxe**

For more information, please contact Van Du at vdu@mapc.org.

MAPC
METROPOLITAN AREA PLANNING COUNCIL

# Hazard Mitigation Plan
# Public Meeting

The Town of Concord is updating its Hazard Mitigation Plan to assess and reduce its vulnerability to natural hazards such as flooding, hurricanes, and winter storms. Please join us for a presentation on the final draft of the Plan and dicusssion of recommended measures to mitigate impacts on community infrastructure and residents.

| | |
|---|---|
| **Date:** | **Wednesday, November 30, 2022** |
| **Time:** | **7:00 pm – 8:00 pm** |
| **Location:** | **Zoom Meeting \| Register in advance here: https://mapc.ma/3hMkSMU** |

**The Plan will also be available for public comment from December 5 through December 15, 2022; it will be posted on the town website.*
*We look forward to your input on the Plan!*

For more information, please contact
Van Du at vdu@mapc.org.

MAPC
METROPOLITAN AREA PLANNING COUNCIL

APPENDIX D: PLAN ADOPTION

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

A RESOLUTION ADOPTING THE
*TOWN OF CONCORD HAZARD MITIGATION PLAN 2022UPDATE*

WHEREAS, the Town of Concord established a Committee to prepare the *Town of Concord Hazard Mitigation Plan 2022 Update*; and

WHEREAS, the *Town of Concord Hazard Mitigation Plan 2022 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 October 12, 2022 and November 30, 2022, 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 2022 Update*, in accordance with M.G.L. 40s §4 or the charter and bylaws of the Town of Concord.

ADOPTED AND SIGNED this Date. April 3, 2023

Name/Title

Matthew Johnson, Select Board Chair

Signature

# APPENDIX E: MVP WORKSHOP RESULTS

Top recommendations from the 2019 Municipal Vulnerability Preparedness workshop that focused on preparing for climate impacts in Concord.

Infrastructure

- Promote and highlight low impact development and green infrastructure.
- Prioritize action plan for police, fire, DPW facilities located in the floodplain.
- Find ways to improve cell service throughout the town to ensure ongoing communication.
- Rehabilitate or build new bridges and dams to account for climate projections and the 100-year flood, starting with South Bridge.

Environmental

- Develop an integrated resource management plan for the town.
- Educate people and encourage ecosystem health by utilizing updated emerging threats and best practices.
- Create an economic action plan/partnership between public and private agricultural sites.
- Take action through policies and programs to increase water efficiency and minimize the use of fresh water for irrigation.

Societal/Economic

- Expand database and educational outreach to seniors and medically vulnerable to collect information on critical needs, including prescriptions.
- Inventory and develop a needs assessment for vulnerable populations to expand plans for emergency preparedness.
- Review existing communication and preparedness and response protocols and plans (from businesses, schools, town departments, etc.) to ensure they are aligned.