THE CITY OF NORTHAMPTON
MULTI-HAZARD MITIGATION PLAN
2020 UPDATE

Adopted by the Northampton City Council on DATE

Prepared by:

The Northampton Hazard Mitigation Committee
and

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Acknowledgements

Thanks to the Northampton Hazard Mitigation Steering Committee and those who participated in the planning process as specialty committee members, attending and consulting as needed, and Planning & Sustainability, the City's Hazard Mitigation Plan project manager.

The City of Northampton, its Mayor, and its City Council offers thanks to the Massachusetts Emergency Management Agency (MEMA) for developing the Massachusetts Hazard Mitigation Plan which served as a model for this plan. In addition, special thanks are extended to the staff of the Pioneer Valley Planning Commission for professional services, process facilitation and preparation of this document.

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1: PLANNING PROCESS

Introduction

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

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

Preparing a Local Natural Hazards Mitigation Plan before a disaster occurs can save the community money and will facilitate post-disaster funding. Costly repairs or replacement of buildings and infrastructure, as well as the high cost of providing emergency services and rescue/recovery operations, can be avoided or significantly lessened if a community implements the mitigation measures detailed in the Plan. FEMA requires that a community adopt a pre-disaster mitigation plan as a condition for mitigation funding, including the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance Program (FMA), and the Pre-Disaster Mitigation Program (PDM).

Hazard Mitigation Planning Committee

In 2020, the City of Northampton completed an update of their 2015 Hazard Mitigation Plan, in collaboration with the Pioneer Valley Planning Commission. All portions of the plan were reviewed and updated as necessary. Planning for hazard mitigation in Northampton involved a seven-member Steering Committee:

- Jon Davine, Fire Department and Emergency Management
- Jody Kasper, Police Chief
- Sarah LaValley, Planning and Sustainability
- Doug McDonald, Stormwater Manager, Public Works
- David Pomerantz, Central Services Director
- David Veleta, PE, City Engineer, Public Works
- Kelly Schuetze, Dispatch Director

In addition to the Steering Committee, the following stakeholders attended committee meetings and were available for consultation throughout the planning process:

- Wayne Feiden, Planning and Sustainability
- Chris Mason, Central Services
- Donna LaScalia, Department of Public Works
- Merridth O'Leary, Department of Health
- Andrew Pelis, Fire Department and Emergency Management

The Hazard Mitigation Plan update process for the City included the following tasks:

- Reviewing and incorporating existing plans and other information.
- Identifying the natural hazards that may impact the community.
- Conducting a Vulnerability/Risk Assessment to identify the infrastructure and structures at the highest risk for being damaged by the identified natural hazards, particularly flooding.
- Identifying and assessing the policies, programs, and regulations the community is currently implementing to protect against future disaster damages.
- Identifying deficiencies in the current strategies and establishing goals for updating, revising or adopting new strategies.
- Adopting and implementing the final updated Hazard Mitigation Plan.

The key product of this process was the development of a Mitigation Strategy and Action Plan with a Prioritized Implementation Schedule.

Hazard Mitigation Committee Meetings

Northampton kicked off its Hazard Mitigation Plan update at the same time as the novel coronavirus (COVID-19) was spreading across the United States and the world. Federal, state, and local restrictions on public gatherings and social distancing inhibited the Steering Committee and project planning team from meeting in person. The same restrictions prohibited in-person public meetings. As a result, all HMP meetings, both of the Steering Committee and for public engagement, were held virtually using a Zoom platform until COVID-19 restrictions were lifted in early summer of 2020. Meetings were held on the dates listed below. Agendas for each meeting are included in Appendix A. After review by MEMA, the Hazard Mitigation Steering Committee met to review and incorporate MEMA feedback.

- April 2, 2020, 9:30 a.m., Zoom
- April 28, 2020, 7:30 p.m. Zoom
- May 21, 2020, 9:30 a.m., Zoom
- June 4, 2020, 9:30 a.m., Zoom
- June 22, 2020, 7:30 p.m., Zoom

Agendas and sign-in sheets for each meeting can be found in Appendix A. While not all members of the Hazard Mitigation Steering Committee were able to attend each meeting, all members collaborated on

the plan and were updated on progress by fellow Committee members after meetings occurred as necessary.

Participation by Stakeholders

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

Local and regional agencies involved in hazard mitigation activities and surrounding community engagement and input

The Pioneer Valley Planning Commission is a regional planning agency for 43 towns and cities in Massachusetts' Hampden and Hampshire Counties. PVPC regularly engages with the City of Northampton as part of its regional planning efforts, which include the following:

- Developing the Pioneer Valley Regional Land Use Plan, Valley Vision 2, which advocates for sustainable land use throughout the region and consideration for the impact of flooding and other natural hazards on development.
- Developing the Pioneer Valley Climate Action and Clean Energy Plan, which assesses the impact that climate change will have on the region and recommends strategies for mitigation that can be implemented by local municipalities and businesses.
- Collaborating with state agencies, such as the Department of Conservation and Recreation, to maintain inventories of critical infrastructure throughout the region.

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

In addition, the Pioneer Valley Planning Commission and several representatives of the Northampton Hazard Mitigation Committee (Jon Davine and Andrew Pelis) are actively involved in the Western Region Homeland Security Advisory Council (WRHSAC). WRHSAC, which includes representatives from western Massachusetts municipalities, Fire Departments, Public Works Departments, Police Departments, area hospitals and regional transit from throughout the four counties of western Massachusetts, is responsible for allocating emergency preparedness funding from the US Department of Homeland Security. The representatives of these disciplines who serve on the WRHSAC are charged with sharing the information discussed at meetings with their colleagues at their regular meetings. During the HMP update process, PVPC staff attended all WRHSAC and WRHSAC Pandemic Flu Planning Subcommittee meetings and all WRHSAC members were aware of the fact that Northampton was updating their Hazard Mitigation Plan. Meetings of WRHSAC regularly involve discussion about how to improve emergency preparedness in western Massachusetts, and hazard mitigation activities are included in this discussion.

For the update of this Hazard Mitigation Plan, PVPC asked fellow members of WRHSAC for feedback on mitigation activities and natural hazards pertaining to Northampton, and kept WRHSAC's Pandemic Flu Planning Subcommittee apprised on the Plan Update process. This was the method through which WRHSAC was engaged in the planning process.

In addition, PVPC staff regularly present to their Executive Committee and Commission (representatives from the 43 cities and towns that comprise the Pioneer Valley), when new projects are launched and when funding opportunities are available. As result, all the communities in the region were informed of Northampton's Hazard Mitigation Plan update process and encouraged to comment.

PVPC staff included a summary article on the status of Hazard Mitigation planning in Northampton and the region in the monthly e-reader newsletter that is mailed to area Chambers of Commerce, all member municipalities, area colleges and universities and other key stakeholders in the region. In this way, businesses, educational institutions and other key stakeholders were educated about and informed of Northampton's Hazard Mitigation planning work.

Agencies that have the authority to regulate development

Several City staff who participated in the Northampton Hazard Mitigation Committee have direct connections to various municipal commissions, boards, and committees within Northampton that have the authority to regulate development. These commissions and the Hazard Mitigation Committee members involved in each are as follows:

- Transportation and Parking Commission, Energy and Sustainability Commission, Bicycle and Pedestrian Committee, Planning Board, Resilience Hub planning group - Wayne Feiden, Planning and Sustainability
- Department of Public Works - David Veleta, PE, City Engineer
- Conservation Commission, Historical Commission, Community Preservation Committee - Sarah LaValley, Planning and Sustainability
- Local Emergency Planning Committee - Jon Davine, Fire Department and Emergency Management Coordinator
- Energy and Sustainability Commission - Chris Mason, Energy and Sustainability Officer in Central Services

Feedback from the stakeholder agencies listed above was ensured through the participation of the Hazard Mitigation Committee members, who were able to attend the Hazard Mitigation Committee meetings representing their respective groups.

In addition, the Pioneer Valley Planning Commission, as a regional planning authority, works with all agencies that regulate development in Northampton, including the municipal entities listed above and state agencies, such as the Department of Conservation and Recreation and MassDOT. This regular involvement ensured that during the development of the Northampton Hazard Mitigation Plan, the operational policies and any mitigation strategies or identified hazards from these entities were incorporated into the Hazard Mitigation Plan.

Participation by the Public, Businesses, and Neighboring Communities

Two public planning sessions were held as part of the development of the Northampton Plan – on April 28th, 2020 at 6:30 p.m. and June 22th, 2020 at 6:30 p.m. While the first public meeting, convened virtually via Zoom, was held early in the planning process, the second meeting, also convened virtually via Zoom, occurred after the Hazard Mitigation Committee had provided input on hazards and mitigation strategies relevant to the community. Notice of both public meetings was posted on the City of Northampton and its Planning and Sustainability webpage calendars and at Northampton City Hall in compliance with the Commonwealth of Massachusetts' Open Meeting Law. Public meeting agendas and notices can be found in Appendix A.

On June 15, 2020, the City sent a press release to all area media outlets to inform the public that a draft of the Northampton Hazard Mitigation Plan had been posted at http://northamptonma.gov/plan and PVPC's website. The release also indicated that hard copies were available at Northampton City Hall, and that all residents of Northampton were encouraged to comment on the Plan by e-mailing or calling staff contacts at PVPC or the City of Northampton.

The press release and a screen shot of PVPC's website showing the link to the press release can be found in Appendix A.

All press releases were sent to local media outlets and the 1849 members of the Planning and Sustainability mailing list, which includes City residents and businesses, local and regional social service organizations, and nonprofits, and municipalities throughout the Pioneer Valley, as well as to Western Massachusetts' media outlets.

The Hazard Mitigation Committee determined that the most effective outreach strategy for engaging with the public, businesses and neighboring communities was through the media and Planning & Sustainability's list serve, and so this was the outreach strategy employed for reaching out to all three groups of stakeholders. The press release indicated that residents of Northampton were invited to attend the public event, which was also intended to include representatives of businesses in Northampton and residents of neighboring communities.

Businesses and neighboring communities were also provided with an opportunity to provide feedback through the Pioneer Valley Planning Commission. PVPC is regularly involved in land use, transportation, and environmental planning initiatives in Northampton and surrounding communities. Regular feedback received from these other initiatives were incorporated into the hazard mitigation planning process.

Additional outreach to surrounding communities occurred through the regular monthly e-newsletter that PVPC sends out to its member communities about its recent activities. In these publications, adjacent municipalities were encouraged to reach out to PVPC about hazard mitigation plans by e-mailing or calling staff contacts at PVPC. These notices are included in Appendix A.

Feedback was received from the public during and in response to the two public meetings. That feedback has been incorporated into the plan body where appropriate. In many cases, members of the

public asked questions and expressed concern over emergency preparedness, response, and recovery topics that fell outside of the purview of this HMP. For instance, one comment related to the City's readiness to handle a natural gas line explosion like the ones that happened in Lawrence, MA in recent years. Another comment expressed concern about maintaining communications during emergency response periods for those who rely solely on internet – a situation that gained particular interest during the COVID-19 quarantine and shelter-in-place periods of the spring of 2020. Wherever possible, these comments and concerns were folded into the Plan under the capabilities assessment or hazard profiles as indirect impacts or vulnerabilities.

The City had undergone multiple planning processes, which included robust community engagement through online and paper surveys, in-person community meetings, and stakeholder meetings, among other strategies, over two years leading up to this HMP update. Some of these planning processes included the development of the City's Climate Resilience and Regeneration Plan (CCRP) in March 2018 and Community Resilience Building (CRB) workshops through the Municipal Vulnerability Preparedness (MVP) Program in May 2018. Community surveys providing valuable insight into the community's needs and concerns relative to natural hazards and climate resilience were a component of the CCRP. The HMP Steering Committee incorporated the concepts and community-driven responses to those planning processes into this Hazard Mitigation Plan update. Many of the priorities and proposed strategies identified in the City's Statement of Findings, through the MVP CRB process, are found in this plan. Northampton residents, boards and committees, and elected officials all contributed to the development of those planning processes, and because they happened so close in time to the HMP update the HMP Steering Committee decided not to conduct an additional public survey. The overlap of these issues and strategies confirms Northampton's commitment of understanding ways to ensure climate resiliency in development, city operations and policies. Those plans and summaries of the associated public engagement processes can be viewed at https://www.northamptonma.gov/2069/Climate and https://www.mass.gov/files/documents/2019/07/11/Northampton%20Report.pdf .

No other feedback was received from businesses or neighboring communities during the plan update process. Any future input received from the public, as well as any other stakeholders, will be incorporated into the Plan during future regular updates.

City Council Meeting

In 2019, the City of Northampton began the process of updating its Hazard Mitigation Plan. Once the plan was provisionally approved by FEMA, the City Council held a public hearing to formally adopt the Plan Update.

2: LOCAL PROFILE

Community Setting

Northampton, Massachusetts, is approximately 36.1 square miles. It is mid-way between Connecticut to the south and Vermont to the north and between Albany, NY, to the west and Boston to the east.

The City lies within the Connecticut River watershed, located west of the river. The land nearest the Connecticut River has rich, fertile soils and a deep agricultural history. Adjacent to these fertile floodplains of the Connecticut River is the deep, flat glacial outwash, underlying much of the historic residential, commercial and industrial development in downtown Northampton, downtown Florence, and many other older established residential neighborhoods.

The population of Northampton was 28,451 in 2019, according to the U.S. Population and Housing Estimates Program, scattered through downtown, and throughout villages of Florence, Leeds, Bay State, and Village Hill.

Development

During the past five years, Northampton has seen new and infill development in various neighborhoods in the City.

The most significant development is the redevelopment of the former Northampton State Hospital, or now Village Hill, which continues to be built out. There are two affordable housing projects, with a total of 66 units, and a co-housing project under construction.

There continues to be development in downtown Northampton and its commercial district of King Street with multi-family, townhome residential development in downtown, and new businesses on King Street. The city also is exploring the Community & Resilience Hub to be sited in downtown Northampton. There are some commercial and municipal development projects in the planning stages elsewhere in the city, and there is healthy residential development all over the city.

There has not been any development in flood zones or other areas determined to be at high risk from the hazards identified in this plan, though downtown Northampton is located in the inundation area that would be affected by a failure of the Connecticut River levee system.

Development in Hazard Areas

Most hazards identified in this plan are regional risks, therefore, all new development falls into the hazard area. The exception to this is flooding. Northampton is a participating member of the National Flood Insurance Program (NFIP). According to FEMA's Community Information System (CIS), there were 88 National Flood Insurance Policy (NFIP) policies in force in Northampton in May, 2020, including 76 residential policies and 12 non-residential policies. The majority of these policies (60 or 88) are

associated with structures located within the Special Flood Hazard Area (SFHA) or 100-year floodplain, shown on the Flood Insurance Rate Maps as zones beginning with the letters 'A' or 'V'.

Infrastructure

Northampton's location on the Connecticut River was a strong determinant on the growth of the city. The river bottom provided rich alluvial soils for agriculture and the river itself provided power and shipping opportunities for the silk industry. The gentle sloping terrain of the Berkshire foothills, in the western section of the city, helped keep development concentrated in the downtown center that grew along the banks of the river. The existing infrastructure reflects the influence of this geography.

Roads and Highways

Northampton sits in the heart of the crossroads of New England and, therefore, has many major thoroughfares running through its borders. The most significant transportation route, Interstate 91, has four exits in Northampton. Other major roadways are Routes 5, 9, 10 and 66. Route 9 connects Northampton with towns to the east including Hadley, Amherst, Belchertown, Ware and all points east as well as the westerly towns of Williamsburg, Cummington and Pittsfield. Route 66 connects Northampton with Westhampton, Huntington and the Hilltowns to the West. Routes 5 and 10 converge in Northampton, providing connection to Hatfield, Greenfield and Brattleboro, Vermont. Route 10 runs south from Northampton to connect with Easthampton and Route 141; Route 5 runs south from Northampton to connect with Holyoke, Springfield, and Enfield, Connecticut.

There are major roadway construction projects currently underway or due to start within the next year throughout the city including construction of a roundabout at Exit 19 off I-91, a roundabout on N. King Street, replacement of the I-91 bridges over Route 5 the railroad and Hockanum Road, and reconstruction of Damon Road and King Street from Bright to Church Streets. There are related repaving, sidewalk replacements, and handicap access projects that are also underway or due to start within the next two years.

Since 2018, the City has led a collaboration to meet the region's unique challenges. ValleyBike share is designed to promote short bike trips within core communities, where clusters of large employers, colleges, shopping, tourist destinations and residents can readily be connected. The program initially started with 50 bike share stations where people are able to rent bicycles. Northampton will be constructing new stations in the future.

Rail

Freight traveling on the Boston and Maine Rail Line runs through the center of downtown Northampton on a daily basis, with a bridge over Route 9, and sharing tracks with Amtrak. The City of Northampton is situated within the Sustainable Knowledge Corridor, a region of New England that includes the Hartford and Springfield metropolitan regions connected by Amtrak's New Haven Rail Line, which runs north-south from Connecticut to Vermont. New passenger train service called the "Valley Flyer" is currently

operating on a pilot basis until the fall of 2021 that provides daily service, tripling Amtrak's daily frequency through the corridor. This new service supplements the existing Vermonter route.

Public Transportation

Served by various regional bus companies, including Greyhound and Peter Pan, downtown Northampton is the pulse point for public transportation in the city. Northampton also has multiple linkages to surrounding communities through both the Pioneer Valley Transit Authority (PVTA) and the Franklin Regional Transit Authority (FRTA). Bus lines operated by the PVTA travel roundtrip east-to-west along Route 9 to and from Amherst, Hadley and South Hadley. These fixed routes run hourly throughout the day and primarily serve Five College commuters. Bus stops are located in both high-volume sections of the city as well intermittent locations along served routes. A PVTA bus route runs between downtown Northampton and downtown Florence during regular business hours. A PVTA bus route runs between downtown Northampton and the Holyoke Mall. Neighboring Easthampton has two bus routes that connect with Northampton, PVTA's Nashawannuck Express, which operates as a flex route shuttle, and a PVTA bus route.

A bus route maintained by FRTA runs between Northampton and Greenfield during regular business hours. The PVTA also provides demand-response transportation services for the elderly and disabled residents within their jurisdiction, which includes Northampton.

Public Drinking Water Supply

City Water is available to Florence, Bay State, Leeds, Village Hill and Northampton and along those routes where development has occurred. The Northampton Department of Public Works provides potable water to approximately 8,705 customers, through 8,534 service connections. These connections include approximately 189 commercial, 17 industrial, 98 institutional and 29 municipal facilities, and over 8,000 residential services. Outlying developed areas of Northampton are served by private wells.

In 2019, approximately 99 percent of the drinking water supply came from three surface water reservoirs and watersheds: the Francis P. Ryan and West Whately Reservoirs and watersheds, located in Whately, Williamsburg and Conway, and the Mountian Street Reservoir and watershed, located in Williamsburg, Hatfield and Whately. The City owns, operates and maintains a water filtration plant in Williamsburg that treats and disinfects drinking water from these sources prior to distribution.

Additionally, Northampton gets approximately 1 percent of its drinking water supply from wells in the Florence section of Northampton. These wells have the capacity to provide up to half of the City's supply under demand, and have chlorination systems installed. In 2018, the dam creating the Upper Roberts Meadow Reservoir was removed for disinfection.

In 2018, the high hazard dam creating the Upper Roberts Meadow Reservoir in Leeds, the long abandoned, original water supply for the City, was removed. The Middle and Lower Roberts Meadow Reservoirs downstream are also former water supply reservoirs that remain but are no longer

connected to the water distribution system. Another surface water source, the Roberts Meadow Reservoir, could be used as a source of water for fire suppression in an emergency.

The primary water supply for the City is delivered through two transmission mains, a 36-inch main installed in 1993 and a 20-inch cross-country main installed in 1901 and field-lined in 1958 that generally follows Beaver Brook from Route 9 to the Mountain Street reservoir with difficult and wet access that also traverses private property. Both mains are in service and needed for water distribution.

According to the most recent Open Space, Recreation & Multi-Use Trail Plan (2018-2025), the City supplies 1.25 billion gallons of water to customers, or an average of 3.4 million gallons per day, with a maximum peak of 4.8 million gallons. The most water used in one day was 3.96 million gallons. The design capacity of the water filtration plant is 6.5 million gallons, which can easily meet the city's peak demand.

During dry summer months, the City's DPW implements a water use restriction policy in order to comply with the MassDEP's requirements. DEP requires that water use be restricted when average daily stream flow in the Mill River drops below 26.3 cubic feet per second for a 3-day period or when the State issues a drought advisory. The Water Use Restriction can be lifted when the stream flow average meets or exceeds the minimum flow for 7 consecutive days. When a water use restriction is in place, there is a ban on non-essential outdoor watering. The City ended the water use restriction most recently in December 2019.

The City has and continues to work with surrounding communities to acquire water supply lands and jointly preserve the watersheds. Additionally, much of Hatfield's drinking water aquifer is located in Northampton, and the City has aggressively regulated this area and acquired open space to protect Hatfield's water supply.

Sewer Service

Northampton, Bay State, Leeds, Village Hill, and Florence have municipal sewer services, as do the connecting points in between. The City has a sewer treatment facility that treats effluent from both Northampton and neighboring Williamsburg, including institutional, commercial, and industrial users. Wastewater receives preliminary treatment, primary treatment, secondary treatment, and disinfection. Wastewater is discharged to the Connecticut River via outfall pipe, with sludge being treated on-site and then trucked outside of Northampton for final disposal.

The city has roughly 110 miles of sanitary sewer pipes. Outlying developed areas of Northampton are served by private septic systems regulated by the Board of Health.

Schools

Public and private schools in Northampton include Bridge Street School, Jackson Street School, Leeds School, Ryan Road School, Smith College Campus School, Smith College, Montessori School of Northampton, Solomon Schechter Day School, JFK Middle School, Northampton High School, and Smith Vocational & Agricultural High School. Smith Vocational & Agricultural High School serves an emergency

regional shelter serving both humans and pets. During the first phase of Covid-19 emergency, the Northampton High School was used as an emergency shelter for homeless populations.

Natural Resources

The rich alluvial floodplains of the Connecticut River define Northampton's eastern boundary. In the bottomlands, wetlands and farm fields continue to provide the same scenic and ecological benefits to Northampton that have existed for thousands of years since the end of the last ice age (and the corresponding formation and draining of Glacial Lake Hitchcock) some 12,000 years ago. On the city's western boundary, the foothills of the Berkshires begin their slow, steady rise to the peak of Mount Greylock. To the north and south, the Connecticut River Valley stretches north to Vermont and South to Connecticut. These features, the river, the valley and the hills, frame Northampton and provide a home to not only Northampton's dynamic population of more than 28,000 individuals but also to hundreds of species of flora and fauna.

Forests

Approximately fifty percent of Northampton is covered by a mixed deciduous forest, including oak, maple, and beech, with smaller coniferous forests, including spruce, pine, and hemlock. Forests provide an abundance of timber, opportunities for recreation, wildlife habitat, the benefits of climate moderation, and the protection of water quality. The City's Tree Warden has planted over 1,000 trees since 2016, bolstering a robust urban forest that helps to mitigate the impacts of climate change. The forest and intermixed agricultural land also provide a visually pleasant landscape for residents and visitors too. The City's forests are mainly closed-canopied and middle-aged, having a great diversity of species, but no diversity of horizontal or vertical structural.

Tree species and forest composition reflect this variety of landforms. Because of Northampton's latitude, those species associated with northern hardwood forests are most common. In Northampton's floodplain, silver maple, cottonwood, elms, along with other species common to frequently inundated areas, are common. In higher, drier terrain, oaks, hickories, maples, black birch and scarlet oak are common species in fields, front lawns and gentle hills. On shady hillsides, it is commons to find oaks, hickories, white birch and other species associated with transitional hardwood forests.

The forests and wetlands that fill Northampton's landscape also play host to a wide variety of wildlife. Bear, bobcat, minx, fishers, moose and deer have all been sighted in Northampton, and the city's wetlands and water bodies are important homes for salamanders, frogs, turtles and snakes as well as many fish species. Water Resources

Northampton water resources include open water bodies, wetlands, floodplain, and drinking water supplies and aquifers. These water resources are all sensitive ecological resources, but they also provide excellent agricultural, forest, open space, scenic, recreation, and wildlife habitat resources for the city's residents.

<u>Rivers and Streams</u>

The Connecticut River forms Northampton's eastern boundary and is the city's most significant river. The Mill River and the Manhan River are two smaller, but important, rivers for the City to monitor and protect. The Mill River runs parallel to downtown Northampton, was once diverted, and has had an Army Corps levee system constructed to reduce flooding risk. The Connecticut River and Mill River both have floodplains, and each has a pumping station that works in conjunction with their levee systems. The Manhan River flows through Northampton's southwestern edge, enters Easthampton, and then drains into the Connecticut River Oxbow. There are 9 major brooks: Marble Brook, Turkey Brook, Beaver Brook, Day Brook, Roberts Meadow Brook, Clark Brook, Broad Brook, Hannum Brook and Parsons Brook.

Wetlands

The City estimates that there are over 3,000 acres of wetlands in Northampton. Many, but certainly not all, of the City's wetlands are mapped by the National Wetlands Inventory with local supplemental data extracted from permit filings.

Beaver Dams

Beaver activity continues to be an issue in Northampton. Wetland areas have been flooded by beaver dam construction. As a result, their vegetation has changed from forested wetland to marshy habitat. Sometimes beaver activity is detrimental to property, causing problems for local land owners (e.g., flooding of wells, septic systems, lawns, out-buildings, and roadways). Affected individuals must contact the Board of Health and Conservation Commission for advice and permission to alleviate the beaver problem.

Aquifers

Northampton has a public drinking water aquifer located in Florence. The City also shares an aquifer with Hatfield, which is in the Broad Brook area of Northampton, and neighboring Easthampton's aquifer is located in the West Farms area of Northampton.

The Northampton Aquifer has three delineated Zone II recharge areas. A Zone II is area of an aquifer that contributes to a well under the most server pumping and recharge conditions that can be anticipated. Threats to Zone II recharge areas can include contamination from residential use, roadways, hazardous materials, oil contamination and agricultural uses.

3: HAZARD IDENTIFICATION AND ANALYSIS

This chapter examines the natural hazards which are identified as likely to affect Northampton in more detail, and includes a summary of disasters that have affected or could affect Northampton. In order to identify natural hazards of concern for the Plan Update, the Committee and its consulting team reviewed the 2015 Northampton Hazard Mitigation Plan, the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP), available hazard mapping, and other weather-related databases. Historical research and conversations with local officials and emergency management personnel were also used to identify and profile the natural hazards which are most likely to have an impact on the City.

The assessment conducted for the former HMP recognized the following 8 natural hazards that could potentially impact Northampton:

- Floods
- Severe snowstorms / ice storms
- Hurricanes
- Severe thunderstorms / wind / tornadoes
- Wildfires / brushfires
- Earthquakes
- Dam failure / levee breech
- Drought

All of the hazards identified and assessed in the 2015 HMP were determined to be relevant for the 2020 Plan Update. However, some of these hazards were reclassified to align with the 2018 SHMCAP (for example, "hurricanes" was expanded to include "hurricanes/ tropical storms," and severe snowstorms / ice storms" was renamed to "severe winter storm/ nor'easter") and three new hazards—extreme temperatures, invasive species, and pandemic—were added.

The resulting refined list of hazards profiled in this plan update is as follows:

- Flooding
- Dam failure / Levee Breech
- Drought
- Extreme Temperatures
- Wildfires / Brushfires
- Invasive Species

In light of the COVID-19 pandemic that took the world by storm during the development of this plan update, the Northampton HMP Committee elected to address "pandemic" as an additional hazard that affects the City. However, a complete hazards vulnerability analysis was not within the scope of this update due to sensitivity and data limitations as it pertains to this hazard. For additional information, MEMA maintains the State Comprehensive Emergency Management Plan (CEMP) as well as other plans that deal with the specific response and mitigation aspects of and non-natural disasters, crime, and other emergencies.

- Hurricanes/ Tropical Storms
- Severe Winter Storm / Nor'Easter
- Severe thunderstorms / Wind / Tornadoes
- Earthquake
- Pandemic

Each of these hazards was assessed by the Committee for location of occurrence, extent, previous occurrences, and probability of future events. (See Appendix E for sources, methodology.) All hazard profiles were updated for the 2020 Plan Update with any new available information, and data from the 2015 HMP were retained where it was appropriate and still deemed current. The resulting hazard risk ranking is presented in Table 2 later this chapter.

Natural Hazard Analysis Methodology

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

Hazard Description

The natural hazards identified for Northampton's 2020 HMP update are: flooding, dam failure / levee breach, drought, extreme temperatures, wildfire/brushfire, invasive species, hurricane/ tropical storm, severe winter storm/nor'easter, , severe thunderstorms / wind / tornado, earthquake, andpandemic/epidemic. Many of these hazards result in similar impacts to a community. For example, hurricanes, tornadoes and severe snowstorms may cause wind-related damage.

Location

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

Percentage of City Impacted by Natural Hazard	
Land Area Affected by Occurrence	**Percentage of City Impacted**
Large	More than 50% of the city affected
Medium	10 to 50% of the city affected
Small	Less than 10% of the city affected

Extent

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

Previous Occurrences

Previous hazard events that have occurred are described. Depending on the nature of the hazard, events listed may have occurred on a local, state-wide, or regional level. Where information is available on emergency costs for specific events, that information is provided.

Probability of Future Events

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

Frequency of Occurrence and Annual Probability of Given Natural Hazard	
Frequency of Occurrence	**Probability of Future Events**
Very High	70-100% probability in the next year
High	40-70% probability in the next year
Moderate	10-40% probability in the next year
Low	1-10% probability in the next year
Very Low	Less than 1% probability in the next year

Impact

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

Extent of Impacts, Magnitude of Multiple Impacts of Given Natural Hazard	
Extent of Impacts	**Magnitude of Multiple Impacts**
Catastrophic	Multiple deaths and injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of facilities for 30 days or more.
Critical	Multiple injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of facilities for more than 1 week.
Limited	Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of facilities for more than 1 day.

Minor	Very few injuries, if any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of facilities.

Vulnerability

Sectors Assessed

A number of key sectors were evaluated as part of the risk assessment for each of the hazards profiled in the sections below. These sectors are introduced here and are included in the hazard profiles where appropriate and where sufficient data allowed.

Populations

The impacts on human health, particularly vulnerable populations, were considered by the Committee and incorporated into the hazard profiles where possible. The risk analysis relied on U.S. Census data and stakeholder information regarding frontline and vulnerable populations (including but not limited to disabled, low-income, homeless and single room occupancy (SRO) residents, and low English proficiency populations) that could potentially be more severely impacted by each hazard. Among other factors, these populations may require extra time or outside assistance during evacuations or during events that cause power outages or isolation, and are considered to be more likely to seek or require emergency services. They are also more likely to live in risk-prone areas with poor infrastructure and higher levels of air pollution.

Vulnerability is influenced by three factors: exposure or contact with the hazard; sensitivity or degree to which people or communities are affected by the exposure to the hazard; and capacity to adapt or the ability of communities, institutions, or people to adjust and respond to and recover from potential hazards. The major health impacts from natural hazards and climate change include:

- Heat-related illnesses and death from an increase in extreme temperatures and poor air quality (SHMCAP, 2018).
- Increases in food and waterborne illnesses and other infectious diseases from altering geographic and seasonal distributions of existing vectors and vector-borne diseases (SHMCAP, 2018).
- Injuries and accidental premature death associated with extreme weather events. Extreme weather events can result in acute health impacts, such as injuries and accidental premature death during an event (e.g., drowning during floods). In addition, health impacts can also occur during disaster preparation and post-event cleanup. Other impacts include damage to property, destruction of assets, loss of infrastructure and public services, social and economic impacts, environmental degradation, and other factors (SHMCAP, 2018).
- Exacerbation of chronic diseases (SHMCAP, 2018).
- Mental health and stress-related disorders ranging from minimal stress and distress symptoms to clinical disorders such as anxiety, depression, post-traumatic stress, and

suicidality. Specific groups of people who are at higher risk for distress and other adverse mental health consequences from exposure to climate-related or weather-related disasters include children, the elderly, women (especially pregnant and post-partum women), people with preexisting mental illness, the economically disadvantaged, the homeless, and first responders. Populations living in areas most susceptible to specific climate change events are at increased risk for adverse mental health outcomes (SHMCAP, 2018).

In most natural hazard events, the vulnerability of a population is largely dependent on local preparedness and availability of human resources for social services staffing and supplies distribution. While this Hazard Mitigation Plan does not aim to recommend specific emergency preparedness and response activities, it should be noted that preparing for emergencies by training a large group of public and professional responders to ensure continuity of operations during a hazard event can be a critical tool for mitigating the overall impacts of any hazard event.

Built Environment

The built environment sector includes all buildings in Northampton including critical facilities owned by the municipality and critical infrastructure sectors that provide or link to key lifeline services, social welfare, and economic development. Assessments were based on assessor's data of the total value of all structures in Northampton ($2,742,056,662.00 in 2014, the most recent year for which data was available according to MassGIS L3 data), along with the median value of a home in Northampton ($321,900 based on median value of owner-occupied housing units, 2014-2018 American Community Survey). The critical facilities assessed were derived from the critical facilities inventory as updated by the Northampton HMP Committee. The facility types include police facilities, fire facilities, hospitals, emergency operation centers, schools, and more. Other critical infrastructure sectors including transportation facilities, water infrastructure, etc. were assessed when applicable and where information was available.

Natural Resources and Environment

The natural resources and environment sector includes land-based assets in the city. It also includes key habitats and natural landscapes documented in the Northampton's BioMap 2 (Conserving the Biodiversity of Massachusetts in a Changing World) and species identified in the State's Wildlife Action Plan as being present in Northampton.

Economy

Economic impacts include economic loss resulting from damage to critical facilities, the built environment, municipal resources, natural resources, and other sectors. Many sectors of the economy are dependent on the integrity of natural resources. For example, if a major recreation area is damaged beyond repair by a storm, that property will no longer attract tourists and the local economy may experience a loss of revenue from tourism and recreation. Other impacts include loss of businesses that do not return after a major catastrophic event and the loss of property tax revenue that could result from a major loss of homes and/or businesses from a disaster.

Climate Change and Natural Hazards

With each update of the Northampton Hazard Mitigation Plan, the planning team widens the lens through which natural hazards are assessed with regards to climate change, or the statistically significant variation in climate data or patterns over multiple decades due to climate variability or human activity. The Northeast Climate Adaptation Science Center (NE CASC) developed downscaled climate data that was used in the development of the 2018 SHMPCAP, forming a new basis and format for the categorization of natural hazards as they relate to the primary climate change interactions discussed in this section.

The risk assessment in this 2020 Northampton HMP Update refers to the 2018 SHMCAP analysis and incorporates climate change interactions into each hazard assessment. A categorization of traditional natural hazards, within the context of climate change, is included below to demonstrate the connections between traditional natural hazard analysis and climate change projections. This categorization also aligns with the four climate change categories included on the Commonwealth's resilient MA Climate Change Clearinghouse website (http://www.resilientma.org/). Those categories are illustrated as follows.

Changes in Precipitation: Changes in the amount, frequency, and timing of precipitation—including both rainfall and snowfall—are occurring across the globe as temperatures rise and other climate patterns shift in response.

Sea Level Rise: Climate change will drive rising sea levels, and rising seas will have wide-ranging impacts on communities, natural resources, and infrastructure along the Commonwealth's 1,519 tidal shoreline miles.

Rising Temperatures: Average global temperatures have risen steadily in the last 50 years, and scientists warn that the trend will continue unless greenhouse gas emissions are significantly reduced. The 9 warmest years on record all occurred in the last 20 years (2017, 2016, 2015, 2014, 2013, 2010, 2009, 2005, and 1998), according to the U.S. National Oceanographic and Atmospheric Administration (NOAA).

Extreme Weather: Climate change is expected to increase extreme weather events across the globe, as well as right here in Massachusetts. There is strong evidence that storms—from heavy downpours and blizzards to tropical cyclones and hurricanes—are becoming more intense and damaging, and can lead to devastating impacts for residents across the state.

The hazards presented in this risk assessment, and the order in which they appear, are based on the taxonomy presented in Table 1 below.

Table 1. Climate Change and Natural Hazard Taxonomy			
Primary Climate Change Interaction	**Natural Hazard**	**Other Climate Change Interactions**	**Representative Climate Change Impacts**
Changes in Precipitation	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	
	Dam Failure/ Levee Breach	Extreme Weather	
Rising Temperatures	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
	Wildfire/ Brushfire	Changes in Precipitation	
	Invasive Species	Changes in Precipitation, Extreme Weather	
Extreme Weather	Hurricane/ Tropical Storm	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		
	Severe Thunderstorm / Wind / Tornado		
Non-Climate-Influenced Hazards	Earthquake	Not Applicable	There is no established correlation between climate change and this hazard
	Pandemic	Not Applicable	There is no established correlation between climate change and this hazard

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

- 1 – Highest risk
- 2 – High risk
- 3 – Medium risk
- 4 – Low risk
- 5 – Lowest risk

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

Table 2. Hazard Identification and Analysis for Northampton

Type of Hazard	Location of Occurrence	Probability of Future Events	Impact	Hazard Risk Index Rating
Flooding	Medium	High	Limited (with loss of key transportation routes)	**2 - High risk**
Dam Failure / Levee Breach	Medium	Low	Critical	**3 - Medium risk**
Drought	Large	Low	Minor	**4 - Low risk**
Extreme Temperatures	Large	High	Limited	**2 – High Risk**
Wildfire / Brushfire	Medium	Low	Minor	**4 - Low risk**
Invasive Species	Medium	High	Minor	**4 – Low Risk**
Hurricane/ Tropical Storm	Large	Moderate	Limited	**3 - Medium risk**
Severe Winter Storm / Nor'easter	Large	High	Limited	**3 - Medium risk**
Severe Thunderstorm / Wind / Tornado	Small	Severe thunderstorms: Moderate Winds: Moderate Tornadoes: Low	Limited	**Severe thunderstorms: 4 – Low Risk** **Winds: 3 – Medium Risk** **Tornadoes: 4 – Low risk**
Earthquake	Large	Low	Limited	**4 - Low risk**
Pandemic	Large	Low	Critical	**3 – Medium Risk**

Flooding

Hazard Description

There are three major types of storms that can generate flooding in Northampton:

- Continental storms are typically low-pressure systems that can be either slow or fast moving. These storms originate from the west and occur throughout the year.
- Coastal storms, also known as nor'easters, usually occur in late summer or early fall and originate from the south. The most severe coastal storms, hurricanes, occasionally reach Massachusetts and generate very large amounts of rainfall.
- Thunderstorms form on warm, humid summer days and cause locally significant rainfall, usually over the course of several hours. These storms can form quickly and are more difficult to predict than continental and coastal storms.

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

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

- **Flash floods** are the product of heavy, localized precipitation in a short time period over a given location. Flash flooding events typically occur within minutes or hours after a period of heavy precipitation, after a dam or levee failure, or from a sudden release of water from an ice jam. Most often, flash flooding is the result of a slow-moving thunderstorm or the heavy rains from a hurricane. In rural areas, flash flooding often occurs when small streams spill over their banks. However, in urbanized areas, flash flooding is often the result of clogged storm drains (leaves and other debris) and the higher amount of impervious surface area (roadways, parking lots, roof tops).
- **General floods** may last for several days or weeks and are caused by precipitation over a longer time period in a particular river basin. Excessive precipitation within a watershed of a stream or river can result in flooding particularly when development in the floodplain has obstructed the natural flow of the water and/or decreased the natural ability of the groundcover to absorb and retain surface water runoff (e.g., the loss of wetlands and the higher amounts of impervious surface area in urban areas).

The National Flood Insurance Program (NFIP) data on flood insurance policies, repetitive loss (RL) properties, and severe repetitive loss (SRL) properties are useful for determining the location of areas vulnerable to flood and severe storm hazards. A RL property is a property for which two or more flood insurance claims of more than $1,000 have been paid by the NFIP within any 10-year period since 1978. A SRL property is defined as one that "has incurred flood-related damage for which 4 or more separate claims payments have been paid under flood insurance coverage, with the amount of each claim payment exceeding $5,000 and with cumulative amount of such claims payments exceeding $20,000; or for which at least 2 separate claims payments have been made with the cumulative amount of such claims exceeding the reported value of the property" (FEMA). It should be noted that policy and claim data reflect the time period from 1978 to 2019, while RL and SRL values are calculated using a rolling 10-year period.

In 2019, FEMA initiated a Risk Mapping, Assessment, and Planning (RiskMAP) Discovery process for the Middle Connecticut Watershed – the first step in a process to update the effective Flood Insurance Rate Maps in the region. The project is now moving into the next phase of the RiskMAP study which includes engineering-related activities and development of Preliminary FIRMs, which will be distributed to the communities upon completion of the revisions. New mapping can be used for community floodplain management activities, local land use discussions, all-hazard mitigation planning, and identification of mitigation strategies, as well as providing a basis for more informed community development. The preliminary maps for Northampton are expected to be issued for public comment in 2021, with formal issuance in 2022 followed by local adoption.

Location

FEMA last published flood insurance rate maps for Hampshire County in the late 1970's, and the City of Northampton adopted those maps to stay compliant with NFIP participation and for residents to remain eligible to buy flood hazard insurance through NFIP.

The Critical Facilities and Past Hazard Areas map for the City of Northampton shows the 100-year and 500-year flood zones identified by FEMA flood maps. The 100-year flood zone is the area that will be covered by water as a result of a flood that has a one percent chance of occurring in any given year. Likewise, the 500-year flood has a 0.2 percent chance of occurring in any given year. In Northampton, the 100-year flood zone covers narrow bands of level floodplain land along the Mill River, the Mill River Diversion, Basset Brook / Parsons Brook, Broad Brook, Manhan Brook, Roberts Meadow Brook, and the Connecticut River. In several areas, the flood zone widens out to encompass farmland, some residential land, and industrial lands. There are also significant areas of localized flooding, including on Lower Elm Street and Avis Circle.

When ice jams occur, water flow can be backed up in the Connecticut River and Mill River and flood nearby low lying lands.

The National Flood Insurance Program has produced maps that identify floodplains across America. The following waterbodies have been designated as contributing to flooding in Northampton:

(1) Mill River
(2) Mill River Diversion
(3) Parsons Brook / Basset Brook
(4) Broad Brook
(5) Marble Brook
(6) Connecticut River
(7) Roberts Meadow Brook
(8) Manhan River

Based on an approximate flood elevation at Route 5 in downtown Northampton of 124' MSL for the 100-year flood (FEMA A Zone), roughly 3,960 acres or 18% of Northampton including 167 acres of downtown could be affected by flooding of the Connecticut River alone. Some other areas outside of the mapped flood zone may still be subject to local flooding and to larger rarer storm events. Therefore, the percentage of City impacted by the flood hazard is considered to be "Medium" (10 to 25 percent of the City).

Extent

The observed 1971 - 2000 average annual precipitation for Northampton and surrounding areas in the Connecticut River watershed is 46.4 inches, with the majority of rainfall occurring in the spring and summer. Relative to this baseline, the total annual precipitation in this watershed is expected to increase by 1.3" to 6.2" by 2050, and winter precipitation is expected to increase by up to 25% by mid-century, and by up to 37% by 2100 (resilient MA, 2018).

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

The following are the historical flooding crests, or highest recorded water levels, for the Mill River. The River's minor flood stage is 11 feet, a height which it has reached 22 times in Northampton since 1950. The River's action stage is 9 feet, a height which has been reached 16 times in Northampton since 1950. Three of the top 7 recorded crest elevations have occurred in the past 5 years.

Table 3. Historical Crests for the Mill River in Northampton			
Rank	**Date**	**Height**	**Stage**
1	8/28/11	16.42 ft	Minor flooding
2	4/16/07	15.58 ft	Minor flooding
3	10/9/05	13.72 ft	Minor flooding
4	2/25/16	13.47 ft	Minor flooding
5	10/30/17	12.80 ft	Minor flooding
6	4/3/05	12.73 ft	Minor flooding
7	9/30/15	12.32 ft	Minor flooding
8	3/7/11	12.26 ft	Minor flooding
9	9/29/11	12.2 ft	Minor flooding
10	9/28/03	12.11 ft	Minor flooding
11	3/31/10	11.83 ft	Minor flooding
12	3/9/08	11.81 ft	Minor flooding
13	8/19/55	11.78 ft	Minor flooding
14	12/21/18	11.64 ft	Minor flooding
15	12/12/08	11.55 ft	Minor

Table 3. Historical Crests for the Mill River in Northampton			
Rank	**Date**	**Height**	**Stage**

			flooding
16	9/7/11	11.5 ft	Minor flooding
17	9/17/99	11.42 ft	Minor flooding
18	9/8/11	11.38 ft	Minor flooding
19	12/8/11	11.27 ft	Minor flooding
20	12/21/12	11.18 ft	Minor flooding
21	9/18/18	11.04 ft	Minor flooding
22	6/6/82	10.98 ft	Action stage
23	10/15/05	10.81 ft	Action stage
24	11/3/18	10.81 ft	Action stage
25	2/14/08	10.58 ft	Action stage
26	11/9/06	10.47 ft	Action stage
27	3/23/10	10.46 ft	Action stage
28	4/5/84	10.42 ft	Action stage
29	5/13/06	10.39 ft	Action stage
30	10/28/06	10.3 ft	Action stage
31	12/27/09	10.29 ft	Action stage
32	4/24/05	10.27 ft	Action stage
33	2/7/08	10.11 ft	Action stage
34	10/25/05	10.02 ft	Action stage
35	10/15/55	9.81 ft	Action stage
36	3/31/51	9.38 ft	Action stage
37	9/12/60	9.1 ft	Action stage

Source: National Weather Service[1]

The following are the historical flooding crests for the Connecticut River. The major flood stage for the river is 120 feet, which has been reached three times since 1935. The moderate flood stage is 115 feet,

[1] NWS, 2020. https://water.weather.gov/ahps2/river.php?wfo=box&wfoid=18682&riverid=205004&pt%5B%5D=145908&allpoints=145908%2C146659&data%5B%5D=impacts&data%5B%5D=stage&data%5B%5D=crests

which has been reached 16 times since 1935. The minor flood stage is 112 feet, which has been reached 64 times since 1935. The action stage is 110 feet, which has been reached 11 times since 1935.

Table 4. Historical Crests of the Connecticut River in Northampton			
Rank	**Date**	**Height**	**Stage**
1	03/19/1936	129.40	Major Flood
2	09/22/1938	125.00	Major Flood
3	05/31/1984	120.80	Major Flood
4	04/06/1960	119.90	Moderate Flood
5	01/01/1949	118.60	Moderate Flood
6	04/01/1987	118.00	Moderate Flood
7	03/23/1948	117.70	Moderate Flood
8	03/29/1953	117.60	Moderate Flood
9	08/30/2011	117.16	Moderate Flood
10	05/05/1940	117.0	Moderate Flood
11	10/09/2005	116.3	Moderate Flood
12	03/15/1977	116.2	Moderate Flood
13	06/03/1952	116.0	Moderate Flood
14	04/03/1976	115.7	Moderate Flood
15	04/23/1969	115.5	Moderate Flood
16	04/01/1951	115.4	Moderate Flood
17	04/24/1958	115.3	Moderate Flood
18	03/24/1968	115.2	Moderate Flood
19	05/01/1956	115.0	Moderate Flood
20	07/02/1973	114.9	Flood Stage
21	04/19/1982	114.8	Flood Stage
22	04/07/1952	114.8	Flood Stage
23	03/27/1979	114.6	Flood Stage
24	04/17/1996	114.6	Flood Stage

Table 4. Historical Crests of the Connecticut River in Northampton			
Rank	**Date**	**Height**	**Stage**
25	04/01/1998	114.6	Flood Stage
26	04/04/2005	114.6	Flood Stage
27	03/19/1973	114.6	Flood Stage
28	04/17/2007	114.5	Flood Stage
29	12/16/1983	114.5	Flood Stage
30	04/13/1947	114.4	Flood Stage
31	04/18/1994	114.4	Flood Stage
32	04/05/1959	114.3	Flood Stage
33	04/24/2001	114.3	Flood Stage
34	05/14/1996	114.2	Flood Stage
35	12/22/1973	114.2	Flood Stage
36	02/26/1981	114.2	Flood Stage
37	04/02/1962	114.1	Flood Stage
38	04/02/2004	114.0	Flood Stage
39	04/02/1977	114.0	Flood Stage
40	03/18/1990	113.9	Flood Stage
41	05/06/1972	113.9	Flood Stage
42	01/19/2006	113.7	Flood Stage
43	04/08/1984	113.7	Flood Stage
44	04/01/1986	113.5	Flood Stage
45	04/01/1993	113.5	Flood Stage
46	03/22/1945	113.5	Flood Stage
47	04/14/2011	113.4	Flood Stage
48	04/17/1993	113.4	Flood Stage

Table 4. Historical Crests of the Connecticut River in Northampton			
Rank	**Date**	**Height**	**Stage**
49	11/30/1959	113.4	Flood Stage
50	03/29/1976	113.4	Flood Stage
51	04/21/1972	113.3	Flood Stage
52	10/30/2003	113.2	Flood Stage
53	04/17/2014	113.1	Flood Stage
54	04/17/2019	113.0	Flood Stage
55	03/31/2003	113.0	Flood Stage
56	10/27/2005	113.0	Flood Stage
57	04/15/2008	112.9	Flood Stage
58	01/10/1998	112.9	Flood Stage
59	02/27/2016	112.8	Flood Stage
60	04/18/2011	112.8	Flood Stage
61	04/17/1955	112.8	Flood Stage
62	03/31/2010	112.8	Flood Stage
63	09/08/2011	112.7	Flood Stage
64	04/06/1950	112.7	Flood Stage
65	09/08/2011	112.7	Flood Stage
66	10/21/1975	112.6	Flood Stage
67	05/07/1989	112.5	Flood Stage
68	05/26/1979	112.5	Flood Stage
69	04/04/1967	112.5	Flood Stage
70	12/19/2000	112.4	Flood Stage
71	04/04/1963	112.4	Flood Stage
72	04/16/1964	112.4	Flood Stage
73	01/28/1996	112.4	Flood Stage
74	04/08/1989	112.4	Flood Stage
75	04/23/2019	112.2	Flood Stage
76	03/24/2010	112.2	Flood Stage
77	04/06/1974	112.2	Flood Stage
78	05/05/1971	112.2	Flood Stage
79	04/26/1970	112.1	Flood Stage
80	08/20/1955	112.0	Flood Stage
81	04/19/1954	112.0	Flood Stage
82	04/11/1980	112.0	Flood Stage
83	12/13/2008	111.9	Action Stage
84	05/21/2006	111.8	Action Stage
85	12/01/1959	111.8	Action Stage
86	04/06/2000	111.8	Action Stage
87	04/05/1990	111.8	Action Stage
88	04/17/2002	111.7	Action Stage
89	12/26/1990	111.7	Action Stage
90	05/05/1983	111.6	Action Stage
91	04/04/1973	111.6	Action Stage
92	04/30/1988	111.6	Action Stage
93	12/26/2003	111.5	Action Stage

Source: National Weather Service[2]

[2] NWS 2020, https://water.weather.gov/ahps2/river.php?wfo=box&wfoid=18682&riverid=203796&pt%5B%5D=1444

The increased amount of strong precipitation events and overall increase in rainfall resulting from climate change will likely result in more flooding in the region.

Previous Occurrences

Between 1954 and 2020, Hampshire County was included in five FEMA declared flood-related disasters (DR) or emergencies (EM) classified as one or a combination of the following hazards: severe storms, flooding, and inland and coastal flooding. Northampton may not have been impacted by all of these events. According to the USACE Ice Jam Database, there were 233 reported ice jams in Massachusetts between 1920 and 2020, 12 of which were located in Northampton as shown below (USACE, 2020).

Table 5. Historic Ice Jams in Northampton

River	Jam date	Water year	Jam type	Gage number	Damages
Connecticut River	03/13/1936	1936	-	?	?
Mill River	02/08/1941	1941	-	01171500	?
Mill River	01/02/1945	1945	-	01171500	?
Connecticut River	03/01/1946	1946	Break-up	?	?
Mill River	03/09/1950	1950	-	01171500	?
Mill River	01/23/1957	1957	-	01171500	?
Mill River	01/22/1959	1959	-	01171500	?
Mill River	01/25/1964	1964	-	01171500	?
Bassett Brook	02/09/1965	1965	-	01171800	?
Mill River	02/08/1965	1965	-	01171500	?
Bassett Brook	02/13/1966	1966	-	01171800	?
Bassett Brook	03/18/1968	1968	-	01171800	?

Though not recorded in the USACE Ice Jam Database, the most significant ice jam event that has occurred in Northampton since the last HMP update was in the winter of 2018 along the CT River. Large blocks of floating ice caused significant damage to floating and permanent structures at the Connecticut River Greenway. The gangway, docks, harbor, and railings were damaged to a cost of roughly $30,000. In response, the City cut out the damaged rails, but Northampton Community Rowing has not yet replaced the gangway and docks. The harbor, dug out when the New Haven and Northampton Canal was built in the early 1800's, silted in more than it had in all that time. The City has never dredged the area, and based on the great expense of doing so it may never happen.

45&allpoints=143763%2C141260%2C143709%2C141640%2C144423%2C150552%2C141250%2C144445%2C142863%2C142203%2C142784%2C142297%2C144501&data%5B%5D=crests

Known flood events, including FEMA disaster declarations, which have impacted Northampton in the past 100 years are identified in Table 6 below. Loss and impact information could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this plan.

Table 6. Floods Causing Significant Damage in Northampton, 1914-2020

Date	Description	Cost of Damage	Cost Adjusted for Inflation
9/18/2018	Flash Flood from Heavy Rain - Storm total rainfall amounts reached two to five inches. The Mill River reached Flood Stage at 11.04 ft.	NA	NA
10/25/2017	Flood from Heavy Rain - In Northampton, flood waters closed the intersection of Main and Market Streets. A car was trapped by flood waters on West Street near Smith College.	NA	NA
8/5/2017	Flood from Heavy Rain - Flooding in Northampton peaked between 2 and 3 PM. At 2:14 PM, State Street had between eight and twelve inches of flooding between Bedford Terrace and Summer Street. Several manhole covers came off due to flooding, including three on Elm Street near Childs Park and one on Old South Street. At 2:27 PM, Jackson Street was flooded and impassable, with the water two feet deep on King Street near the Bluebonnet Diner. At 2:40 PM, an underpass near North Street and Market Street was flooded and impassable.	NA	NA
2/25/2016	Flood from Heavy Rain - In Northampton, the Mill River overflowed its banks resulting in flooding on Meadow Street in Leeds. On 2/27 CT River reached Flood Stage at 112.88 ft.	NA	NA
9/30/2015	Flood from Heavy Rain - Twelve inches of water was flooding portions of Route 9 near in Haydenville the Northampton town line.	NA	NA
8/27/2011	Hurricane Irene	$96,400	$111,600
4/15/07 –	100-year flood Mill River Floodplain	NA	NA

Table 6. Floods Causing Significant Damage in Northampton, 1914-2020			
Date	**Description**	**Cost of Damage**	**Cost Adjusted for Inflation**
4/16/07			
5/13/2006	Heavy rainfall caused the Mill River to flood	$5,000	$6,400
9/16/1999	Tropical Storm Floyd, Flooding to Mill River Floodplain	$900,000	$1,394,000
3/31/87/ - 4/7/87	Connecticut River Floodplain	$126,000	$286,000
5/28/84 – 6/5/84	50-year flood Connecticut River Floodplain	$377,000	$937,000
6/6/82	50 to 100 year flood Mill River Floodplain	$104,000	$278,000
3/15/77	10-year flood; Connecticut River Floodplain	$112,000	$447,000
4/6/60	10-year flood; Connecticut River Floodplain	$38,000	$331,000
10/15/55	50 to 100-year flood Mill River Floodplain	$48,000	$462,000
3/29/53	10-year flood Connecticut River Floodplain	$40,000	$387,000
6/3/52	10-year flood Connecticut River Floodplain	$38,000	$370,000
1/1/49	10-year flood Connecticut River Floodplain	$37,000	$401,000
3/23/48	10-year flood Connecticut River Floodplain	$32,000	$323,000
9/22/38	100-year flood Connecticut River Floodplain	$81,500	$1,492,000
3/13/36	100-year flood Connecticut River Floodplain	$200,000	$3,714,000

Northampton's most significant flood event on record was the "the Great Flood" of March 1936. The account of the flood is as follows:

An unusually cold and snowy winter, followed by a spell of warm and rainy weather, turned the normal spring rising of the Connecticut River into an unprecedented natural catastrophe. The flood inundated Hadley, Hatfield, Northampton, Holyoke, and Springfield, as well as smaller towns and villages along its course. In Massachusetts alone, the Great Flood killed ten people and left 50,000 homeless. It was an unmatched natural catastrophe for the Bay State, causing over $200,000,000 in damage in 1936 dollars.

Probability of Future Events

Based upon previous data, there is a "high" chance (between 40 percent and 70 percent in the next year) of flash flooding or general flooding occurring in Northampton. This is partly a function of the presence of the Connecticut River and the Mill River, both of which contain significant floodplain acreage in Northampton.

Flooding frequencies for the various floodplains in Northampton are defined by FEMA as the following:

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

In actuality, flooding occurs more frequently than this because the current FEMA-defined flood zones are based on historical patterns of rainfall intensity and frequency, and do not take into account the impacts that climate change will have on Northampton. Overall it is anticipated that the severity of flood-inducing weather events and storms will increase as a result of climate change. Research has shown that rainfall is increasingly concentrated into the most severe events (Easterling, 2017). While trends in overall precipitation are less clear, the increase in severe rainfall events will exacerbate the risk of localized flooding. In future years, it is likely that the currently designated 10-year, 25-year, 100-year and 500-year floodplains of the Mill River and Connecticut River will flood more frequently due to climate change.

The City of Northampton believes this to be a severe risk.

Impact

The City faces a "limited" impact, with 10 percent or less of total city area affected, from flooding.

The National Weather Service maintains water level gauges on the Mill River and Connecticut River in Northampton, to monitor flooding. The NWS has various flooding classifications based on water level. These classifications and their definitions are:

Action Stage - the stage which, when reached by a rising stream, represents the level where the NWS or a partner/user needs to take some type of mitigation action in preparation for possible significant hydrologic activity. The type of action taken varies for each gauge location. Gauge data should be closely monitored by any affected people if the stage is above action stage.

Minor Flooding is defined to have minimal or no property damage, but possibly some public threat. A Flood Advisory product is issued to advise the public of flood events that are expected not to exceed the minor flood category. Examples of conditions that would be considered minor flooding include:

- water over banks and in yards
- no building flooded, but some water may be under buildings built on stilts (elevated)

- personal property in low lying areas needs to be moved or it will get wet
- water overtopping roads, but not very deep or fast flowing
- water in campgrounds or on bike paths
- inconvenience or nuisance flooding
- small part of the airstrip flooded, and aircraft can still land
- one or two homes in the lowest parts of town may be cut off or get a little water in the crawl spaces or homes themselves if they are not elevated

Moderate Flooding is defined to have some inundation of structures and roads near the stream. Some evacuations of people and/or transfer of property to higher elevations may be necessary. A Flood Warning is issued if moderate flooding is expected during the event. Examples of conditions that would be considered moderate flooding include:

- several buildings flooded with minor or moderate damage
- various types of infrastructure rendered temporarily useless (i.e. fuel tanks cannot be reached due to high water, roads flooded that have no alternates, generator station flooded)
- elders and those living in the lowest parts of the village are evacuated to higher ground
- access to the airstrip is cut off or requires a boat
- water over the road is deep enough to make driving unsafe
- gravel roads likely eroded due to current moving over them
- widespread flooding, but not deep enough to float ice chunks through town
- water deep enough to make life difficult, normal life is disrupted and some hardship is endured
- airstrip closed
- travel is most likely restricted to boats

Major Flooding is defined to have extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations are necessary. A Flood Warning is issued if major flooding is expected during the event. Examples of conditions that would be considered major flooding include:

- many buildings flooded, some with substantial damage or destruction
- infrastructure destroyed or rendered useless for an extended period of time
- multiple homes are flooded or moved off foundations
- everyone in threatened area is asked to evacuate
- National Guard units assist in evacuation efforts
- erosion problems are extreme
- the airstrip, fuel tanks, and the generator station are likely flooded
- loss of transportation access, communication, power and/or fuel spills are likely
- fuel tanks may float and spill and possibly float downstream
- ice chunks floating through town that could cause structural damage
- high damage estimates and high degree of danger to residents

Various critical facilities are at risk within Northampton's floodplain:

100-year floodplain

- EPA Tier II Facility on Island Road in the Connecticut River Oxbow area
- The Northampton Airport
- Fair Grounds—potential gathering spot for thousands of people and livestock during the Three County Fair. In addition, the area is also susceptible to localized flooding.
- Sections of Route 5, Mount Tom Road, and Route 10 at the South St bridge with the flood control drop structure underneath, cutting off southbound access to the City.
- Waterlines and sewer lines mounted on the City's bridges—a flood that destroyed a bridge could result in a potential loss of services for residential populations.
- Road adjacent to the Mill River (causing destruction to road)
- Power substations at Smith College, King Street, and Route 5 at Easthampton line

500-year floodplain

- Group Home/Assisted Living Facility and Paradise Pond Transitional Apartments within the Mill River's floodplain on West Street

In addition, there are several facilities that are located outside the floodplain because of the City's levee system. Should this system fail, these facilities would be at risk:

- Power facilities located on West Street
- The City's wastewater treatment facility
- Much of downtown

Localized flooding

The Hazard Mitigation Committee identified several points in the City as areas that flood frequently but are outside of the community's Flood Insurance Rate Map boundaries. The locations of these areas and the impact of flooding to them are the following:

- Ice pond culvert on Route 66/Rocky Hill Road has a history of flooding and is on a primary evacuation route.
- The intersections of Church Street, Stoddard Street, State Street, and Perkins Avenue to Route 5 & 10.
- The area surrounding Elm Street, Riverside Drive, Nutting Avenue, Ormond Street, and Federal Street.
- Austin Circle.
- Reservoir Road. The road was closed during Hurricane Irene.
- Denise Court area.
- King Street Brook.
- Elm Street Brook.

- Williams Street Brook.

Flooding can also cause damage to bridges, especially the lowest bridges in the City which are located in Florence at Pine Street and Meadows Street. Many water lines in the City are located on bridges and damage to these could disrupt the water supply.

Vulnerability

Based on the above analysis, Northampton has a hazard index rating of "2 – high risk" for flooding.

There are approximately 4,150 acres of land within the FEMA mapped 100-year floodplain and 82 acres of land within the 500-year floodplain within the City of Northampton. There are approximately 90 residential structures located within the 100-year flood plain in Northampton, with roughly 573 people living in the 100-year flood plain and 132 people live in the 500-year flood plain.[3] According to FEMA's Community Information System (CIS) reporting from April, 2020, there are only 76 residential structures holding flood insurance through the National Flood Insurance Program. This may indicate that some structures within the 100-year floodplain, one of the highest flood risk areas in town, may not have insurance against flood damage.

Utilizing the City's median home value of $321,900 (American Community Survey, 2014-2018), up to $28,971,000 worth of damage could occur from a 100-year flood. The damage estimate is a rough estimate and likely reflects a worst-case scenario. Computing more detailed damage assessments based on assessor's records is a labor-intensive task and beyond the scope of this project.

Areas where localized flooding has been a problem in the past will also be vulnerable to increased flooding from climate change, though their risk is presumed to be moderate.

Population

Advance weather forecasting, blockades, and emergency alerts and warnings help to minimize the total number of injuries and casualties that typically result from riverine flooding. However, even a relatively low-level flood can be hazardous and can result in direct mortality to individuals interacting with the flood zone. For example, while 6 inches of moving water can cause adults to fall, 1 foot to 2 feet of water can sweep cars away. Downed powerlines, sharp objects in the water, or fast-moving debris that may be moving in or near the water, all present an immediate danger to individuals in the flood zone. Floodwater can also carry a wide range of infectious organisms from raw sewage and/or chemicals and hazardous materials swept away from containment areas.

The most vulnerable populations exposed to the flood hazard include people with low socioeconomic status, people over the age of 65, young children, people with medical needs, and those with low

[3] These figures are carried forward from the 2015 HMP Update. Updated data on these figures was unavailable for the 2020 update.

English language fluency. Populations that live or work in proximity to facilities that use or store toxic substances are at greater risk of exposure to these substances during a flood event.

The increased flooding due to climate change will have disproportionate impacts to several special populations in Northampton. The socioeconomic status of residents in the floodplains is lower than the City as a whole, meaning that flooding will have more of an impact on lower income residents. Several facilities that serve special populations are located near the City's levee system, and would be within the floodplain should the levee system be compromised. These facilities include: Salvo House, ServiceNet, the Hampshire Dialysis Center, and the Northampton Senior Center. Flooding in this area will affect both low-income and market rate housing development. Other locations that provide critical social services or that support vulnerable populations are exposed to flooding, including the Meals on Wheels kitchen, the bike path where it crosses under the train tracks, and the homeless tent encampment.

Built Environment and Economy

Buildings, infrastructure, and other elements of the built environment are vulnerable to inland flooding. Buildings within the floodplain are highly vulnerable to inland flooding and are likely to become increasingly vulnerable as riverine flooding increases due to climate change (resilient MA, 2018).

The intersections of Church Street, Stoddard Street, State Street, and Perkins Avenue to Route 5 & 10 are susceptible to localized flooding. This neighborhood is medium density residential. Approximately 18 structures could be affected by a flood incident. At a rate of 100 percent damage to 100 percent of the structures, the estimated cost of repairing or replacing these properties would be $5,794,200.

The area surrounding Elm Street, Riverside Drive, Nutting Avenue, Ormond Street, and Federal Street is susceptible to localized flooding. Approximately 68 structures could be affected by a flood incident. At 100 percent damage to 100 percent of the structures, the estimated cost of repairing or replacing would be $21,889,200.

The City of Northampton's levee protection system, designed after the 1936 Hurricane, is designed to prevent flooding from up to a 500-year flood. The damage estimates above are based on one of two scenarios: 1) the levee system is structurally compromised or 2) flooding occurs that exceeds the design height of the levee system. Furthermore, flood control pump stations that are located at the WWTP are fairly old and showing signs of wear. These pump stations are essential to the City's standing flood mitigation capabilities and if they failed, they could create severe damage to both the treatment plant and the surrounding low-lying neighborhood.

The City is currently assessing the levee system to determine what changes are needed, if any, to allow them to be FEMA certified. In addition, a Comprehensive Wastewater Management Plan (CWMP) was completed and submitted to MassDEP in 2016. The CWMP recommended system-wide improvements of approximately $80M over 20 years, with $30M of that in the first 5 years. As part of an initial project, a conversion from gaseous chlorine to hypochlorite, mitigating a significant hazard, was completed in 2017. Other near-term upgrades would address daily and emergency power reliability issues, reducing vulnerability of a failure.

The impacts of climate change will increase the vulnerability of the nearly 600 people who currently live in the 100-year flood plain and more than 100 people who live in the 500-year flood plain. More damage will occur in areas too small to have FEMA floodplain designation and not already zoned floodplain, such as Roberts Meadows Brook. Currently 284 people live in this area and could be affected. Many of these areas already flood consistently, and so climate change will be potentially very damaging to these areas. The City of Northampton believes these risks to be severe.

Flooding can cause direct damage to critical facilities and result in roadblocks and inaccessible streets that impact the ability of public safety and emergency vehicles to respond to calls for service.

Gas stations located within the 100-year floodplain and the 500-year floodplain should take precautions to ensure a flood event would not result in facility damage or environmental contamination from a gas spill.

At a neighborhood to regional scale, highly developed areas and areas with high impervious surface coverage may be most vulnerable to flooding. Even moderate development that results in as little as 3 percent impervious cover can lead to flashier flows and river degradation, including channel deepening, widening, and instability (SHMCAP, 2018). Additionally, changes in precipitation will threaten key infrastructure assets with flood and water damage. Climate change has the potential to impact public and private services and business operations.

Most flood events that occur in Northampton are not accompanied by a FEMA Emergency or Disaster declaration and, as a result, all costs associated with the events are borne by local City budgets. In FY19, $97,751 was budgeted from Northampton's Stormwater Enterprise Fund for flood. [4]Any City response to the events listed in the Previous Occurrences section above would have likely included payroll overtime for personnel, and operational costs for electricity, natural gas, fuel, and repair and maintenance costs for equipment, buildings, grounds, communication and supplies, and safety supplies. If the frequency of flooding increases in future years, so will the financial burden on tax payers to support City response.

Natural Resources

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

One common environmental effect of flooding is riverbank and soil erosion. Riverbank erosion occurs when high, fast water flows scour the edges of the river, transporting sediment downstream and reshaping the ecosystem. This process can clog riverbeds and streams, disrupting the water supply to

[4] Information obtained from the Northampton DPW Director and the Financial Administrator, 2020.

downstream habitats. In Northampton, the FEMA SFHA overlaps with BioMap2 Critical Natural Landscapes and Core Habitat along the banks of the Mill and CT Rivers, as well as along Marble Brook, Bassett Brook, Parson's Brook and Broad Brook. These areas are particularly vulnerable to the impacts of bank destabilization and erosion from flooding.

Dam Failure / Levee Breach

Hazard Description

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

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

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

The City of Northampton's levees are part of the City's Flood Control System constructed by the Army Corps of Engineers (USACE) between March 1939 and June 1941. The system is designed to protect a large portion of the City against flooding from the Connecticut River and the Mill River. The City of Northampton is responsible for maintenance and operation of the Northampton Flood Control System and for maintaining compliance with standards set forth by the USACE. The USACE conducts annual inspections of the Northampton Flood Control System.

Location

There are 18 dams on public and private land in the City of Northampton, as well as one dam in West Whately and one dam in Williamsburg impacting the City's drinking water supply. In addition, levee systems exist along the Mill River and Connecticut River. The names and hazard levels of the individual structures are:

Table 7. Dams and Levees in Northampton or Affecting Northampton

Dam	Street Name	Hazard Level
Lower Roberts Meadow Dam	Reservoir Road	High
Middle Roberts Meadow Dam	Reservoir Road	High
Ryan Reservoir Dam	West Whately	High
Mountain Street Reservoir Dam	Williamsburg	High
Paradise Pond	College Lane	High
Chartpac Dam (Orange Dam)	River Road	Significant
Clear Falls Pool Dam	Drury Lane	Significant
Mill River Diversion Dam	South Street	Significant
Vistron Pro Corporation Dam	Pine Street	Significant
Country Club Dam (Cook Dam)	Arch Street, Main Street	Significant
Button Shop #2 Dam	Main Street, Leeds	Significant
Button Shop #1 Dam	Main Street, Leeds	Significant
Rocky Hill Pond Dam	Rocky Hill Road	Low
Fitzgerald Lake Dam	North Farms Road	Low
Mill River/Yankee Hill	Ladd Avenue	Low
Howards Ice Pond Dam	Dimock Street	Low
Vaznis Farm Pond Dam	Unknown	NA
Florence Ice Pond Dam	Spring Street Extension	NA
Look Park Dam	North Main Street, Florence	NA
Connecticut River levee system	Along Connecticut River	NA
Mill River levee system	Along Mill River	NA

Source: MassDEP 2019

The failure of a high hazard dam or flood control levee could affect a "medium" amount of the land area in Northampton, or between 10 and 50 percent of the total land area.

The Connecticut River Flood Control System consists of approximately 4,800 linear feet of levee that extends from Pomeroy Terrace to the high ground west of Route 5 (Pleasant Street/Mount Tom Road). The levee has a maximum height of 23 feet. The Mill River Flood Control System consists of two levee sections. The Smith College Levee is located along the east bank of the Mill River between Paradise Pond Dam and West Street. The Diversion Levee extends from the Manhan Rail Trail to Hebert Avenue. Combined, these two sections of levee are approximately 2,000 feet in length with a maximum height of 25 feet.

While the state does not evaluate the hazard level of levees, the Hazard Mitigation Committee assessed both the Mill River levee system and Connecticut River levee system and determined the percent of City affected by their failure to be 5 percent and 15 percent respectively, meaning they would affect a "medium" amount of the total land area, but would flood some of the highest value areas in the city.

Extent

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

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

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

Previous Occurrences

There have been no catastrophic dam or levee failures in Northampton in over a century. The scars of an 1874 failure of a dam upriver of Northampton which largely destroyed the Northampton village of Leeds, however, remains a powerful reminder of the potential.

Probability of Future Events

Currently the frequency of dam failures is “very low” with a less than 1 percent chance of a dam failing in any given year. As Northampton’s high hazard dams age, precipitation and impoundment volumes increase with climate change, and if maintenance is deferred, the likelihood of a dam failure will increase.

Mass DEP has evaluated the overall condition of 15 of the dams in Northampton. Of those evaluated, four were deemed “Satisfactory,” eight were deemed “Fair,” and two were deemed “Poor.” An explanation for each of these ratings is provided below.

- SATISFACTORY - Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result in deficiencies.

- FAIR - Significant operational and maintenance deficiencies, no structural deficiencies. Potential deficiencies exist under unusual loading conditions that may realistically occur. Can be used when uncertainties exist as to critical parameters.
- POOR - Significant structural, operational, and maintenance deficiencies are clearly recognized under normal loading conditions.

Northampton's levee systems along the Mill River and Connecticut River were very well constructed in 1940 and are regularly maintained, though a sufficiently large flood could cause structural damage to the levee and cause it to partially breach. Given current conditions, the primary risk is where the levees meet the original grade that water, with enough hydrostatic pressure, could slip below the levees. Core samples of the levees were drilled in 2020 and are currently being analyzed to ensure the integrity of the levees.

However, due to rarity of major floods during the last few decades, the frequency of levee breach or failure remains "very low," with a less than 1 percent chance in any given year.

Impact

The City faces a "critical" impact from failure of dams or levees with a high hazard level, with 25 percent of Northampton affected.

Complete failure of a high significant hazard dam in Northampton is estimated to impact between 0 and 25 percent of the City, and resulting in property losses up to $685,514,166. Other dams are not expected to have a risk to property and people. Costs are based on the total value of all structures in Northampton of $2,742,056,662.

While the state does not evaluate the hazard level of levees, the Hazard Mitigation Committee assessed both the Mill River levee system and Connecticut River levee system and determined the percent of City affected by their failure to be 5 percent and 25 percent respectively.

Vulnerability

Based on this analysis, Northampton has a hazard index rating of "5 – very low risk" from dam failure or levee breach.

Population

The most vulnerable populations exposed to the Dam Failure / Levee Breach hazard include people in frontline communities, those with low socioeconomic status, over the age of 65, young children, people with medical needs, and those with low English language fluency. Populations that live or work in proximity to facilities that use or store toxic substances within the affected area of a dam failure or levee breach are at greater risk of exposure to these substances. Populations identified by the 2010 Census as minority, low income, and English isolated that are living in an area protected by a levee are particularly vulnerable.

Advance weather forecasting, blockades, and emergency alerts and warnings help to minimize the total number of injuries and casualties that typically result from dam failure or levee breach. While dam failure can lead to flash flood conditions that are harder to mitigate with early warning messages, even a relatively low-level flood can be hazardous and can result in direct mortality to individuals interacting with the flood zone. See the Vulnerability discussion under the Flood profile above for additional information.

Built Environment and Economy

Flooding from dam failure or levee breach can cause direct damage to critical facilities and result in roadblocks and inaccessible streets that impact the ability of public safety and emergency vehicles to respond to calls for service.

There are a number of critical facilities in the levee-protected zone. For instance, the wastewater treatment facility is in the levee-protected zone – if any part of the flood control system, such as the levee of pump stations, were to fail, this would be one of the first facilities to flood. This and other critical facilities in the levee-protected area should take precautions to ensure a flood event would not result in facility damage or environmental contamination.

A catastrophic failure of Northampton's flood control system would impact many of the downtown businesses. FEMA research has shown that nearly 1 in 4, or 25%, of businesses do not return after a major catastrophic event. This would have a major impact on City tax income and operating budget. A significant loss of homes due to the same levee failure or a dam failure could also have major tax implications that could strain City cash flow for years after the event.

Natural Resources

Dam failures and levee breaches result in severe and flash flood conditions leading to substantial damage to the environment and natural resources, particularly in areas where human development has interfered with natural flood-related processes. The Francis P. Ryan Reservoir Dam and the adjascent West Whately Reservoir Dam retain one of the City's primary sources of drinking water and are rated in "Fair" condition according the Office of Dam Safety (ODS) regulations. Improvements to the spillways and embankments are required to address current deficiencies and to provide sufficient capacity to pass the one half the Probable Maximum Flood (1/2 PMF) without overtopping the dams.

Drought

Hazard Description

Like flooding, drought is a normal, recurrent feature of climate. It occurs almost everywhere, although its features vary from region to region. In the most general sense, drought originates from a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector. Reduced crop, rangeland, and forest productivity; increased fire hazard; reduced water levels; increased livestock and wildlife mortality rates; and damage to wildlife and fish

habitat are a few examples of the direct impacts of drought. Of course, these impacts can have far-reaching effects throughout the region and even the country.

Location

Because of this hazard's regional nature, a drought would impact the entire city, meaning the location of occurrence is "large" or over 50 percent of the City affected. How a drought is experienced can depend on geographic factors such as land use change, the existence of dams, and water supply withdrawals or diversions. For example, impervious surfaces associated with development can exacerbate the effects of drought due to decreased groundwater recharge.

Extent

The severity of a drought would determine the scale of the event and would vary among city residents depending on whether the residents' water supply is derived from a private well or the public water system.

The U.S. Drought Monitor also records information on historical drought occurrence. Unfortunately, data could only be found at the state level. The U.S. Drought Monitor categorizes drought on a D0-D4 scale as shown below.

U.S. Drought Monitor

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

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

When evaluating drought risk utilizing the Palmer Drought Severity Index, Massachusetts is historically in the lowest percentile for severity and risk of drought. Even so, there have been several years of

drought-like conditions in Western Massachusetts: 1940-1952, 1980-1983, 1995-2001, 2010 and 2016. Furthermore, global warming and climate change may have an effect on drought risk in the region. With the projected temperature increases, some scientists think that the global hydrological cycle will also intensify. This would increase the severity and duration of droughts that might impact Northampton.

The extent of a severe drought in Northampton would be minor, with very few injuries, if any, only minor property damage and minimal disruption on quality of life, and a temporary shutdown of facilities or limits placed on water usage.

Previous Occurrences

In Massachusetts, six major droughts have occurred statewide since 1930, the most severe in 1960 and the most recent in 2016. [5] They range in severity and length, from three to eight years. Although it was shorted in duration, the severity of the 2016 drought state-wide was equivalent to that of the historic drought of the 1960s. In many of these droughts, water-supply systems were found to be inadequate. Water was piped in to urban areas, and water-supply systems were modified to permit withdrawals at lower water levels. The following table indicates previous occurrences of drought since 2000, based on the US Drought Monitor. Note, the table below only reports on the highest recorded drought level for each year:

Annual Drought Status	
Year	**Maximum Severity**
2000	No drought
2001	D2 conditions in 21% and D1 conditions in 79% of the state
2002	D2 conditions in 99% of the state
2003	No drought
2004	D0 conditions in 44% of the state
2005	D1 conditions in 7% and D0 conditions in 100% of the state
2006	D0 conditions in 98% of the state
2007	D1 conditions in 71% and D0 conditions in 100% of the state
2008	D0 conditions in 57% of the state
2009	D0 conditions in 44% of the state
2010	D1 conditions in 27% and D0 conditions in 100% of the state

[5] US Geological Survey Water-Supply Paper 2375. "National Water Summary 1989 – Floods and Droughts: Massachusetts." Prepared by S. William Wandle, Jr., US Geological Survey.

Annual Drought Status	
Year	**Maximum Severity**
2011	D0 conditions in 0.01% of the state
2012	D2 conditions in 51% and D1 conditions in 96% of the state
2016	D3 conditions in 52% of the state, D2 in 38%, and D1 in 8% of the state
2017	D3 conditions in 9% of the state, D2 in 60%, and D1 in 28% of the state
2018	D1 in 36% of the state and D0 conditions in 49% of the state
2019	D0 conditions in 85% of the state
Through May 2020	D0 conditions in 26% of the state

Source: US Drought Monitor

Northampton has had limited experience with severe drought conditions. According to the Massachusetts SHMCAP, between 2001 and 2017 the City experienced up to 69 weeks of Severe Drought and 21 weeks of Extreme Drought, as many weeks as any other municipality in the State as classified by the U.S. Drought Monitor.

In the summer of 2016, Northampton experienced drought conditions that were impacting most of the Commonwealth. The lack of adequate rainfall coupled with warm summer temperatures over a span of months prompted authorities to implement water-use restrictions for residents and businesses alike. The City's Water Department actively managed the two water supply reservoirs and activated their two groundwater wells to supplement supply from the reservoirs. Restrictions were placed on the allowable time and location for outdoor watering, including the use of hoses and sprinklers. The partial water ban was in accordance with the state's Water Management Act and Northampton's Public Water Supply Water Management Act permit with MassDEP. Similar bans were enacted and enforced in the summers of 2015, 2017, 2018, and 2019.

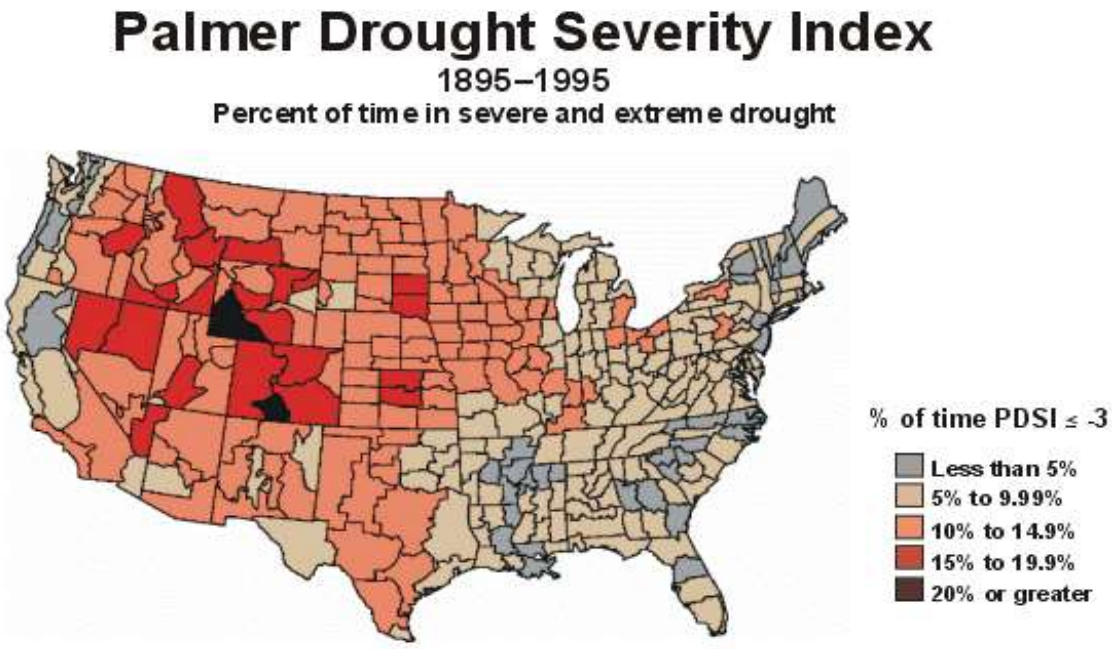
Probability of Future Events

The frequency and intensity of droughts are projected to increase during summer and fall as higher temperatures lead to greater evaporation and earlier winter and spring snowmelt, and precipitation patterns become more variable and extreme. Also due to climate change, the proportion of precipitation falling as rain instead of snow in our region and the length of time snowpack remains are both expected to decrease. This reduces the period during which snow melt can recharge groundwater supplies, bolster streamflow, and provide water for the growing period.

In Northampton, as in the rest of the state, drought occurs at a "low" probability (1 to 10 percent in the next year). Based on past events and current criteria outlined in the Massachusetts Drought Management Plan, it appears that western Massachusetts may be more vulnerable than eastern Massachusetts to severe drought conditions. However, many factors, such as water supply sources,

population, economic factors (i.e., agriculture based economy), and infrastructure, may affect the severity and length of a drought event. When evaluating the region's risk for drought on a national level, utilizing the Palmer Drought Severity Index, Massachusetts is historically in the lowest percentile for severity and risk of drought.[6]

Due to the water richness of western Massachusetts, Northampton is unlikely to be adversely affected by anything other than a major, extended drought. While such a drought would require water saving measures to be implemented, there would be no foreseeable damage to structures or loss of life resulting from the hazard.



Average temperatures in the Pioneer Valley have been increasing over time in the Pioneer Valley due to climate change, and this trend is likely to continue in the future. Higher temperatures due to climate change will likely have an effect on future drought risk in Northampton. A slight decrease in summer precipitation will also support more frequent droughts, especially short-term (1 to 3 months). Droughts are likely to increase in their frequency in the Northeast to the level of once per year.

Impact

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

- Slowing or loss of crops and pastures
- Water shortages or restrictions

[6] National Drought Mitigation Center – http://drought.unl.edu

- Minor to significant damage to crops, pastures;
- Low water levels in streams, reservoirs, or wells

However, the City's local aquifer supply would help to reduce the effects of widespread drought on the local water supply. The impact of a drought is thus "minor," with very few damages to people or property likely to occur.

Secondary Hazards

Another hazard commonly associated with drought is wildfire. A prolonged lack of precipitation dries out soil and vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends. As a result, a drought may increase the probability of a wildfire occurring. Additional information is provided on the wildfire hazard later in this section.

In Northampton, the inability to provide sufficient water supply can itself be secondary to other natural or man-made hazard events. Power outage, tornado, building fires, construction/maintenance projects, aging infrastructure, and inadequate water main sizes are the significant causes of water loss to the Town.

Vulnerability

Based on the above assessment, Northampton has a hazard index rating of "5 – very low risk" from drought. No loss of property, or damages to people or property, is expected due to this hazard.

Populations

The entire population of Northampton would be vulnerable to the impacts of a drought. Residents with a private water supply such as a well, homeless residents, and populations with respiratory health conditions are most vulnerable.

Built Environment

Some infrastructure may not be built to operate in drought conditions. Intake pipes may be too high above drought water levels, and wells may be too shallow. Private suppliers or residents with private systems may need to drill deeper wells or find alternative supplies for emergency back-up during severe droughts.

Natural Resources

Prolonged droughts can have severe impacts on groundwater and surface water-dependent ecosystems and natural resources, as most organisms require water throughout their life cycle.

Economy

Economic impacts of drought can be significant in the agriculture, recreation, forestry, and energy sectors. Coca-Cola, a major employer and economic driver in Northampton, relies on local water sources for its productivity. A prolonged drought may lead to reduced production capability or temporary closure. Farmers in the Meadows area of Northampton work with particularly fertile and wet soil conditions, and therefore are not equipped with irrigation systems that would be required to maintain crop viability in the case of a severe drought.

Impacts on the individual level include the need to buy water from an alternative source during a drought emergency. Crop failure can also increase food prices, straining a portion of the economy.

Extreme Temperatures

Hazard Description

What constitutes "extreme cold" or "extreme heat" can vary across different geographies, based on what the population of a particular place is accustomed to. According to the Massachusetts State Hazard Mitigation and Climate Adaptation Plan, extreme heat for Massachusetts is usually defined as a period of 3 or more consecutive days above 90 degrees Fahrenheit (°F), but more generally as a prolonged period of excessively hot weather, which may be accompanied by high humidity. Extreme cold is also considered relative to the normal climatic lows in a region.

More broadly, extreme temperatures can be defined as those that are far outside the normal ranges. The average highs and lows of the hottest and coolest months in the nearby town of Amherst, the closest site for which data was available, are provided in Table 8 below.

Table 8. Monthly Temperature Normals

	July (Hottest Month)	January (Coldest Month)
Average High (°F)	82.2	33.1
Average Low (°F)	59.2	23.1

Source: NOAA NWS, 2020. Monthly Climate Normals (1981 – 2010) Amherst, MA

The highest temperature recorded at the Amherst station for the period from 1893 to present[7] was 104°F on July 4, 1911 (NOAA NOW Data, Boston / Norton Weather Forecast Office, https://w2.weather.gov/climate/xmacis.php?wfo=box).

Projected temperature extremes will shift with climate change, according to research conducted by the Massachusetts Executive office for Energy and Environmental Affairs and the University of

[7] https://w2.weather.gov/climate/xmacis.php?wfo=box; https://www.ncdc.noaa.gov/extremes/scec/records

Massachusetts, Amherst. By 2050, summer maximum temperatures (including the presumed hottest month of July) are expected to reach as high as 87.7°F in the Connecticut River Basin, as opposed to a 1971-2000 baseline of 80.2°F (resilientma.org).

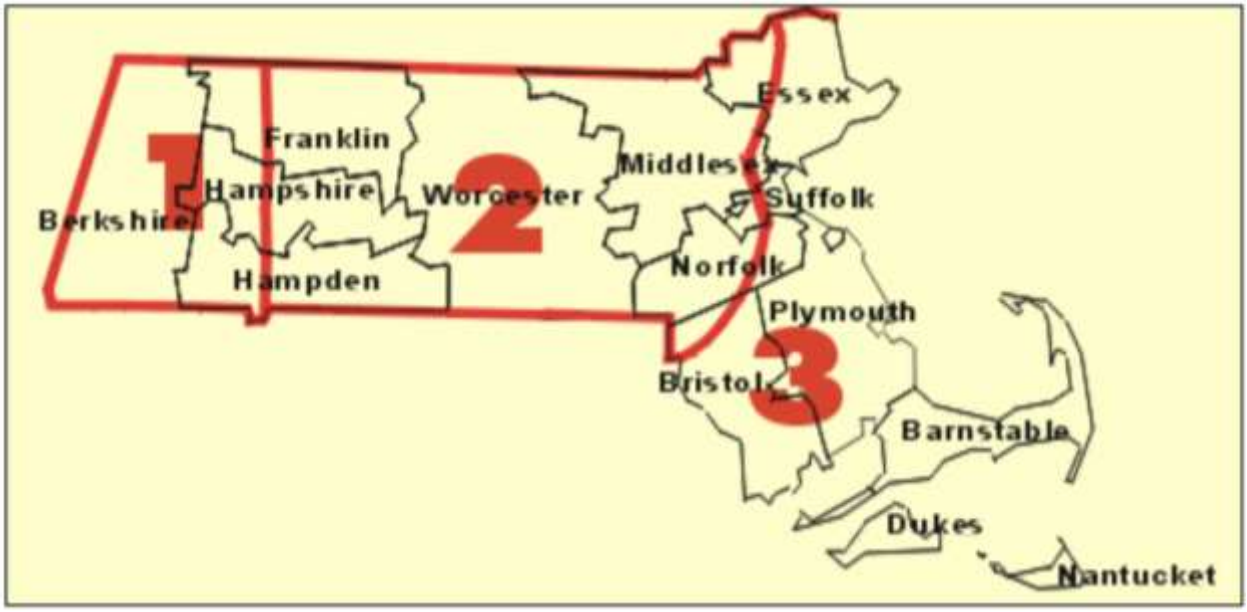
Extreme cold events are when temperatures drop well below normal in an area. Generally, extreme cold temperatures are characterized by the ambient air temperature dropping to or below 0 degrees Fahrenheit (ºF) (National Weather Service [NWS] 2015). When winter temperatures drop significantly below normal, staying warm and safe can become a challenge. Extremely cold temperatures may accompany or follow a winter storm, which may also cause power failures and icy roads. Many homes will be too cold, either due to a power failure or because the heating system is not adequate for the weather. Extensive exposure to extreme cold temperatures can cause frostbite or hypothermia and can become life-threatening.

Extreme heat is defined by the Center for Disease Control (CDC) as temperatures which hover 10 degrees or more above the average high temperature for a region and that last for several weeks (CDC 2016). Heat waves cause more fatalities in the U.S. than the total of all other meteorological events combined. Since 1979, more than 9,000 Americans have died from heat-related ailments (EPA, 2016). In Massachusetts, a heat wave is defined as 3 or more days of temperatures of 90°F or above and is often accompanied by high humidity. The designation implies an extended period of unusually high atmosphere-related heat stress, which forces affected populations to make temporary modifications in lifestyle to avoid adverse health consequences (MA HMCAP, 2018).

Location

NOAA divides Massachusetts up into three climate divisions - Western, Central, and Coastal – and average annual temperatures vary slightly over the divisions. Another distinction between the divisions is that extreme temperature events occur more frequently and vary more in the inland regions where temperatures are not moderated by the Atlantic Ocean. Northampton sits along the western edge of the Central Division, with annual average temperatures of around 49°F.

Figure 1. Climate Divisions of Massachusetts



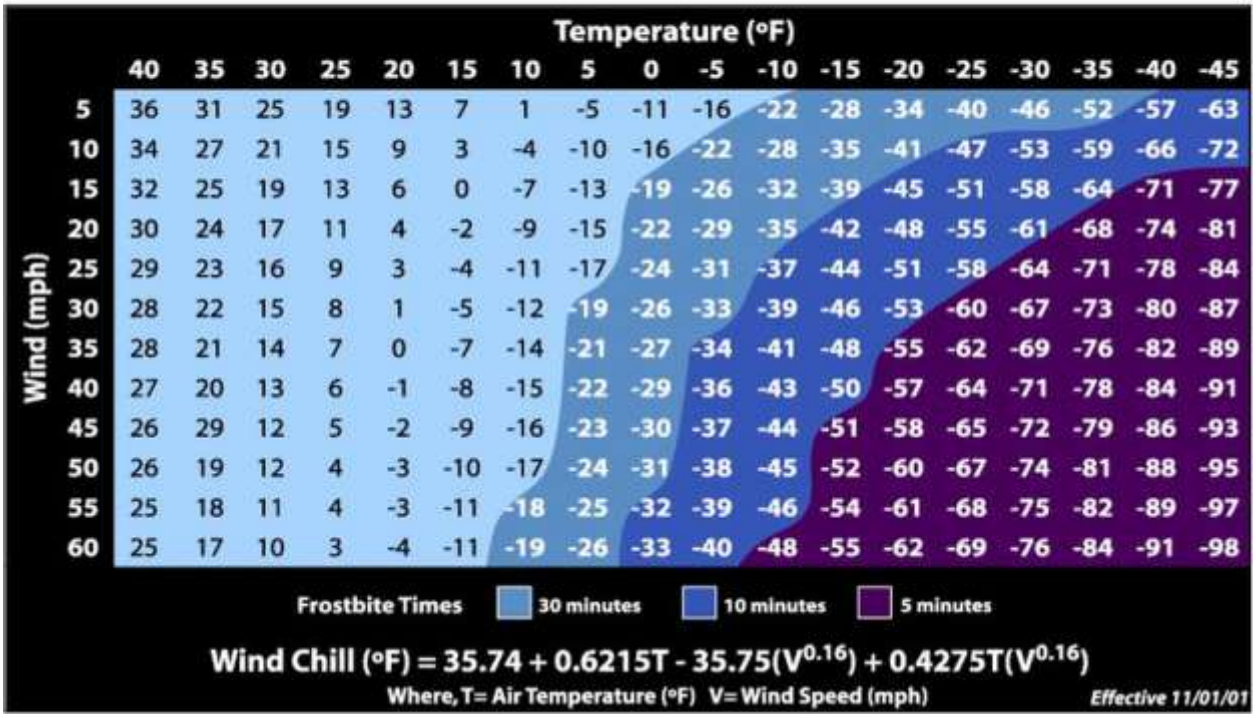
Source: NOAA, n.d.

Extreme temperatures would affect the whole community in Northampton, resulting in a "large" location of occurrence, or more than 50 percent of total land area affected.

Extent

The extent (severity or magnitude) of extreme cold temperatures are generally measured through the Wind Chill Temperature (WCT) Index. Wind Chill Temperature is the temperature that people and animals feel when outside and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. The chart shows three shaded areas of frostbite danger. Each shaded area shows how long a person can be exposed before frostbite develops. In Massachusetts, a wind chill warning is issued by the NWS Taunton Forecast Office when the Wind Chill Temperature Index, based on sustained wind, is –25ºF or lower for at least three hours. The WCT is presented in Figure 2.

Figure 2. NWS Wind Chill Index

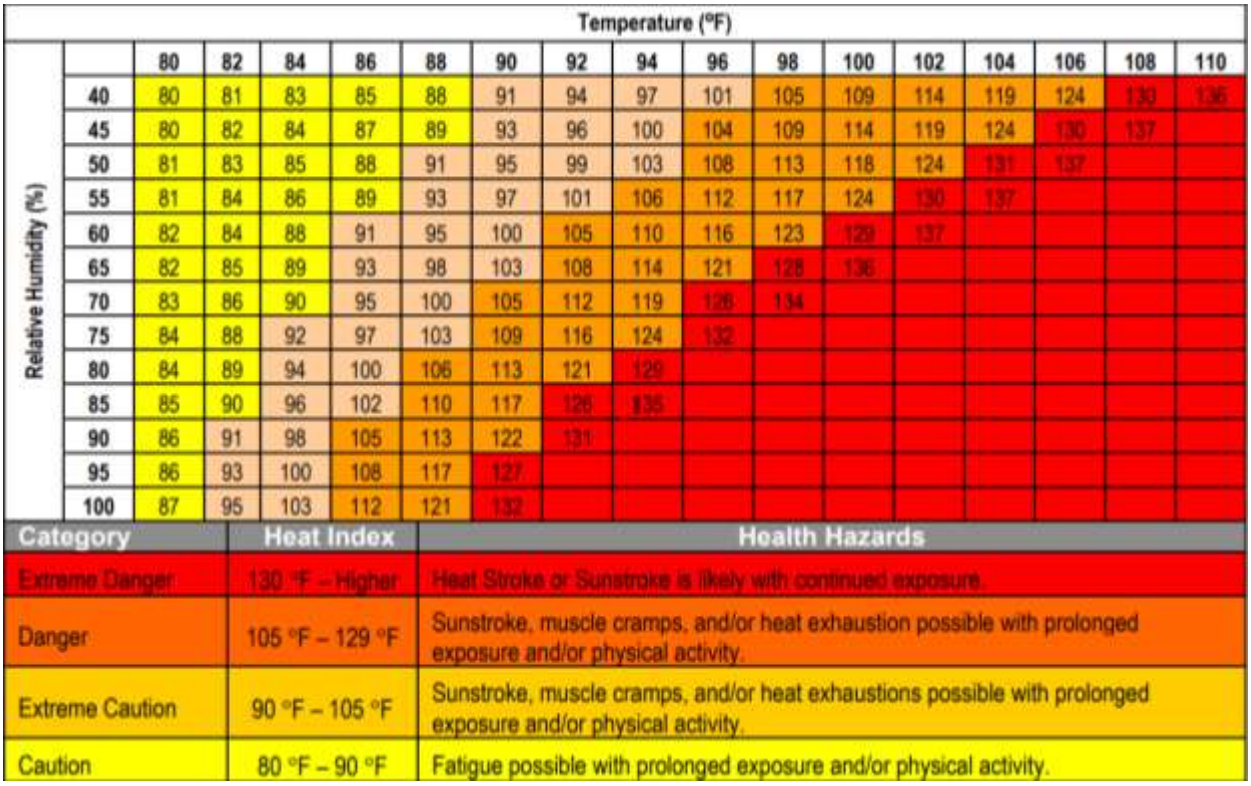


Wind (mph)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29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

Source: NWS 2018

The NWS Heat Index is used to measure extremely hot temperatures, combining relative humidity with actual air temperature to determine the risk to humans. The NWS issues a Heat Advisory when the Heat Index is forecast to reach 100-104°F for 2 or more hours, and an Excessive Heat Warning if the Heat Index is forecast to reach 105°F or higher for 2 or more hours. The chart in Figure 3 indicates the relationship between heat index and relative humidity and illustrates the adverse effects that prolonged exposure to heat and humidity can have on an individual.

Figure 3. NWS Heat Index Chart



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

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

Source: National Weather Service (NWS), Heat Index, 2018

According to recent downscaled climate projections for Massachusetts, high, low, and average temperatures in Hampshire County are likely to increase significantly over the next century as a result of climate change (resilient MA, 2019). This gradual change will put long-term stress on a variety of social and natural systems, and will exacerbate the influence of discrete events. In the event of an extreme cold or heat event, multiple injuries and health impacts would be possible. Therefore, the extent of this hazard is critical.

Previous Occurrences

The following are the lowest temperatures recorded in parts of Massachusetts for the period from 1895 to present according to NOAA's State Climate Extremes Committee (SCEC):

- Taunton: -35°F, January 5, 1904
- Coldbrook: -35°F, February 15, 1943
- Chester: -35°F, January 12, 1981

Since 1994, there have been 33 cold weather events within the Commonwealth, ranging from Cold/Wind Chill to Extreme Cold/Wind Chill events. In February 2015, a series of snowstorms piled up to 60 inches in some areas in 3 weeks and caused recurrent blizzards across eastern Massachusetts. Temperature gauges across the Commonwealth measured extreme cold, with wind chills as low as 31°F. Four indirect fatalities occurred as a result of this event: two adults died shoveling snow and two adults

were hit by snowplows. In February 2016, one cold weather event broke records throughout the state. Extreme cold/wind chill events were declared in 16 climate zones across the Commonwealth (MASHMCAP, 2018).

According to the NOAA's Storm Events Database, there were 43 heat events (ranging from Record Warmth/Heat to Excessive Heat events) in Massachusetts between 1995 and 2018, the most recent of which occurred in July 2013. Whenever the heat index values meet or exceed locally or regionally established heat or excessive heat warning thresholds, an event is reported in the database. In 2012, Massachusetts temperatures broke 27 heat records. Most of these records were broken between June 20 and June 22, 2012, during the first major heat wave of the summer to hit Massachusetts and the East Coast. In July 2013, a long period of hot and humid weather occurred throughout New England. One fatality occurred on July 6, when a postal worker collapsed as the Heat Index reached 100°F (MASHMCAP, 2018). None of these events was known to impact individuals in Northampton.

The lowest temperature recorded at the Barnes Municipal Airport in Westfield for the period from 1893 to present was -30°F on January 22, 1961 (NOAA NOW Data, Boston / Norton Weather Forecast Office, https://w2.weather.gov/climate/xmacis.php?wfo=box).

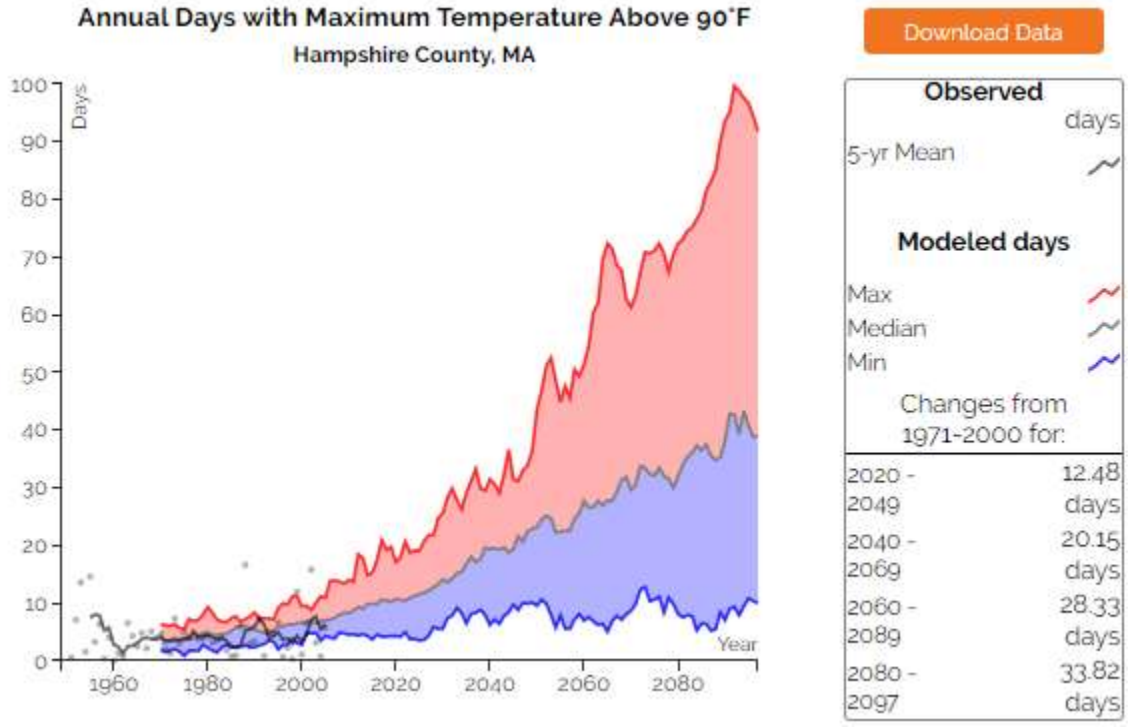
Between 1954 and 2019, Hampshire County was not included in any FEMA declared extreme temperature-related disasters (DR) or emergencies (EM).

Probability of Future Events

The NE CASC data support the trends of an increased frequency of extreme hot weather events and a decreased frequency of extreme cold weather events. Figure 4 and

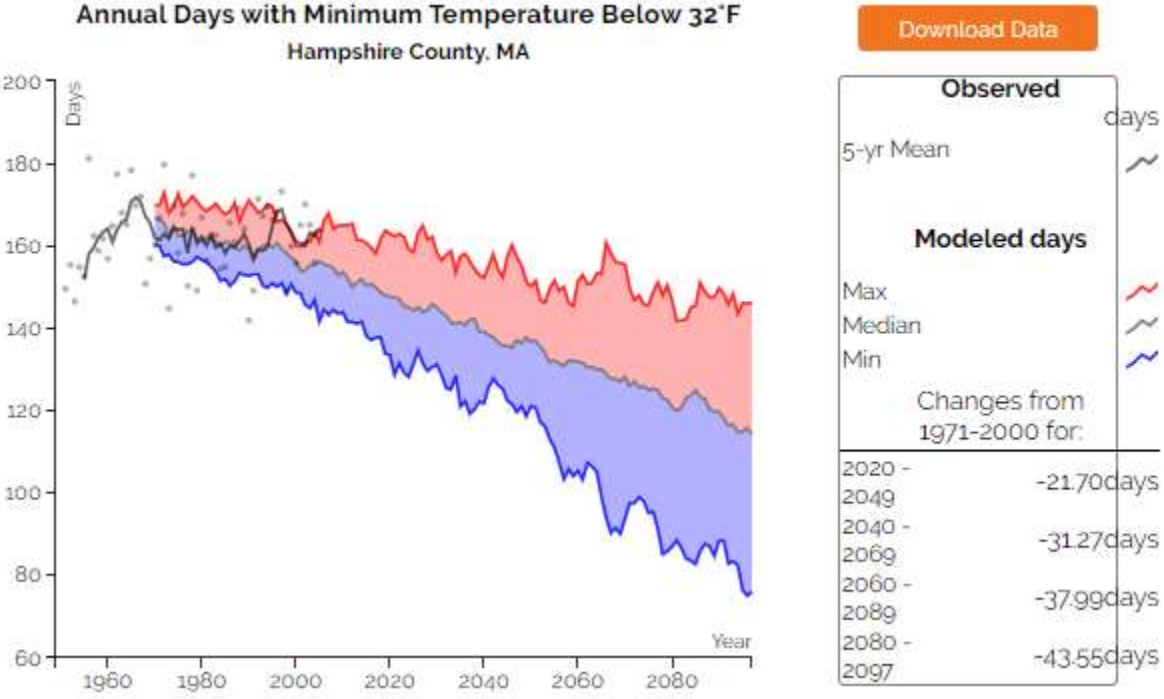
Figure 5 show the projected changes in these variables between 2020 and the end of this century.

Figure 4. Projected Annual Days with Temperature Above 90°F



Source: resilient MA, 2019

Figure 5. Projected Annual Days with Temperature below 32°F



Source: resilient MA, 2019

The probability of future extreme heat and extreme cold is considered to be "high," or between 40 and 70 percent in any given year.

Secondary Hazard

According to the 2018 SHMCAMP, the most significant secondary hazard associated with extreme temperatures is a severe weather event. Severe heat events are often associated with drought, as evaporation increases with temperature, and with wildfire, as high temperatures can cause vegetation to dry out and become more flammable. Warmer weather will also have an impact on invasive species (see Invasive Species section below for additional detail). More commonly, heat events contribute to poor air quality that can exacerbate asthma and result in an increase in emergency department visits.

Conversely, extreme cold events are primarily associated with severe winter storms. The combination of cold weather with severe winter storm events is especially dangerous because winter weather can knock out heat and power, increasing exposure to extreme cold temperatures. Loss of heat and power may also lead to carbon monoxide poisoning from inappropriate use of combustion-powered generators, heaters, and cooking appliances, and heavy snowfall may block vents for gas dryers and heaters. Similarly, prolonged exposure to extreme heat can compromise power infrastructure, leaving customers without power or the ability to operate air conditioning. Power failure leads to increased use of diesel generators for power and more wood stoves are used in extreme cold; both situations lead to increasing air pollution and health impacts.

Impact

In the event of an extreme cold or heat event, multiple injuries and health impacts would be possible. As shown in Figure 3 above, the NWS Heat Index chart describes the impacts of extreme high temperatures when coupled with higher humidity levels (which are characteristic of the Pioneer Valley region) as follows:

- Extreme Danger: Heat stroke likely.
- Danger: Sunstroke, muscle cramps, and/or heat exhaustion likely. Heatstroke possible with prolonged exposure and/or physical activity.
- Caution: Fatigue possible with prolonged exposure and/or physical activity.
- Since heat index values were devised for shady, light wind conditions, exposure to full sunshine can increase heat index values by up to 15°F.

According to recent downscaled climate projections for Massachusetts, high, low, and average temperatures in Hampshire County are likely to increase significantly over the next century as a result of climate change (resilient MA, 2019), as are the occurrences of days over 90°F, 95°F, and 100°F. This pattern change will put long-term stress on a variety of social and natural systems, and will exacerbate the influence of discrete events. Multiple instance of heat stress could occur during any given extreme heat event, and therefore, the City faces a “Limited” impact from extreme temperatures.

Vulnerability

Extreme temperature can have a significant impact to human health, commercial/agricultural business

Population

Extensive exposure to extreme cold temperatures can cause frostbite or hypothermia and can become life-threatening. Extreme cold and extreme heat are dangerous situations that can result in health emergencies for individuals without shelter or some other way to stay cool, or who live in homes that are poorly insulated, or without adequate heat or air conditioning. Power outages may also result in inappropriate use of combustion heaters and other appliances, as discussed under Secondary Impacts above.

Extreme heat events can also contribute to a worsening of air quality, as high temperatures increase the production of ozone from aerosols such as volatile organic compounds. Weather patterns that bring high temperatures can also transport air pollutants from other areas of the continent. Additionally, atmospheric inversions and low wind speeds associated with heat waves allow polluted air to remain in one location for a prolonged period of time (UCI, 2017).

According to the 2018 SHMCAP, the interaction of heat and cardiovascular disease caused approximately 25 percent of the heat related deaths since 1999. Other vulnerability indicators relative to extreme heat are presented in Table 9.

Table 9. General Vulnerability Indicators

Location	Estimated Increase in Average Temperature by 2100 (°F)	Proportion of Population Aged 65 or Older	Proportion of Population Aged Younger than 5 Years	Proportion of the Population Living Below Poverty Level
Hampshire County	+5.23 to +9.63°	17.2%	3.4%	11.1%
Northampton	N/A	16.6% (1)	3.6% (1)	16.1% (1)

Notes: U.S. Census Bureau Quick Facts, Hampshire County, MA. 2019.

(1) 2019 American Community Survey states that estimates are not comparable to other geographic levels due to methodology differences that may exist between different data sources.

Built Environment

With the exception of power infrastructure, most structures and infrastructure within the City are not at risk for damage due to extreme temperatures, but populations that are not prepared to contend with these temperature extremes could be most vulnerable. However, extreme cold temperature events can damage buildings through freezing or bursting pipes and freeze and thaw cycles. Furthermore, secondary impacts of this hazard include extreme temperature fluctuations, which have serious implications for transportation infrastructure life-span and maintenance needs.

Natural Resources

Individual extreme temperature events usually have a limited long-term impact on natural systems, although unusual frost events occurring after plants begin to bloom in the spring can cause significant damage. However, changing average temperatures and the changing frequency of extreme climate events will likely have a major impact on natural resources throughout the Commonwealth and worldwide (2018 SHMCAP).

Changing temperatures will impact the natural environment in many ways. Because the species that exist in a given area have adapted to survive within a specific temperature range, extreme temperature events can place significant stress both on individual species and the ecosystems in which they function.

Massachusetts ecosystems that are expected to be particularly vulnerable to warming temperatures include:

- Coldwater streams and fisheries
- Vernal pools
- Spruce-fir forests
- Northern hardwood (Maple-Beech-Birch) forests, which are economically important due to their role in sugar production
- Hemlock forests, particularly those with the hemlock woolly adelgid
- Urban forests, which will experience extra impacts due to the urban heat island effect (2018 SHMCAP)

Additional impacts of warming temperatures include the increased survival and grazing damage of white-tailed deer, increased invasion rates of invasive plants, and increased survival and productivity of insect pests, which cause damage to forests.

Economy

Extreme temperatures can impact a municipal and regional economy in various ways. Northampton business owners may be faced with increased financial burdens due to unexpected building repairs (e.g., repairs for burst pipes), higher than normal utility bills, or business interruptions due to power failure (i.e., loss of electricity and telecommunications). There is a loss of productivity and income when the transportation sector is impacted and people and commodities cannot get to their intended destination. Employers with outdoor workers (such as agricultural and construction companies) may have to reduce employees' exposure to the elements by reducing or shifting their hours to cooler or warmer periods of the day – these shifts can impact the earnings of both the company and the individual employee.

The agricultural industry is most directly at risk in terms of economic impact and damage due to extreme temperature and drought events. Extreme heat can result in drought and dry conditions, which directly impact livestock and crop production (2018 SHMCAP) and also have adverse impacts on outdoor entertainment and dining, an important part of Northampton's downtown economy.

Wildfires / Brushfires

Hazard Description

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

FEMA has classifications for 3 different classes of wildfires:

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

Location

While Northampton is a city with a dense, well-defined downtown, it still contains several thousand acres of largely undeveloped space. The rural-urban interface is most pronounced in those sections of city that are experiencing development, most notably Florence and Leeds. The total amount of city that could be affected by wildfire is categorized as "medium," at between 10 percent to 50 percent of the total area.

Extent

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

Approximately 1,150 acres of land in Northampton is forested according to MassGIS 2016 Land Cover/Land Use[8] data and is therefore at risk of fire. Forested areas in Northampton cover many of the city's outlying areas, which can be remote and difficult for emergency crews to access. In drought conditions, a brushfire or wildfire would be a matter of concern. A large wildfire could damage much of the land mass, including vital watershed lands, in a short period of time.

As described in the next section describing previous occurrences of wildfire, there have not been any major wildfires recorded in Northampton. However, based on other major wildfires that have occurred in western Massachusetts, it is estimated that such a fire would likely destroy around 50 to 500 acres of forested area.

[8] MassGIS Data: 2016 Land Cover/Land Use, 2020

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

Extent of Wildfires

Rating	Basic Description	Detailed Description
CLASS 1: Low Danger (L) **Color Code: Green**	Fires not easily started	Fuels do not ignite readily from small firebrands. Fires in open or cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
CLASS 2: Moderate Danger (M) **Color Code: Blue**	Fires start easily and spread at a moderate rate	Fires can start from most accidental causes. Fires in open cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel – especially draped fuel -- may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
CLASS 3: High Danger (H) **Color Code: Yellow**	Fires start easily and spread at a rapid rate	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.
CLASS 4: Very High Danger (VH) **Color Code: Orange**	Fires start very easily and spread at a very fast rate	Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics - such as long-distance spotting - and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
CLASS 5: Extreme (E) **Color Code: Red**	Fire situation is explosive and can result in extensive property damage	Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the Very High Danger class (4). Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks, until the weather changes or the fuel supply lessens.

Previous Occurrences

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

Few wildfires have been recorded in the past 100 years in the Pioneer Valley, and none has ever resulted in a FEMA disaster declaration. During the past 100 years, there have not been many wildfires occurring in the Pioneer Valley. However, several have occurred during the past 20 years, as shown in the list below:

- 1995 – Russell, 500 acres burned on Mt. Tekoa
- 2000 – South Hadley, 310 acres burned over 14 days in the Litihia Springs Watershed
- 2001 – Ware, 400 acres burned
- 2010 – Russell, 320 acres burned on Mt. Tekoa
- 2012 – Eastern Hampden County, dry conditions and wind gusts created a brush fire in Brimfield, and burned 50 acres
- 2016 - Montgomery, 60 acres burned on Mt. Tekoa (MA HMP, 2013)

As a point of reference, the total number of any type of fire incidence in Northampton for the years 2013-2017 is provided below. The "Total # of Incidents" includes structural and vehicle fires, while incidents classified as "other" could include, but do not necessarily include, brush fires. The Northampton Fire Department responds to house fires and the few "wildfires" that occur.

Table 10. Total Fire Incidents in Northampton

Year	Total # of Incidents	"Other Fires"
2013	81	36
2014	67	36
2015	67	36
2016	73	28
2017	57	18

Source: Massachusetts Fire Incidence Reporting System, County Profiles, 2017 Fire Data Analysis and Annual Fact Sheets, https://www.mass.gov/service-details/fire-data-and-statistics

There are no other records, authenticated or anecdotal, of wildfires in Northampton.

Probability of Future Events

In accordance with the Massachusetts Hazard Mitigation Plan, the Northampton Hazard Mitigation Committee found it is difficult to predict the likelihood of wildfires in a probabilistic manner because of the number of variables involved. Research has found that the frequency of lightning strikes – an

occasional cause of wildfire – could increase by approximately 12 percent for every degree Celsius of warming (2018 SHMCAP). However, even with the increased lightning risks, based on previous occurrences, the Committee determined the probability of future events to be "low" (1 percent to 10 percent probability in the next year).

Climate scenarios project summer temperature increases between 3.2ºF and 7.3ºF and fall precipitation decreases of up to 11 percent by 2050 in Northampton. Such conditions would exacerbate summer drought and further promote high-elevation wildfires, releasing stores of carbon and further contributing to the buildup of greenhouse gases. Forest response to increased atmospheric carbon dioxide—the so-called "fertilization effect"—could also contribute to more tree growth and thus more fuel for fires, but the effects of carbon dioxide on mature forests are still largely unknown.

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

Impact

While a large wildfire could damage much of the landmass of Northampton, these areas are not populated by people, meaning that wildfire affected areas are not likely to cause damage to property. For this reason, the City faces a "minor" impact from wildfires, with very few damages likely to occur.

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

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

Vulnerability

Based on the above assessment, Northampton has a hazard risk index of "4 – low risk" from wildfires.

Using a total value of all structures in Northampton of $2,742,056,662 and an estimated 50 percent of damage to 1 percent of all structures, the estimated amount of damage from a forest fire is $13,710,283. The cost of repairing or replacing the roads, bridges, utilities, and contents of structures is not included in this estimate.

Population

Human health and the lives of residents and responders are at risk from wildfire. The most vulnerable populations include emergency responders and those within a short distance of the interface between the built environment and the wildland environment.

Built Environment

For the purposes of this planning effort, all elements of the built environment located near forested areas are considered exposed to the wildfire hazard.

Critical facilities are particularly important for routine town operation and emergency response in case of a severe wildfire. Energy distribution lines are subject to wildfire risk because most poles are made of wood and susceptible to burning. Transmission lines are also at risk to faulting during wildfires, which can result in a broad area outage.

Natural Resources

Fire can serve important ecological purposes as a natural part of many ecosystems. Functions include facilitating the nutrient cycling from dead and decaying matter, removing diseased plants and pests, and regenerating seeds or stimulating germination of certain plants. This is an important part of the cycle in the very limited Pine Barrens section of Northampton, which developed with a fire ecology. Conversely, wildfires can also have significant negative impacts on the environment. Specifically, the ash they generate can distort the flow of nutrients through an ecosystem, reducing the biodiversity that can be supported and adding to stream and waterbody sedimentation and eutrophication.

Economy

The initial loss of structures and the subsequent loss of revenue from destroyed businesses from a wildfire can have major economic impacts on a community. Individuals and families will face economic challenges if their home is impacted by wildfire. The exposure of homes to this hazard is widespread. According to the characterization of wildland hazard areas by Radeloff et al., the Massachusetts intermix hazard area contains 476,934 housing units (or approximately 17 percent of the total housing units in the Commonwealth). The interface hazard area contains 715,209 housing units (or approximately 26 percent of the total housing units in the Commonwealth).

Invasive Species

Hazard Description

Invasive species are non-native species that threaten and damage local ecosystems, economies, and/or public health (NISC 2006). The Massachusetts Invasive Plant Advisory Group (MIPAG), a collaborative representing organizations and professionals concerned with the conservation of the Massachusetts landscape, is charged by EOEEA to provide recommendations to the Commonwealth to manage invasive

species. MIPAG defines invasive plants as "non-native species that have spread into native or minimally managed plant systems in Massachusetts, causing economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems" (MIPAG, n.d.).

Invasive terrestrial plants are the most studied and managed typed of invasive, but invasive insects are also relevant to Northampton. In all cases, these species have biological traits that provide them with competitive advantages over native species, particularly because in a new habitat they are not restricted by the biological controls of their native habitat. As a result, these invasive species can monopolize natural communities, displacing many native species and causing widespread economic and environmental damage.

The spread of invasive species is primarily caused by human activity. Common examples include:

- Wood Products: Insects can get into wood, shipping palettes, and crates that are shipped around the world as well as travel in firewood.
- Ornamental Plants: Some ornamental plants can escape into the wild and become invasive.
- Pet Trade: Some invasive species start as pets that are intentionally or accidentally released.
- Climate change: Warmer temperatures place stress on cold-weather species, while allowing non-native species accustomed to warmer climates to spread northward. As rainfall and snowfall patterns change, certain habitats and species that have specific physiological requirements may be affected. The stresses experienced by native ecosystems as a result of these changes may increase the chances of a successful invasion of non-native species.

Invasive plant species such as Asian honeysuckles, bittersweet, Japanese barberry, Japanese knotweed, autumn olive, burning bush, multiflora rose, garlic mustard, and glossy buckthorn, are considered by the Massachusetts Department of Agricultural Resources, New England Wildflower Society, U.S. Forest Service, and others as some of the worst invaders in the region.

Non-native insects which currently threaten the region are the emerald ash borer (EAB), Asian longhorned beetle (ALB), Red Pine Scale, and hemlock wooly adelgid (HWA).

Emerald ash borer (EAB) is an exotic beetle that was discovered in southeastern Michigan in the summer of 2002. The larvae feed in the cambium between the bark and wood, producing S-shaped galleries that girdle and kill branches and trees. As of February 22, 2019, EAB had been confirmed in 51 Massachusetts cities in towns, including Northampton (MDAR, 2019).

The Asian longhorned beetle (Anoplophora glabripennis, or ALB) is a major threat to hardwood trees. The species has decimated tree stock in Worcester County, but has not yet spread to western Massachusetts.

Red Pine Scale (RPS) is an exotic invasive insect originating from Asai that only attacks Red Pine, one of North America’s only native pine species of “Eurasian” descent. RPS is a piercing, sucking insect that overtakes trees in large numbers, with tens of thousands of the tiny insects feeding on the inner bark of the tree’s crown. Red pine trees succumb quickly, and mortality can be hastened by compounding

threats such as attacks by bark beetles or periods of drought. The insect spread into MA in the 1990s and has decimated areas of watershed land in Northampton.

Hemlock woolly adelgid, a small aphid-type insect, was introduced into Massachusetts in 1988 from an already existing infestation in Connecticut. The critter attacks both the Carolina and Eastern hemlock and is capable of severely weakening and killing its host plants. It is atypical of most insect species in the Northeast in that it is inactive for much of the growing season and very active throughout the winter. Hemlock wooly adelgid is currently present in the region, and has been positively identified on a number of conservation lands in Northampton.

Location

Invasive species can travel far distances (either via natural mechanisms or accidental human interference) and therefore can propagate rapidly over a large geographic area, often with no natural predators. Open freshwater ecosystems generally don't have physical barriers to prevent establishment (outside of physiological tolerances) so invasive species can quickly spread once introduced, and find myriad opportunities for transport to new locations (by boats, for example).

In general, invasive species are most threatening to native or minimally managed ecosystems in Northampton. This includes many of the rivers and streams throughout the City, conservation lands, as well as the City's water supply watershed land serving reservoirs in Williamsburg, Whately and Conway. The total amount of City land that could be impacted by invasive species is categorized as "medium," between 10 percent to 50 percent of the total area.

"Hemlock woolly adelgid remains the single greatest threat to the health and sustainability of hemlock as a forest resource in the eastern United States. This nonnative pest has impacts comparable to those of the gypsy moth, Dutch elm disease, and chestnut blight. It has the potential to remove a major ecological component from eastern forest that is important for maintaining clean water and supporting wildlife."

USDA Hemlock Woolly Adelgid Coordinated Commitment to Improved Management and Restoration of Hemlock: 2014-2018

Extent

Many invasive species have been identified in Northampton. On just one of the many conservation properties in Northampton alone, the Barrett Street Marsh, there were more than a dozen invasive plant species identified in 2019 including Japanese barberry, glossy buckthorn, and multi-flora rose, all mentioned above, as well as Norway maple, black locust, common buckthorn, Morrow's honeysuckle, privet, Japanese knotweed, garlic mustard, moneywort, lesser celandine, yellow iris, purple loosestrife, Asiatic bittersweet, tansy, sweet cherry, and Japanese maple.

Invasive insect species are also documented throughout the City, and those known to be present are also having the greatest impact on conservation areas and other forested tracts. Hemlock woolly adelgid has weakened large stands hemlocks throughout Massachusetts and similarly led to

declining health of hemlocks trees across the City. The Asian longhorned beetle has the potential to cause more damage than Dutch elm disease, chestnut blight and gypsy moths combined, destroying millions of acres of America's treasured hardwoods, including national forests and backyard trees. With no current cure, early identification and eradication are critical to its control. The Emerald ash borer causes the most amount of damage to ash trees in its larval stage. Heavily infested trees exhibit canopy dieback, beginning at the top of the tree. When emerald ash borer populations are high, small trees can die within 1-2 years of initial infestation, while larger trees may take 3-4 years before succumbing to this pest.

A full list of "Invasive" terrestrial, freshwater, and marine species are available on the MIPAG website (last updated April 2016) https://www.massnrc.org/mipag/speciesreviewed_category.htm and in the 2018 SHMCAP, which also includes details on the nature of the ecological and economic challenges presented by each species as well as information on when and where the species was first detected in Massachusetts. Despite the presence of these species, their impacts have not been clearly recorded. Anticipated impacts include increased tree mortality leading to more downed trees and power outages during storm events.

Other species, while not yet well established in the region, are of particular concern to human health. These include species like the Asian tiger mosquito (Aedes albopictus). This invasive mosquito, originally from southeast and subtropical Asia has moved through the Eastern U.S. and has recently arrived in Massachusetts. Capable of spreading West Nile Virus, Equine Encephalitis, Zika, and numerous other tropical diseases, this aggressive mosquito is likely range-limited by cold winter temperatures, suitable landscape conditions (it prefers urban areas), and variation in moisture. As winter temperatures increase, the species is likely to become more prevalent in Massachusetts and throughout the Northeast, increasing the risk of serious illness for residents in summer months.

Based on current understanding of the impact and previous occurrences, the extent of significant impacts Northampton will likely suffer from invasive species in the short term is Limited.

Probability of Future Events

Changes in temperature and precipitation may increase chances of a successful invasion of non-native species. To become an invasive species, the species must first be transported to a new region, colonize and become established, and then spread across the new landscape. Climate change may impact each stage of this process. Species may shift their ranges north as the climate warms and be successful in regions they previously had not colonized. Invasives may also be able to spread more rapidly in response to climate change, given their high dispersal rates and fast generation times. These faster moving species may be at a competitive advantage if they can move into new areas before their native competitors.

Here in the Northeast, observed and projected warming conditions are particularly concerning for some invasives because species ranges in temperate regions are often limited by extreme cold temperatures or snowfall, both of which we will see less of in coming decades. There is concern that aquatic species,

such as hydrilla (Hydrilla verticillata) and water hyacinth (Eichhornia crassipes), may be able to survive and overwinter in Massachusetts with increased temperatures and reduced snowfall. Nutria (Myocastor coypus), large, non-native, semi-aquatic rodents that are currently established in Maryland and Delaware, are likely to move north with warming temperatures - perhaps as far as Massachusetts.

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

In many cases, efforts to control invasive species growth are met by opposition either from natural processes or social factors. As an example, Northampton has management plans for its watershed forests, and these plans guide a number of efforts to regenerate native flora and mitigate the spread of invasive plant species. However, much of the forest regeneration that does occur is promptly browsed by deer (and to a lesser extent, moose). Recommended actions for addressing this issue include exploring ways to control the deer population, or exploring ways to reduce deer access to recently harvested areas, but these are politically fraught issues.

Given these considerations, and the fact that some invasive species are already present in Northampton, the frequency of occurrence and annual probability of this hazard is High.

Impact

Invasive species in Northampton will not likely contribute directly to injuries, significant property damage, or facility shutdown and therefor the impact is deemed “Minor.” However, while the impacts of invasive species may not be as direct as the impacts of other natural hazards in Northampton, our changing climate is creating an environment in which invasive species could become more of a widespread threat. Anticipated impacts of declining tree health include more downed trees and subsequent power outages (due to weakened or dead trees falling on powerlines) during storm events. The hemlock woolly Adelgid, for instance, mainly damages varieties of Hemlock trees. Hemlock, like White Pine, is a foundation tree species, and when any foundation species experiences widespread illness and/or mortality they leave room for invasive plant species to take over, causing wildlife habitat and water quality decrease. Deer use healthy hemlock stands for winter shelter, so there could be a detrimental impact to the deer population, and hunting, caused by the loss of hemlock. Hemlocks provide shade to waterways, so their loss could mean warmer streams and lower water quality, potentially impacting aquatic life. The hemlock is not a comparatively very valuable wood product, but it is used for logging and wood products, so there are economic threats to its loss (Brrokline, 2017)[9].

[9] Brookline, VT, Hazard Mitigation Plan, 2017.

Another example of the impact is illustrated by Northampton's experience with large stands of red pine that died quickly and en mass. The City took on several significant logging contracts to remove dead and dangerous trees that threatened adjacent roadways and power lines. This clearing results in a prime opportunity for invasive plants to get established.

The impact of the emerald ash borer could be more significant. Ash logs are more valuable than hemlock logs, but the bigger concern with the loss of ash is the cascading ecological impacts. There are over 40 arthropod obligate species that are threatened by the loss of ash trees (they depend on ash for their survival), and ripple effects of the loss of these arthropods and the interrelationships aren't even fully known at this point. Ash is a valuable tree for wood products and logging, so the economic impacts on a regional scale could be severe. More locally, though, the cost to Northampton for removing dead or dying trees, and the aesthetic and community open space impacts caused by their loss could be significant.

Many invasive plants in Northampton threaten forest regeneration, and multi-flora rose and Asiatic bittersweet can destroy mature trees. Smaller invasive plants such as garlic mustard, purple loosestrife, and goutweed present a threat to native herbaceous plants. Jeffrey Ward, Chief Scientist at the Connecticut Agricultural Experiment Station, described the health threat posed by Japanese barberry as a forest infested with Japanese barberry harbors an average of 120 black-legged ticks per acre while a forest without barberry harbors an average of only 10 black-legged ticks per acre. Black-legged ticks are known to transmit the causal agents of several diseases, including Lyme disease[10].

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

Vulnerability

Populations

Invasive species can also directly or indirectly cause harm to human health. Some invasive plant species like giant hogweed and wild parsnip have phytophototoxic properties, meaning direct contact of their sap with human skin can cause a chemical reaction that makes skin hypersensitive to ultraviolet light. Another example is that of Japanese barberry, which has been proven to increase the incidence of Lyme disease by providing sheltered habitat that increases the abundance of small rodents, which act as hosts to the ticks that carry Lyme disease pathogens (https://mnfi.anr.msu.edu/invasive-species/JapaneseBarberryBCP.pdf).

[10] Ibid

In Northampton, tree mortality resulting from invasive species infestation can lead to blocked roads and downed powerlines, as well as increased erosion, wildfire risk, and tree clearing expenses.

Natural Environment

Risk to native or minimally managed ecosystems has increased as dispersion of exotic species has increased. One of the greatest challenges facing Northampton in the management of invasive species is that many cannot be effectively eradicated (e.g., Japanese knotweed and bittersweet) without the use of herbicides. This has been the only way to effectively manage intrusion of invasive plant species on the flood control levies and in other locations throughout the City, creating a secondary hazard to local ecosystems if not correctly applied and to citizen opposition.

The Nature Conservancy reports that invasive species have contributed directly to the decline of 42% of the threatened and endangered species in the United States. Further, the annual cost to the U.S. economy is estimated at $120 billion per year, with more than 100 million acres suffering from invasive plant infestation. Freshwater ecosystems and estuaries are especially vulnerable to invasion, as these areas are very difficult to contain and reverse (the Nature Conservancy, https://www.nature.org/en-us/about-us/where-we-work/united-states/ohio/stories-in-ohio/invasive-species-protecting-native-plants-and-animals/).

Hurricane/ Tropical Storm

Hazard Description

Hurricanes and tropical storms are classified as cyclones and defined as any closed circulation developing around a low-pressure center in which the winds rotate counter-clockwise in the Northern Hemisphere (or clockwise in the Southern Hemisphere). The primary damaging forces associated with these storms are high-level sustained winds and heavy precipitation. Tropical cyclones (tropical depressions, tropical storms, and hurricanes) form over the warm, moist waters of the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico, and are classified into one of three categories:

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

Hurricanes are violent rainstorms with strong winds that can reach speeds of up to 200 miles per hour and which generate large amounts of precipitation. Hurricanes generally occur between June and November and can result in flooding and wind damage to structures and above-ground utilities.

Climate change increases the threat of hurricanes and severe wind as oceans and the atmosphere warms. Warmer water fuels more intense and longer-lasting storms and expands the area in which hurricanes can form. Warmer air can hold more moisture than cool air, increasing potential rainfall rates.

Location

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

Extent

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

Table 11. Hurricane Damage Classifications			
Storm Category	**Damage Level**	**Description of Damages**	**Wind Speed (MPH)**
1	MINIMAL Very dangerous winds will produce some damage	No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Also, some coastal flooding and minor pier damage. An example of a Category 1 hurricane is Hurricane Dolly (2008).	74-95
2	MODERATE Extremely dangerous winds will cause extensive damage	Some roofing material, door, and window damage. Considerable damage to vegetation, mobile homes, etc. Flooding damages piers and small craft in unprotected moorings may break their moorings. An example of a Category 2 hurricane is Hurricane Francis in 2004.	96-110
3	EXTENSIVE Devastating damage will occur	Some structural damage to small residences and utility buildings, with a minor amount of curtain wall failures. Mobile homes are destroyed. Flooding near the coast destroys smaller structures, with larger structures damaged by floating debris. Terrain may be flooded well inland. An example of a Category 3 hurricane is Hurricane Ivan (2004).	111-129
4	EXTREME Catastrophic damage will occur	More extensive curtain wall failures with some complete roof structure failure on small residences. Major erosion of beach areas. Terrain may be flooded well inland. An example of a Category 4 hurricane is Hurricane Charley (2004).	130-156
5	CATASTROPHIC Catastrophic damage will occur	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Flooding causes major damage to lower floors of all structures near the shoreline. Massive evacuation of residential areas may be required. An example of a Category 5 hurricane is Hurricane Andrew (1992).	157+

Source: National Hurricane Center, 2012

Previous Occurrences

Between 1954 and 2017, Hampshire County was included in 5 FEMA declared severe Hurricane/Tropical Storm-related disasters (DR) or emergencies (EM) classified as one or a combination of the following hazards: hurricane and tropical storm. Northampton may not have been impacted by all of these events.

According to NOAA's Historical Hurricane Tracks tool, there have been 30 hurricanes or tropical storms in recorded history that tracked within 65 miles of Northampton. They are shown in the following table.

These hurricanes and tropical storms did not cause any significant damage to Northampton.

Table 12. Major Hurricanes and Tropical Storms Affecting Northampton

Hurricane/Storm Name	Year	Saffir/Simpson Category (when reached study area)
Unnamed	1861	Tropical Storm
Unnamed	1863	Tropical Storm
Unnamed	1874	Tropical Storm
Unnamed	1888	Tropical Storm
Unnamed	1893	H1
Unnamed	1893	Tropical Storm
Unnamed	1894	H1
Unnamed	1934	Tropical Storm
Great Hurricane of 1938	1938	H3
Able	1952	Tropical Storm
Carol	1954	H3
Brenda	1960	Tropical Storm
Donna	1960	H1
Unnamed	1961	Tropical Storm
Doria	1971	Tropical Storm
Belle	1976	Tropical Storm
Gloria	1985	H1
Bertha	1996	Tropical Storm
Floyd	1999	Tropical Storm
Irene	2011	Tropical Storm

Source: NOAA National Hurricane Center, 2019

While Superstorm Sandy in late October of 2012 had severe impacts on much of the Northeastern United States, there was minimal damage that occurred due to the storm locally in Northampton. No roads were flooded or washed out. While shelters were opened temporarily in town, no residents encountered long-term displacement due to the storm's impacts. In nearby, more rural areas of western Massachusetts, there were modest impacts, with localized flooding and downed power lines. Overall, western Massachusetts was able to send emergency response resources to other states where the storm had a larger impact. [11]

No known hurricane or tropical storm events have impacted Northampton since the last HMP (between 2015 and 2020).

Probability of Future Events

Northampton's location in western Massachusetts reduces the risk of extremely high winds that are associated with hurricanes and tropical storms, although it can experience some high wind events. Based upon past occurrences, it is reasonable to say that there is a "moderate" probability (10 percent to 40 percent in any given year) of hurricanes or tropical in Northampton. Climate change is projected to result in more severe weather, including increased occurrence of hurricanes and tropical storms. Because of this, the occurrence of hurricanes will increase in the future.

Impact

A description of the damages that could occur due to a hurricane is described by the Saffir-Simpson scale, as shown in Table 11 above. The City faces a "limited" impact from hurricanes, with 10 percent or less of Northampton affected.

Vulnerability

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

Using a total value of all structures in Northampton of $2,742,056,622 and an estimated 10 percent of damage to 5 percent of all structures, the estimated amount of wind damage from a hurricane is $13,710,283. Estimating that flooding would create 10 percent of damage to 20 percent of structures, the resulting damage would be $54,841,132. The cost of repairing or replacing the roads, bridges, utilities, and contents of structures is not included in this estimate.

[11] "Western Massachusetts escapes Hurricane Sandy's wrath, but impact elsewhere still being felt." http://www.masslive.com/news/index.ssf/2012/10/western_massachusetts_escapes.html. October 30, 2012. Accessed March 6, 2015.

Populations

Populations unable to safely evacuate are most at risk during a Hurricane or Tropical Storm hazard. Low income populations may lack means to evacuate. The elderly often face physical challenges or require regular medical attention. Limited English proficiency populations may face challenges receiving and understanding emergency directions.

Built Environment and Economy

The entire town would be vulnerable to the impact of a hurricane or tropical storm. Hurricanes and tropical storms can result in power outages and road closures that impact emergency response. Heavy rains can lead to contamination of well water, septic system failure, and overburdened stormwater systems. Areas prone to flooding are particularly vulnerable. Additionally, high winds could impact the City's communication and energy infrastructure, and damage older buildings.

Sometimes, wind gusts of only 40 to 45 mph can cause scattered power outages from downed trees and wires. This is especially true after periods of prolonged drought, excessive rainfall, or insect damage, since all are situations that can weaken the root systems and branches and make them more susceptible to the winds' effects. Roads may become impassable due to downed trees or roadway flooding resulting from a severe wind or thunderstorm.

Natural Environment

High winds, flooding, and large quantities of debris can damage the natural environment through contamination of resources, felling trees, scouring riverbeds, and injury and mortality of animals.

Severe Winter Storm / Nor'easter

Hazard Description

Severe winter storms include ice storms, nor'easters, heavy snow, blowing snow, ice storms, and other extreme forms of winter precipitation.

Snow is characterized as frozen precipitation in the form of six-sided ice crystal. In order for snow to occur, temperatures in the atmosphere (from ground level to cloud level) must be at or below freezing. The strongest form of a severe snow storm is a blizzard. Blizzards are characterized by frequent wind gusts above 35 miles per hour, limited to no visibility due to falling snow and extreme cold that lasts longer than three hours.

Ice storms are liquid rain that falls and freezes upon contact with cold objects. There must be an ice build-up of greater than ¼ inch for it to be considered an ice storm. When more than a ½ inch of ice build-up is forecasted a winter storm warning can be triggered.

Nor'easters are among winter's most ferocious storms. They are characterized by a large counter-clockwise wind circulation around a low-pressure center, and are known for producing heavy snow, high winds, and rain. These storms occur most often in late fall and early winter.

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

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

New England generally experiences at least one or two severe winter storms each year with varying degrees of severity. Research on climate change indicates that there is great potential for stronger, more frequent storms as the global temperature increases. Severe winter storms typically occur during January and February; however, they can occur from late September through late April.

Location

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

Extent

Since 2005, the Regional Snowfall Index (RSI) has become the descriptor of choice for measuring winter events that impact the six climactic regions in the eastern two-thirds of the U.S. The RSI ranks snowstorm impacts on a scale system from 1 to 5 as depicted in the table below. The RSI is similar to the scale used to measure tornadoes (Fujita) or hurricanes (Saffir-Simpson), with the added benefit of considering population as a variable. The RSI is based on three factors: the spatial extent of the storm, the amount of snowfall, and population (NOAA, n.d.). As a regional index, the RSI incorporates region-specific parameters and thresholds for calculating a storm's category. Snowfall thresholds in Massachusetts (in the Northeast region) are 4, 10, 20, and 30 inches of snowfall, while thresholds in the Southeast U.S. are 2, 5, 10, and 15 inches.

Regional Snowfall Index Categories, Corresponding RSI Values, and Description

Category	RSI Value	Description
1	1—3	Notable
2	3—6	Significant
3	6—10	Major
4	10—18	Crippling
5	18.0+	Extreme

Source: NCDC, n.d.

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

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

Northeast Snowfall Impact Scale Categories		
Category	**NESIS Value**	**Description**
1	1—2.499	Notable
2	2.5—3.99	Significant
3	4—5.99	Major
4	6—9.99	Crippling
5	10.0+	Extreme

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

The Sperry-Piltz Ice Accumulation (SPIA) Index (below) is a prediction tool (algorithm) that can be used in conjunction with National Weather Service data to predict the impact of winter weather in terms of ice damage. It is currently being tested by the National Weather Service and FEMA in several regions with potential implementation in the future. In the meantime, the index provides an outline of the potential damage impacts of ice storms based on accumulation and wind.

The Sperry-Piltz Ice Accumulation (SPIA) Index	
Ice Damage Index	**Damage and Impact Descriptions**
0	Minimal risk of damage to exposed utility systems; no alerts or advisories needed for crews, few outages.
1	Some isolated or localized utility interruptions are possible, typically lasting only a few hours. Roads and bridges may become slick and hazardous.
2	Scattered utility interruptions expected, typically lasting 12 to 24 hours. Roads and travel conditions may be extremely hazardous due to ice accumulation.
3	Numerous utility interruptions with some damage to main feeder lines and equipment expected. Tree limb damage is excessive. Outages lasting 1-5 days.
4	Prolonged and widespread utility interruptions with extensive damage to main distribution feeder lines and some high voltage transmission lines/structures/ Outages lasting 5-10 days.
5	Catastrophic damage to entire exposed utility systems, including both distribution and transmission networks. Outages could last several weeks in some areas. Shelters needed.

Source: http://www.spia-index.com/images/SPIAIndexDescription.png

The extent of a severe winter storm event would be "Critical," with 25 percent or more of property in the affected area damaged, multiple injuries possible, and a complete shutdown of facilities for more than one week.

Previous Occurrences

There is significant overlap between winter weather disasters and other types of disaster, such as flooding. Based on data available from the National Oceanic and Atmospheric Administration, there were 27 winter storms in the Northeast Urban Corridor since 2010 that have registered on the NESIS scale. Of these, approximately 13 storms resulted in snow falls of at least 10 inches in the Pioneer Valley. These storms are listed in Table 13 in order of their NESIS severity.

Table 13. Winter Storms Producing Over 10 inches of Snow in Northampton, 1958-2018

Date	NESIS Value	NESIS Category	NESIS Classification
3/12/1993	13.2	5	Extreme
1/21/2005	6.8	4	Crippling
2/15/2003	7.5	4	Crippling
2/10/1983	6.25	4	Crippling
1/19/1978	6.53	4	Crippling
12/25/1969	6.29	4	Crippling
2/2/1961	7.06	4	Crippling
3/2/1960	8.77	4	Crippling
2/14/1958	6.25	4	Crippling
1/29/2015	5.42	3	Major
2/11/2014	5.28	3	Major
3/12/2017	5.03	3	Major
2/7/2013	4.35	3	Major
1/9/2011	5.31	3	Major
2/23/2010	5.46	3	Major
2/8/1994	5.39	3	Major
2/5/1978	5.78	3	Major
2/18/1972	4.77	3	Major
2/22/1969	4.29	3	Major

Table 13. Winter Storms Producing Over 10 inches of Snow in Northampton, 1958-2018			
Date	**NESIS Value**	**NESIS Category**	**NESIS Classification**
1/18/1961	4.04	3	Major
12/11/1960	4.53	3	Major
3/11/2018	3.16	2	Significant
1/25/2015	2.62	2	Significant
3/5/2018	3.45	2	Significant
3/4/2013	3.05	2	Significant
3/15/2007	2.54	2	Significant
4/6/1982	3.35	2	Significant
2/8/1969	3.51	2	Significant
2/5/1967	3.5	2	Significant
1/3/2018	1.65	1	Notable
2/8/2015	1.32	1	Notable
10/29/2011	1.75	1	Notable
3/31/1997	2.29	1	Notable
2/2/1995	1.43	1	Notable
1/25/1987	1.19	1	Notable

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

Note: These dates may indicate the beginning of a storm, but may not align with the day the storm impacted Northampton.

Between 2015 and 2020, Hampshire County was not included in any FEMA declared severe winter storm-related disasters (DR) or emergencies (EM). It should be noted that because population is used as a criteria for FEMA declarations, the storms that rank higher will be those that impact densely populated areas and regions such as Boston and other large cities and, as such, might not necessarily reflect the storms that impact less populated areas. For example, one of the most famous storms in the Commonwealth in modern history was the Blizzard of '78, which dropped over two feet of snow in the Boston area during 65 mph winds that created enormous drifts and stranded hundreds of people on local highways. The storm hit the snow-weary city that was still digging out of a similar two-foot snowstorm 17 days earlier. Although Hampshire County received snow from this storm, it was not listed in the declaration.

The October Snow Storm in 2011, which caused major damages and disruptions across New England, also impacted Northampton. Most Northampton residents of the City were without electricity for over a week. While this was a severe storm paired with trees sill in full foliage, most winter storms that hit

Northampton are manageable and simply more of a nuisance. Northampton DPW was awarded reimbursements from FEMA for emergency work require as a result of this event.

There currently isn't good local data on ice storms in Northampton. According to the 2013 State Hazard Mitigation Plan, there were 20 ice storms in Hampshire County between 1971 and 2012. This equates to a major ice storm every two years. The 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan indicates that ice storms of lesser magnitudes occur on at least an annual basis. Areas located in higher elevations are more likely to experience ice storms. In recent history, there has been no loss of life from snow or ice storms, but each year there are incidences of property damage and personal injuries.

Well-known as the most serious storm to impact Pioneer Valley communities in recent history was the Ice Storm of December 11, 2008. The storm created widespread downed trees and power outages all across New York State, Massachusetts and New Hampshire. Over one million customers were without electricity, with 800,000 without power three days later and some without power weeks later. Challenging living conditions were acerbated by extremely cold temperatures in the days following the event.

Known severe snowstorm and ice storm events, including FEMA disaster declarations, that have impacted Northampton since the 2015 HMP, are identified in Table 14. Detailed information on damages and impacts are included when available. Please note that not all losses and damages that have occurred in the City are included due to the extent of documentation and the fact that not all sources may have been identified or researched.

Table 14. Severe Snowstorm and Ice Storm Events in Northampton, 2015-2020

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	Losses/Impacts
October 27, 2016	Winter Weather	N/A	Several inches of wet snow fell across southern New England. An average of 4-5 inches of snow fell in western Hampshire County. Most trees still had leaves at this time, allowing the snow to cause a significant amount of tree damage. There were many reports from Northampton: a tree was down on a house on Pentcastle Avenue; trees and wires were down at Fort Hill Terrace, Clement Street, Hockanum Road; wires were down on Elm Street, Hatfield Street, and Adare Place; a tree was down on wires at Mount Tom, Loudville Road at Westhampton Road, Mountain Road, Old Ferry Road, and North Farms Road; and a tree was blocking the road at the intersection of Depot and Main Streets.
December 11, 2016	Heavy Snow	N/A	Up to 6 to 7 inches of snow was reported in the slopes of the Berkshires, in the higher terrain of northwest Hampshire and western Franklin Counties. Snowfall totals of 5 inches were

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	Losses/Impacts
			reported in Northampton.
December 29, 2016	Heavy Snow	N/A	3 to 6 inches of snow was common in western and central Massachusetts, with 5 to 7 inches in the slopes of the Berkshires. Numerous reports (amateur radio, social media, CoCoRaHS, and Cooperative Observer) indicated around 6 inches of snowfall in the towns of western Hampshire County. 5 inches were reported in Northampton. Strong winds occurred behind the storm during the overnight hours, causing scattered tree and power line damage, with gusts mainly in the 30-50 mph range.
March 14, 2017	Heavy Snow	N/A	Winter storm "Stella" moved up the east coast, hugging the southern NJ coast then moving rapidly northeast across southern Rhode Island and interior southeast Massachusetts. Snowfall rates of 3 inches per hour were observed in western MA. NESIS value of 5.03, classified as Major Heavy snow fell throughout much of the day in eastern Hampshire County, where snowfall totals ranged from 9.2 inches in Amherst to 13.5 inches in Northampton. No damages were reported.
March 2, 2018	Winter Storm	N/A	This storm brought heavy snow to northwest Massachusetts, heavy rain and strong winds to central and eastern Massachusetts, and coastal flooding to the coastline. Snowfall from one inch to twelve inches fell on Western Hampshire County, with the 1.5 inches reported in Northampton. NESIS value if 3.45, classified as Significant.
March 11, 2018	Snow storm	N/A	No reports were available for Northampton. Snowfall in Williamsburg reached 12.5 inches, and Westhampton saw 8.2 inches. NESIS value of 3.16, classified as Significant
November 15, 2018	Heavy Snow / Nor'easter	N/A	An early-season nor'easter moved from the Mid-Atlantic coast to southeastern Massachusetts on the 15th and away from the region on the 16th. A quick thump of heavy snow occurred on the front end of the storm, with most accumulations over with by or shortly after midnight on the 16th. Based on numerous reports from CoCoRaHS, trained spotter, and amateur radio observers, snowfall ranged from 5.0 inches to 9.5 inches in eastern Hampshire County. 8.0 inches were reported in Northampton. No damage was reported.

Source: NOAA Storm Events Database, 2020; FEMA 2020; CoCoRaHS, 2020 https://www.cocorahs.org/Maps/ViewMap.aspx?type=snow

Probability of Future Events

Based upon the availability of records for Hampshire County and the NESIS scale, the likelihood that a severe snow storm will affect Northampton is "high" (between 40 and 70 percent in any given year).

Research on climate change indicates that there is great potential for stronger, more frequent storms as the global temperature increases. Extreme weather events—including extreme precipitation and snowfall levels—are anticipated to occur more frequently as climate change occurs. However, as temperatures throughout the year increase, it is possible that nor'easter events may become more concentrated in the coldest winter months when atmospheric temperatures are still low enough to result in snowfall rather than rain. More information about the effect of Climate Change can be found at the Climate Change Clearinghouse for the Commonwealth at www.resiilentma.org.

The Massachusetts State Hazard Mitigation and Climate Adaptation Plan has additional information about the impact of climate change and can be accessed at http://www.resilientma.org/shmcap-portal/index.html#/full-plan.

Impact

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

The weight from multiple snowfall events can test the load ratings of building roofs and potentially cause significant damage. For example, the roof of JFK Middle School is not designed for multiple heavy snowfalls. Multiple freeze-thaw cycles can also create large amounts of ice and make for even heavier roof loads.

Other impacts from snowstorms and ice storms include:

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

Vulnerability

Based on the above assessment, Northampton has a hazard index rating of "3 — medium risk" from severe winter storms and nor'easters.

Using an estimated value of $2,742,056,622 for all property in the City and an estimated 5 percent of damage to 10 percent of residential structures, approximately $ 13,710,283 worth of damage could occur from a severe snowstorm. This is a rough estimate and likely reflects a worst-case scenario. Computing more detailed damage assessments based on assessor's records is a labor-

intensive task and beyond the scope of this project. The cost of repairing or replacing the roads, bridges, utilities, and contents of structures is not included in this estimate.

Populations

Winter storms are considered deceptive killers because most deaths and other impacts or losses are indirectly related to the storm. They generally bring strong winds which create blizzard conditions with blinding wind-driven snow, drifting snow, and extreme cold temperatures with dangerous wind chill. Injuries and deaths may occur due to traffic accidents on icy roads, heart attacks while shoveling snow, or hypothermia from prolonged exposure to cold. Heavy snow can paralyze a region or town, shutting down transportation, stopping the flow of supplies, and disrupting medical and emergency services. Accumulations of snow can cause buildings to collapse and knock down trees and power lines. Rural populations especially may become isolated by downed trees, blocked roadways, and power outages. Residents may be displaced or require temporary to long-term sheltering.

Elderly populations are particularly susceptible to risks of extreme winter weather such as injury from falls, hypothermia, and overexertion. Low income residents are also susceptible if they are not able to secure housing with adequate insulation and heating.

Built Environment and Economy

The City of Northampton's power and communication infrastructure are vulnerable to the impacts of a severe winter storm. Because many of Northampton's streets are lined with mature trees, a severe snow or ice storm could also cause damage and power outages from downed trees. This could cause residents and businesses to lose power and could impact the City's ability to operate normally, impacting the City's economy. Additionally, buildings with flat roofs are especially vulnerable to damage, especially when the snow is wet and heavy.

Most winter storm events that occur in Northampton are not accompanied by a FEMA Emergency or Disaster declaration and, as a result, all costs associated with the events are borne by local City budgets. Any City response to the events listed in the Previous Occurrences section above would have likely included payroll overtime for DPW staff. Furthermore, spending on snow and ice operations in the City typically exceeds the budgeted amount and, because it comes out of the General Fund, requires a City Council transfer to cover the deficit. For example, the original allocation for FY19 was $500,000, the revised budget was $664,291, and the amount expended was $663,446. This included personnel services and ordinary maintenance for: repair and maintenance of vehicles, snow removal, communication, weather reports, vehicle supplies, fuel, snow removal supplies and food. If the frequency of severe winter storms increase in future years, so will the financial burden on taxpayers to support City response.

Natural Resources

Severe winter weather is common in Massachusetts and native species and habitats are well adapted to withstand most winter weather.

Severe Thunderstorm / Wind / Tornado

Hazard Description

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

Wind is air in motion relative to surface of the earth. For non-tropical events over land, the NWS issues a Wind Advisory (sustained winds of 31 to 39 mph for at least 1 hour or any gusts 46 to 57 mph) or a High Wind Warning (sustained winds 40+ mph or any gusts 58+ mph). For non-tropical events over water, the NWS issues a small craft advisory (sustained winds 25-33 knots), a gale warning (sustained winds 34-47 knots), a storm warning (sustained winds 48 to 63 knots), or a hurricane force wind warning (sustained winds 64+ knots). For tropical systems, the NWS issues a tropical storm warning for any areas (inland or coastal) that are expecting sustained winds from 39 to 73 mph. A hurricane warning is issued for any areas (inland or coastal) that are expecting sustained winds of 74 mph. Effects from high winds can include downed trees and/or power lines and damage to roofs, windows, etc. High winds can cause scattered power outages. High winds are also a hazard for the boating, shipping, and aviation industry sectors.

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

Location

As per the Massachusetts Hazard Mitigation Plan, the entire City is at risk of high winds, severe thunderstorms, and tornadoes. The plan also identifies Northampton and the surrounding communities as having a high frequency of tornados occurrence within Massachusetts. However, the actual area affected by thunderstorms, wind, or tornadoes is "small," with less than 10 percent of the City affected.

Extent

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

The extent of hail that can be present in severe thunderstorms can be found in the table below.

Hail Extent	
Hail Size	**Object Analog**
.50	Marble, moth ball
.75	Penny
.88	Nickel
1.00	Quarter
1.25	Half dollar
1.50	Walnut, ping pong
1.75	Golf ball
2.00	Hen egg
2.50	Tennis ball
2.75	Baseball
3.00	Tea cup
4.00	Grapefruit
4.50	Softball

Source: http://www.spc.noaa.gov/misc/tables/hailsize.htm

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

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

Previous Occurrences

Within Massachusetts, tornadoes have occurred most frequently in Worcester County and in communities west of Worcester. The most common months are June, July, and August, but the Great Barrington, MA tornado (1995) occurred in May and the Windsor Locks, CT tornado (1979) occurred in October.

Since the 1950s, there have been 10 tornadoes reported in Hampshire County. Most recently, on February 25, 2017, an EF1 tornado touched down in Conway and Goshen, Massachusetts. The tornado damaged dozens of homes, hundreds of trees and left 75% of the residents without power. This was the first tornado in Massachusetts to touch down in February since record keeping stated in the 1950s.

Only thee recorded tornadoes have touched down in Northampton: a category F1 on June 2, 2000, a category F2 on August 14, 1958, and a category F3 on September 13, 1971. No records contained information about damage or specific locations of touchdown, however the 1958 tornado was documented in southeastern Northampton and the 1971 tornado was documented in Florence. The

2000 tornado touched down in Leeds in June.[12] This tornado was ranked F1 (Moderate Tornado) on the Fujita Scale of Tornado Intensity.

Probability of Future Events

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

Tornado Index for Hampshire County	
Hampshire County	125.73
Massachusetts	87.60
United States	136.45

Source: USA.com http://www.usa.com/hampshire-county-ma-natural-disasters-extremes.htm

Based upon the available historical record, even given Northampton's location in a high-density cluster of state-wide tornado activity, there is a "very low" probability (less than 1 percent chance in any given year) of a tornado affecting the City.

As per the Massachusetts Hazard Mitigation Plan, there are approximately 10 to 30 days of thunderstorm activity in the state each year. Thus, there is a "moderate" probability (10 percent to 40 percent chance in any given year) of a severe thunderstorm or winds affecting the City.

Impact

Overall, Northampton faces a "limited" impact from severe thunderstorms, winds, or tornadoes, with 10 percent or less of the City affected.

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

- EFO - Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages to sign boards.
- EF1 - The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
- EF2 - Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.

[12] National Climactic Data Center

- EF3 - Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
- EF4 - Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.

Vulnerability

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

The potential for locally catastrophic damage is a factor in any tornado, severe thunderstorm, or wind event. In Northampton, a tornado that hit the residential areas would leave much more damage than a tornado with a travel path that ran along the city's forested uplands, where little settlement has occurred. Most buildings in the city have not been built to Zone 1, Design Wind Speed Codes. The first edition of the Massachusetts State Building Code went into effect on January 1, 1975, and 85 percent of the City's housing was constructed prior to this date.

Using a total value of all structures in Northampton of $2,742,056,662 and an estimated 10 percent of damage to 5 percent of all structures, the estimated amount of damage from a tornado is $13,710,283. The cost of repairing or replacing the roads, bridges, utilities, and contents of structures is not included in this estimate.

Populations

Populations unable to safely evacuate are most at risk from tornados. Low income populations may lack means to evacuate. The elderly often face physical challenges or require regular medical attention. Limited English Proficiency (LEP) populations may face challenges receiving and understanding emergency directions.

Built Environment and Economy

The most common problem associated with severe weather is loss of utilities. Downed trees from severe wind storms can create serious impacts on power and aboveground communication lines. Water and sewer systems may not function if power is lost. The vulnerabilities associated with flooding could be present if substantial rain accompanies severe thunderstorms. Additionally, severe wind may damage older buildings. Many buildings throughout Northampton are older and designed to withstand lower wind speeds, meaning they are more vulnerable to damage from high wind events, microbursts of tornadoes.

Sometimes, wind gusts of only 40 to 45 mph can cause scattered power outages from downed trees and wires. This is especially true after periods of prolonged drought or excessive rainfall, since both are situations that can weaken the root systems and make them more susceptible to the winds' effects. Roads may become impassable due to downed trees or roadway flooding resulting from a severe wind or thunderstorm.

Natural Resources

Downed trees and the transportation of small flora and fauna by high winds can cause damage to the natural environment.

Earthquake

Hazard Description

An earthquake is a sudden, rapid shaking of the ground that is caused by the breaking and shifting of rock beneath the Earth's surface. Earthquakes can occur suddenly, without warning, at any time of the year. New England experiences an average of 30 to 40 earthquakes each year although most are not noticed by people.[13] Ground shaking from earthquakes can rupture gas mains and disrupt other utility service, damage buildings, bridges and roads, and trigger other hazardous events such as avalanches, flash floods (dam failure) and fires. Un-reinforced masonry buildings, buildings with foundations that rest on filled land or unconsolidated, unstable soil, and mobile homes not tied to their foundations are at risk during an earthquake.[14]

Location

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

Extent

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

Richter Scale Magnitudes and Effects	
Magnitude	**Effects**
< 3.5	Generally not felt, but recorded.
3.5 - 5.4	Often felt, but rarely causes damage.
5.4 - 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1 - 6.9	Can be destructive in areas up to about 100 kilometers across where people live.

[13] Northeast States Emergency Consortium Web site: *www.*nesec*.org/hazards/earthquakes.cfm.*

[14] Federal Emergency Management Agency Web site: *www.fema.gov/hazards/earthquakes/quake.shtm.*

7.0 - 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or >	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

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

Modified Mercalli Intensity Scale for and Effects

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

Source: US Federal Emergency Management Agency

Previous Occurrences

The most recent earthquakes to affect Northampton are shown in the table below. According to the Northeast States Emergency Consortium, only one magnitude 4 or higher earthquake has occurred in New England since 2010. This was a 4.6 magnitude earthquake centered at Hollis Center Maine, on October 16, 2012. This earthquake was not noted to cause any damage in Northampton or the surrounding area.

Table 15. Largest Earthquakes Affecting Northampton, MA, 1924 – 2020

Location	Date	Magnitude
Ossipee, NH	December 20, 1940	5.5
Ossipee, NH	December 24, 1940	5.5
Dover-Foxcroft, ME	December 28, 1947	4.5
Kingston, RI	June 10, 1951	4.6
Portland, ME	April 26, 1957	4.7
Middlebury, VT	April 10, 1962	4.2
Near NH Quebec Border, NH	June 15, 1973	4.8
West of Laconia, NH	Jan. 19, 1982	4.5
Plattsburg, NY	April 20, 2002	5.1
Bar Harbor, NH	October 3, 2006	4.2
Hollis Center, ME	October 16, 2012	4.6

Source: Northeast States Emergency Consortium, 2019 website: www.nesec.org/hazards/earthquakes.cfm

Table 16. New England States Record of Historic Earthquakes

State	Years of Record	Number Of Earthquakes
Connecticut	1678 - 2016	115
Maine	1766 - 2016	454
Massachusetts	1668 - 2016	408
New Hampshire	1638 - 2016	320
Rhode Island	1766 - 2016	34
Vermont	1843 - 2016	50
New York	1737-2016	551
Note: Total Number of Earthquakes within the New England states between 1568 and 2007 is 1,932.		

Source: Northeast States Emergency Consortium website, *www.nesec.org/hazards/earthquakes.cfm*

Probability of Future Events

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

Earthquake Index for Hampshire County	
Hampshire County	0.17
Massachusetts	0.70
United States	1.81

Source: USA.com

Based upon existing records, there is a “very low” frequency (less than 1 percent probability in any given year) of an earthquake in Northampton.

Impact

Massachusetts introduced earthquake design requirements into their building code in 1975 and improved building code for seismic reasons in the 1980s. However, these specifications apply only to new buildings or to extensively-modified existing buildings. Buildings, bridges, water supply lines, electrical power lines and facilities built before the 1980s may not have been designed to withstand the forces of an earthquake. This is particularly true for a large number of the buildings in downtown Northampton, most of which could likely be completely destroyed by a significant earthquake. The seismic standards have also been upgraded with the 1997 revision of the State Building Code. Liquefaction of the land near water could also lead to extensive destruction.

While a significant earthquake, estimated to be approximately of magnitude 6.1 or higher, would cause a “critical” impact, with more than 25 percent of Northampton affected, a smaller earthquake that is more likely to occur in Northampton would have "minor" impact, with only small damage to property. As shown in the table of the Richter Scale above, an earthquake of 6.0 or lower would result in at most slight damage to well-designed buildings, which are the vast majority of structures in Northampton. Earthquakes between 3.5 and 5.4 would be felt but rarely cause damage, and earthquakes smaller than 3.5 would not be noticed. Therefore, the overall impact rating for earthquake in Northampton is “Limited.”

Vulnerability

Based on the above analysis, Northampton has a hazard index rating of “4- low risk” from earthquakes. Using a total value of all structures in Northampton of $2,742,056,662 and an estimated 100 percent of damage to 25 percent of all structures (“critical” impact), the estimated amount of damage from an earthquake is $685,514,166. The cost of repairing or replacing the roads, bridges, utilities, and contents of structures is not included in this estimate.

Populations

Socially vulnerable populations are at the highest risk from earthquakes. These populations may lack the means physically or financially to respond to an earthquake. They may not be able to prepare and live self-sufficiently in the aftermath of an earthquake. Low-income populations are more likely to live in structurally compromised buildings.

Built Environment and Economy

Older buildings are particularly vulnerable to earthquakes because their construction pre-dates building codes that included strong seismic consideration. The City has a number of historical buildings that could be damaged or destroyed if a large enough earthquake were to happen. A loss of these historic buildings could represent a loss of Northampton's history and culture. There have been no studies done to determine how Northampton's critical infrastructure, such as the City Hall, would fair in an earthquake. The City's Public Safety Complex was built recently and would likely withstand an earthquake with little or no damage.

There are many ways in which Northampton's structures, infrastructure, and individuals would be vulnerable to earthquakes. Road closures could isolate populations and keep people from getting to work, and loss of utilities could impact populations that suffered no direct damage from the earthquake itself. Following a severe earthquake, damage to roadways, bridges or underpasses that serve as evacuation routes would limit access to emergency services and hospitals.

A catastrophic earthquake in Northampton would impact all structures, commercial and residential alike. FEMA research has shown that nearly 1 in 4, or 25%, of businesses do not return after a major catastrophic event. The loss of 25% of businesses would have a major impact on City tax income and operating budget. A significant loss of homes due to the same earthquake could also have major tax implications that could strain City cash flow for years after the event.

Natural Resources

A strong earthquake can cause trees to fall and cliffs or rock outcroppings to collapse. Such environmental damage can impact the balance within a habitat or ecosystem leading to increased vulnerability to invasive species.

Pandemic and Epidemic

Hazard Description

Pandemic is defined as an epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people. Different from a pandemic, an epidemic occurs when new cases of a certain disease, in a given population, substantially exceed what is expected. An epidemic may be restricted to one locale, and if it becomes global it is called a pandemic. The severity of any pandemic can be higher when a large number of people in the population lack pre-existing immunity to the causative agent or when a larger proportion of the population is infected. Organisms that cause pandemics may be transmitted from animals to humans, but the potential to cause a pandemic is increased when organisms are readily transmitted from human to human, especially before a person has any symptoms.

A pandemic will cause both widespread and sustained effects and is likely to stress the resources of the federal, state, and local governments and health departments. The Massachusetts Department of Public Health is the primary agency responsible for the study, planning, isolation/quarantine and actions, surveillance, and reporting for all public health emergencies in Massachusetts.

The following diseases, in alphabetical order, have potential to become widespread, potentially affecting Northampton.

Coronavirus is a kind of common virus that causes an infection in the nose, sinuses, or upper throat. There are many different kinds of coronaviruses, and while most are not dangerous, some cause disease. Coronavirus disease (COVID-19 or SARS-CoV-2) is one such infectious disease caused by a newly discovered coronavirus that emerged in China in December 2019. The COVID-19 virus spreads primarily through droplets of saliva or discharge from the mouth or nose when an infected person coughs or sneezes. Most people infected with the COVID-19 virus will experience mild to moderate respiratory illness and recover without requiring special treatment, and symptoms tend to present within 14 days of exposure to the virus. Older people and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease and cancer, are more likely to develop serious illness. SARS, or severe acute respiratory syndrome, is is another type of coronavirus that had an outbreak originating in China in 2003 and spread to other countries before ending in 2004.

Ebola virus disease is a rare and deadly disease caused by infection with one of the Ebola virus species. Ebola viruses are transmitted through direct contact with contaminated blood or body fluids of a person who is sick or has died from Ebola. Ebola virus may have spread in central and west Africa as a result of handling wild animals hunted for food. Ebola was first discovered in 1976 near the Ebola River in what is now the Democratic Republic of the Congo and the virus is now found in several African countries (https://www.cdc.gov/vhf/ebola/outbreaks/history/distribution-map.html) where outbreaks have occurred sporadically. There have been no reported cases of Ebola virus disease contracted in the United States, but in 2014, two U.S. residents were infected with Ebola virus while traveling to areas

where it is found, and were diagnosed in the United States; two healthcare workers who provided care for the first of these patients also became infected with Ebola virus (CDC 2020).

HIV, or human immunodeficiency virus, is a viral infection that can be transmitted between two individuals by exposure to certain body fluids through sexual intercourse, sharing needles or syringes, from an infected mother to child during pregnancy or breastfeeding, and by receiving a blood transfusion, blood products, or organ/tissue transplants that are contaminated by HIV (currently an extremely small risk in the United States). If left untreated after HIV is contracted, the viral infection severely compromises the immune system and leads to AIDS (acquired immune deficiency syndrome). There is no effective cure for HIV, but it can be controlled with proper medical care and antiretroviral therapy. The first official report of what became known as the AIDS epidemic occurred in 1981 (CDC 2020).

Influenza (Flu) is an infectious viral disease of birds and mammals commonly transmitted through the air through coughing and sneezing. Influenza type A viruses are found in many different animals and in rare cases can evolve to infect humans (https://www.cdc.gov/flu/other_flu.htm). Influenza B viruses circulate widely only among humans. People who have influenza can have some or all of these symptoms: fever, cough, sore throat, runny nose, muscle aches, headaches, fatigue, and sometimes vomiting and diarrhea. Complications from influenza virus infection can be moderate (e.g., sinus or ear infections) to severe (e.g., pneumonia, inflammation of the heart [myocarditis], inflammation of the brain [encephalitis], failure of multiple organs, and death).

The CDC describes an influenza pandemic as a global outbreak of a new influenza A virus when new (novel) influenza A viruses emerge which are able to infect people easily and spread from person to person in an efficient and sustained way. New/novel influenza virus strains, or strains that had not circulated widely among the living population caused pandemics in the late 20th and 21st centuries (https://www.cdc.gov/flu/pandemic-resources/basics/past-pandemics.html). Vaccines against a novel pandemic influenza will not be available immediately in most pandemics (CDC 2020).

Measles (also known as rubella) is a serious respiratory disease caused by the measles virus. It can lead to pneumonia, encephalitis (swelling of the brain), and death. Measles is one of the most contagious of all infectious diseases: approximately 90% of susceptible people with close contact to someone with measles will get measles. The virus spreads through aerosols produced by coughing or sneezing. The measles-mumps-rubella (MMR) vaccine protects against measles (CDC 2020).

Mosquito-borne diseases are those transmitted to humans by the bite of an infected mosquito. They include Chikungunya, dengue, malaria, Saint Louis encephalitis (SLE), West Nile virus (WNV) disease, and Zika virus disease. Diseases included in this plan that seem most relevant to Northampton are West Nile virus disease and Zika virus disease.

> **West Nile** virus is the leading cause of mosquito-borne disease in the continental United States and is most commonly spread to people by mosquito bites. About 1 in 5 people who are infected have a fever and other symptoms. About 1 out of 150 infected people develop a serious, sometimes fatal, illness. There are no vaccines to prevent WNV disease in humans and

no specific medications to treat WNV disease. WNV has been reported from all states in the continental United States (CDC 2020).

Zika virus is mostly transmitted by the bite of an infected *Aedes* species mosquito (*Aedes aegypti* and *Aedes albopictus*), but can also spread through sex, from an infected pregnant woman to her fetus, and likely by transfusion of tainted blood. Many people infected with Zika virus won't have symptoms or will only have mild symptoms. The most common symptoms of Zika virus disease are fever, rash, headache, joint pain, red eyes, and muscle pain. Zika virus infection during pregnancy can cause a birth defect of the brain called microcephaly and other severe brain defects. It is also linked to other problems, such as miscarriage, stillbirth, and other birth defects. Anyone who lives in or travels to an area where local transmission of Zika virus is occurring can be infected. Once a person has been infected, he or she is likely to be protected from future infections.

Prior to 2014, very few travel-associated cases of Zika virus disease were identified in the United States. In 2015 and 2016, large outbreaks of the virus occurred in the Americas, resulting in an increase in travel-associated cases in the U.S., widespread transmission in Puerto Rico and the U.S. Virgin Islands, and limited local transmission in Florida and Texas. Cases in the U.S. started to decline in 2017, and in 2018 and 2019 no confirmed Zika virus disease cases were reported from United States territories.

The mosquito species known to transmit Zika virus are able to live and reproduce in some areas of Massachusetts, and this range may change to cover the entire state given warming temperatures associated with climate change. Furthermore, these mosquitos could be imported (for example, in tires or potted plants) from areas where they occur (CDC 2020).

Mumps

Mumps is a contagious disease that is caused by the mumps virus. It is spread through saliva or mucus from the mouth, nose, or throat through coughing, sneezing or talking, sharing items such as cups or eating utensils, and touching contaminated objects. Mumps typically starts with a few days of fever; headache, muscle aches, tiredness, and loss of appetite, and is followed by swelling of salivary glands. Some people who get mumps have very mild or no symptoms; most people with mumps recover completely in a few weeks. Others may experience symptoms and serious complications. There is no specific treatment for mumps. Anyone who is not immune from either previous mumps infection or from vaccination can get mumps. However, outbreaks can also occur in a highly vaccinated population, especially in settings where people are in close contact, such as colleges and camps (CDC 2020).

Norovirus

Norovirus, formerly called norwalk-like virus, is a very contagious virus that causes diarrhea, vomiting, and abdominal pain in humans. Fever, chills, headache, body aches and fatigue may also be present. Norovirus is sometimes called the stomach flu or stomach bug. However, norovirus illness is not related to the flu which is caused by influenza virus.

Norovirus is spread through contaminated food or water, by contact with an infected person, or by contamination of environmental surfaces. A person usually develops symptoms 12 to 48 hours after being exposed to norovirus. Most people with norovirus illness get better within 1 to 3 days. The virus has an incubation period of 24 to 48 hours. Infected individuals are symptomatic for one to two days, but can still spread the virus for up to two weeks after recovering (CDC, 2020).

Location and Extent

By definition, a pandemic affects entire populations over large areas, so the whole City of Northampton could be affected. Densely populated areas have greater potential for person-to-person transmission than less densely populated areas. Areas of abundant standing water (including areas used for flood irrigation or dumping sites with discarded plastic and tires) which provide a breeding site for mosquitos could be more prone to an outbreak of mosquito-borne diseases.

The exact size and extent of an infected population depends on factors related to the virus organism, the people or animals affected, and the environment. Factors related to the organism include what species it affects, how much of an organism is needed to establish an infection, how the organism is transmitted, and how stable it is in a given environment. Factors related to people include how susceptible they are to infection, how long they are infectious, and the amount of contact between infected and uninfected individuals.

Previous Occurrences

Infectious diseases have been causing human illness and death since the dawn of human existence. The effective prevention and control of these diseases is one of the major reasons for increases in life expectancy. In 1701, Massachusetts passed legislation requiring the isolation of the sick for better preventing the spread of infection. Since then, Massachusetts has led the nation in infection prevention and control. Reportable conditions are captured by the Massachusetts Virtual Epidemiologic Network (MAVEN). MAVEN is an integrated, web-based surveillance and case management system that enables state and local health departments to appropriately share public health, clinical, and case management data efficiently and securely over the Internet. MAVEN provides automatic notifications around the clock to state and local officials of any event requiring immediate attention. (MA SHA, 2019[15])

The most recent flu pandemics occurred in 1889-90, 1918, 1957, 1968 and 2009. The 1918 pandemic resulted in an estimated 500,000 deaths in the United States (out of a total population then of about 105 million), the 1968 pandemic caused an estimated 34,000 US deaths (out of a total population then of about 201 million), and the 2009 (H1N1) pandemic resulted in approximately 12,500 US deaths (out

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https://www.mass.gov/files/documents/2017/11/03/Chapter%204.pdf?_ga=2.25220475.759884785.1589405533-1602091269.1500652517

of a total population then of about 305 million) (CDC, 2017[16]). The H1N1 flu (also referred to as the swine flu) was first recognized in the Commonwealth in April of 2009. The H1N1 flu was identified by authorities as a pandemic as it spread quickly to many parts of the world and was declared a public health emergency in Massachusetts.

Since its emergence as a human disease in 1938, the mosquito-borne virus of eastern equine encephalitis (EEE) has caused 100 identified human cases, 55 deaths and left 80% of survivors with permanent neurological damage in Massachusetts. West Nile virus, which first appeared in the US in 1999, has caused at least 148 cases of clinical disease in Massachusetts. Instances of other diseases and viruses profiled in this chapter may be more common, though not at a pandemic scale.

Between 1954 and 2020, FEMA declared one pandemic-related disaster in the State of Massachusetts. This declaration was made for all counties in the state on March 27, 2020 for the COVID-19 Pandemic. Four months earlier, in December, 2019, the Municipal Health Commission in Wuhan, China, had reported a cluster of cases of pneumonia in Wuhan, Hubei Province. A novel coronavirus that likely surfaced in a Chinese seafood and poultry market was eventually identified. Officials confirmed the first recorded case of the virus outside of China in Thailand on January 13, 2020, and by the end of that month the World Health Organization (W.H.O.) situation report indicated 7818 total confirmed cases worldwide, with the majority of these in China, and 82 cases reported in 18 countries outside China including the United States. The first confirmed case in the United States was in Washington State, where a man in his 30s developed symptoms after returning from a trip to Wuhan. On February 11, the W.H.O. proposed an official name for the disease caused by the new coronavirus: COVID-19, an acronym that stands for coronavirus disease 2019. COVID-19 was characterized as a pandemic on March 11, 2020. As of May 28 (the time of writing this report) COVID-19 had spread to at least 203 countries, killing more than 357,896 and sickening more than 5.8 million people. There are more infections in the United States than any other country in the world and over 100,000 people have died in the United States. Massachusetts is fifth in the country for infections and has the third highest death rate in the country.

The City of Northampton Department of Public Health delivered public service announcements and situational awareness reports about the evolving pandemic, and ordered closures of non-essential businesses and some play areas and recreational facilities. Schools were closed and local emergency shelters activated. The Northampton High School was used as a primary shelter for the City's most vulnerable residents who lack housing, and was run cooperatively by the City's Department of Public Health, Medical Reserve Corps Coordinator, and ServiceNet, with support from Northampton's Fire Rescue and Police Departments and Cooley Dickinson Hospital.

The full extent of the COVID-19 pandemic is yet to be known, but the disconnect between Massachusetts long-standing commitment to public health and the very high infection rate and extremely high death rate must be explored and understood.

[16] https://www.cdc.gov/flu/pandemic-resources/pdf/pan-flu-report-2017v2.pdf

Probability of Future Events

Future occurrences of pandemic events are expected to continue, although the probability of a major pandemic impacting Northampton in any given year is "Low," or less than 10%.[17] As bacteria and viruses continually evolve, there is always the opportunity for new diseases to occur. Factors in Northampton that heighten the probability of occurrences of such events include large numbers of transient residents such as college students, and the large number of visitors that move in and out of the City on a daily basis which could lead to disease transmission through individuals transporting or coming into contact with infected persons. Factors that reduce the probability of occurrence of high infection rates include the overwhelmingly white racial make-up of the city as well as the relatively high incomes of most residents and the very few multi-family residences in which people may be unable to social distance.

Although many of the diseases listed earlier in this section have not been experienced at pandemic magnitudes, there is the potential of a pandemic occurring at any time, with pandemic influenza being the most likely.

Pandemics are unpredictable. While history offers useful benchmarks, there is no way to know the characteristics of a pandemic virus before it emerges. Nevertheless, public health officials must make assumptions to facilitate planning efforts. According to the 2006 Pandemic Influenza Preparedness, Response, and Recovery Guide published by Homeland Security, Federal planning efforts assume the following about the certain eventuality of the next pandemic influenza virus:

- Susceptibility to the pandemic influenza virus will be universal.
- Efficient and sustained person-to-person transmission signals an imminent pandemic.
- Epidemics will last 6 to 8 weeks in affected communities.
- Multiple waves (periods during which community outbreaks occur across the country) of illness are likely to occur with each wave lasting 2 to 3 months. Historically, the largest waves have occurred in the fall and winter, but the seasonality of a pandemic cannot be predicted with certainty.

Worldwide, there has been an apparent increase in reports of infectious diseases, which is reflective of rapid demographic, environmental, social, technological, and other changes in in human society. Mathematical models predict that climate change will likely affect changes in transmission patterns of infectious diseases (Climate Change and Human Health, Risks and Responses. World Health Organization, 2003, http://www.who.int/globalchange/environment/en/chapter6.pdf), although the relationship between climate change and infectious diseases is complex and not well understood. The ranges and impacts of important pathogens might change as a result of changing temperatures and precipitation. Changing climate might increase or change the range of disease vectors such as mosquitoes or rodents. Heavy rainfall and flooding can be associated with waterborne disease outbreaks, especially where the drinking water supply is not treated. (Advancing the Science of Climate Change, National Academies Press, 2010, https://www.nap.edu/read/12782/chapter/15#314).

[17] https://www.ncbi.nlm.nih.gov/books/NBK525302/

Impact

The severity of an infectious disease pandemic, epidemic, or threat in Northampton varies depending on the organism, the susceptible population, ease of transmission, ability to identify infected persons before they can spread disease, and availability and effectiveness of control measures. It is expected that during a pandemic of influenza, 25% of the population could fall ill (NY Department of Health, 2020)[18], and some facilities would be forced to shut down for more than one week. Therefore, the impact is considered "Critical."

Pandemics could occur with very little warning. As seen with the COVID-19 pandemic in 2019-2020, air travel can hasten or facilitate the spread of a new organism and decrease the time available for early implementation of interventions. When outbreaks of a virus occur simultaneously in many parts of the country, sharing of human and material resources that would usually occur in response to other disasters becomes limited. In general, warning time for pandemics will depend on the origin of the virus and the amount of time needed to identify the virus.

As described in the Massachusetts Emergency Operations Plan (EOP), a yearlong influenza pandemic without intervention could result in almost 10 million hospitalizations and an estimated 1.9 million Americans could die. The direct and indirect health costs alone (not including disruptions in trade and other costs to business and industry) have been estimated to approach $181 billion for a moderate pandemic (similar to those in 1957 and 1968) with no interventions (CDC, 2017).

Vulnerability

While all individuals could experience pandemic impacts, the COVID-19 crisis showed that the most vulnerable were the elderly, especially in nursing homes, individuals with pre-existing health issues, housing insecurities, Frontline communities, and front-line workers including health care workers, social service providers, delivery personnel, etc. Other infectious diseases have higher risks for children and pregnant women.

Populations

Pandemics throughout history have exacerbated existing public health and socioeconomic disparities. When diseases become associated with certain people and communities, the stigma and bigotry that can result often lead to dangerous secondary impacts that often interfere with effective public health responses. Racial inequalities and health disparities that exist in a society before a pandemic put disadvantaged and disenfranchised people at greater risk of severe symptoms and complications. During the COVID-19 outbreak in both New York City and Barcelona, low income neighborhoods where poorer families are more likely to live in close-quarter housing experienced disproportionately high occurrences of the disease. These populations are also more likely to work in low-skill labor force, working as

18 https://omh.ny.gov/omhweb/disaster_resources/pandemic_influenza/frequently_asked_questions.htm

supermarket tellers and elder care providers, which were deemed essential during the crisis and therefor led to increased exposure to the virus. In Northampton, the greatest challenge for local emergency responders has been providing adequate sheltering for the region's homeless and nursing home residents, while also abiding by social distancing requirements.

Other social impacts of pandemics are the result of strained or suspended community, religious, and social activities. Schools may be closed for extended periods of time, increasing pressure on families with working parents. Similarly, places of worship may be closed. Social isolation due to quarantine and social-distancing guidelines, fear, and unemployment and financial factors can lead to or worsen existing mental health illness, and lead to an increase in domestic violence and intimate partner violence[19].

Economy

In addition to the impact on human health, the impact of a pandemic to national, state, and local economies would be severe. A pandemic will likely reduce dramatically the number of available workers in all sectors, and significantly disrupt the movement of people and goods, which will threaten essential services and operations within and across many economic sectors, especially those that cannot transition easily to remote working. Given today's highly mobile population, disease outbreaks may occur simultaneously throughout the country making the reallocation of human and material resources more difficult than in other disaster or emergency situations.

Rates of employee absenteeism will depend on the severity of the pandemic. In a severe pandemic, absenteeism attributable to illness, the need to care for ill family members, and fear of infection would be highest during the peak weeks of a community outbreak, with lower rates of absenteeism during the weeks before and after the peak. Certain public health measures (closing schools, quarantining household contacts of infected individuals, "snow days") are likely to increase rates of absenteeism.

Economic impacts of a pandemic will be experienced in the short and long term. During a quarantine period, lost revenues from parking, meals, excise, and marijuana taxes, among others, could have a major impact on the City's operating budgets. Unlike an extended power outage that could force similar business closures, economic shutdowns or slowdowns due to a pandemic can last months or even years, leading to uncertainty that could limit investments in other important areas such as infrastructure improvement.

As described in the Dam/Levee Failure and Earthquake hazard profiles above, FEMA research has shown that nearly 1 in 4, or 25%, of businesses do not return after a major catastrophic event. Social distancing and other restrictions placed on businesses during a pandemic could restrict revenues so severely that many businesses would be forced to close permanently. This would have a major impact on City tax income and operating budget, potentially straining City cash flow for years after the event.

[19] "Mental health and psychosocial considerations during the COVID-19 outbreak" (PDF). World Health Organization. 18 March 2020.; Godbole T (9 April 2020). "Domestic violence rises amid coronavirus lockdowns in Asia". Deutsche Welle (DW). Retrieved 11 April 2020.

Natural Resources

Widespread mortality and economic shifts that result from a pandemic can lead to profound impacts on the natural environment. According to anthropologist Elic Weitzel, the social and economic fallout from the 14th century bubonic plague that wiped out at least one-third of Europe's population within a few years had dramatic long-term environmental consequences. Farm fields, abandoned because laborers died or had to move for economic opportunity, reverted to forest land, lowering atmospheric carbon dioxide levels. A glacial ice core also revealed a reduction in atmospheric lead pollution due to a slowdown in mining and metallurgical activity.[20] Modern pandemics that necessitate social distancing or shelter in place orders will reduce airplane and automobile traffic and fossil fuel combustion, reducing contaminant loads from stormwater runoff entering waterways, and more. In 2020, public health restrictions to prevent the spread of Covid-19 resulted in a sharp dip in air pollution across China, Europe and the US, rapidly reducing carbon emissions from the burning of fossil fuels. Some estimate showed environmental pollution reduced up to 30%, and mobility reduced up to 90%.[21] It should be noted that any environmental impacts are minor compared to the great social and economic losses inflicted by a pandemic.

Other Hazards

In addition to the hazards identified above, the Hazard Mitigation Committee reviewed the full list of hazards listed in the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan. Due to the location and context of the City, coastal erosion, landslides, and tsunamis, were determined to not be a threat.

During the public engagement process for this HMP update, the committee received public comments that, among other things, highlighted concerns over non-natural hazard events such as gas explosions and cyber-attack. Gas explosion is one of many man-made hazards that may pose a threat to people, property, or critical infrastructure in Northampton. Manmade hazards may be included in a Local Hazard Mitigation Plan according to FEMA, but they are not required and will not be reviewed to meet plan requirements. See Integrating Manmade Hazards into Mitigation Planning (FEMA 386-7 https://www.fema.gov/media-library/assets/documents/4528) for suggestions and information on including these types of hazards in the mitigation plan.

For this *Natural* Hazard Mitigation Plan update, the Committee only evaluated man-made hazards that would pose a threat as a result of a natural hazard occurring. These instances are often referred to as secondary risks or secondary hazards. For instance, secondary risks of a flood include hazardous materials spills or leaching due to floodwaters reaching extremely high elevations. The secondary risks of snowstorms could possibly include fires and carbon monoxide poisoning due to the use of alternate heat sources. The Hazard Mitigation Committee will revisit the discussion about the City's vulnerability

[20] https://www.sapiens.org/archaeology/covid-19-environment/

[21] https://www.sciencedirect.com/science/article/pii/S0048969720323378

to man-made hazards during future updates of this Hazard Mitigation Plan. Alternatively, the City may want to explore these concerns in a complementary planning document such as a Threat and Hazard Identification and Risk Assessment (THIRA) specific to man-made hazards, or with other disaster preparedness planning tools.

4: CRITICAL FACILITIES

Section 201.6 44CFR states that a Local Hazard Mitigation Plan risk assessment shall provide a description of the jurisdictions vulnerability to the identified hazards of concern and this vulnerability should be described in terms of:

- The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas.

The law does not specify or define the term "Critical Facility," but instead allows each unique planning effort to identify and define those facilities and infrastructure that are critical to providing emergency services to the planning area. These definitions can and should be unique to the defined planning area.

FEMA defines critical facilities as facilities/infrastructure that are critical to the health and welfare of the population and that are especially important following hazard events. Critical facilities include, but are not limited to, shelters, police and fire stations, and hospitals. For the purposes of the Northampton Hazard Mitigation Plan Update, a Critical Facility is defined as a building, structure, or location which:

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

Critical Facilities within Hazard Areas

Northampton's Hazard Mitigation Committee reviewed the Critical Facilities list from the 2015 Plan, and made updates based on local knowledge and updated MassGIS data to create the following list.

Northampton's Hazard Mitigation Committee has broken up this list of facilities into three categories:

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

The Critical Facilities Map at the end of this Plan identifies these facilities.

Category 1 – Emergency Response Services

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

1. Emergency Operations Center (EOC)

Northampton Fire Department – Carlon Drive
Northampton Police Department (Secondary EOC) – Center Street

2. Fire Station

Northampton Fire Station – Carlon Drive
Florence Substation – Maple Street

3. Police Station

Northampton Police Station – Center Street
State Police Station B-6 - North King Street
Hampshire County Sheriff - Rocky Hill Road

4. Transportation Network Maintenance

DPW Complex – Locust Street
Forests, Parks, and Cemeteries Facility – 320 North Maple Street
MassDOT Highway Maintenance Shed #1
MassDOT Highway Maintenance Shed #2

5. Potable Water

Water Treatment Plant - Mountain Street, Williamsburg

6. Waste Water and Flood Control

Northampton Wastewater Treatment Plant – Hockanum Road
Seven wastewater pump stations[22]
Flood control pump stations that are located at the WWTP
West Street flood control pump station

7. Emergency Fuel Storage

DPW Complex Fuel Depot – two above-ground storage tanks, diesel and gasoline, just under 12,000 gallons each
Fire Department Headquarters – Diesel storage tank

8. Emergency Shelters

[22] The Northampton DPW maintains a list for official purposes, but will not compromise this list in a public plan.

Smith Vocational and Agricultural High School (Regional Shelter) – 80 Locust Street
Northampton High School – 380 Elm Street
JFK Middle School – 100 Bridge Road, Florence
Senior Center (cooling/warming center) – 67 Conz Street
All libraries in Northampton elementary schools have cooling capacity, and therefore could be used as temporary cooling or warming centers as needed.

9. Transfer Station

Northampton Transfer Facility – Locust Street
Secondary Transfer Facility – Glendale Road

10. Helicopter Landing Sites

Northampton Airport – Old Ferry Road
Cooley Dickinson Helicopter Pad – Hospital Road

11. Primary Evacuation Routes

Interstate 91
MA Route 5
MA Route 10
MA Route 9
MA Route 66
MA Route 5 &10

12. Bridges Located on Evacuation Routes

MA Route 10, Earle Street
MA Route 9, Calvin Coolidge Bridge
I-91 bridges

Bicycle and pedestrian only bridges over CT River, North Street, Main Street (Route 9), and Easthampton Road (Route 5).

13. Communication Facilities

<u>Registered Towers</u>
Crown Atlantic Company LLC - Atwood Drive
SBA Infrastructures LLC - 254 Old Wilson Road
IWG Towers Assets I LLC - 790 Florence Road
City of Northampton - 26 Carlon Drive
American Towers LLC – 170 Glendale Road: hosts a repeater for the Police Department as well as other cell subleases
Commonwealth of Massachusetts - 555 North King Street (at State Police)
Global Tower LLC through American Towers LLC 123 - Haydenville Road (on Smith Vocational land)
Cell tower (name unknown) – King Street

14. Critical IT Equipment

The HMP Committee also made note of IT equipment housed in the following facilities that would be critical to emergency operations:
DPW Water Treatment Plant - Mountain Street, Williamsburg
Puchalski Municipal Building - 212 Main Street
Emergency Communications Center - 26 Carlon Drive
Northampton High School - 380 Elm Street
DPW Administration Building - 125 Locust Street
Northampton IT Offices, James House - 42 Gothic Street

Of the critical emergency response facilities listed in Category 1, the following are known to be equipped with back-up power generation capabilities to support at least partial facility operation during an outage of the power grid.

Northampton High School
JFK Middle School
Northampton VA Medical Center
Cooley Dickinson Hospital
Smith College Campus School
Hampshire County House of Correction
Fire Department / Emergency Operations Center
Northampton Police Department
Northampton Department of Public Works
Municipal Building
Smith Vocational & Agricultural High School
Smith College (multiple)
Wastewater Treatment Plant
Water Treatment Plant
Wastewater Treatment Plant Flood Control System
Waste Water Pump Stations (7 – not all have permanent back-up power, but all are equipped with hookups to connect to mobile generator)

Category 2 – Non Emergency Response Facilities

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

1. Water Supply

Francis P. Ryan Reservoir – Whately
West Whately Reservoir – Whately
Mountain Street Reservoir – Williamsburg
Supplemental water supplies are obtained from two wells in Florence, one off Spring Street and another off Clark Street.
The three Roberts Meadow Reservoirs do not serve as emergency drinking water supply. They may be suitable for very localized firefighting in an extreme emergency limited by reservoir capacity and pressure head.

2. Communications and Utilities

National Grid power sub-stations - West Street, King Street, and Florence Junction
Verizon Station – Masonic Street

3. Problem Culverts

A list of potential problem culverts is compiled by the Highway Superintendent and on file with the Northampton DPW.

Category 3 – Facilities/Populations to Protect

The third category contains people and facilities that need to be protected in event of a disaster.

1. Medical Facilities

Cooley Dickinson Hospital – Elm Street
Hampshire County Dialysis Center – Conz Street
US Veterans (VA) Medical Center Hospital – North Main Street

2. Vulnerable Populations

Climate-vulnerable frontline populations – homeless, single room occupancy (SRO) and public housing residents, and food insecure
Individuals without a reliable form of private transportation
Populations with functional needs/disabilities
Elderly – Significant population in Downtown Areas
Hampshire County Jail and House of Correction - Rocky Hill Road
Community Enterprises - Pleasant Street (job training, employment, case management, education and housing support for people with disabilities)

3. Elderly Housing

Walter Salvo House – Conz Street
Frank J. Cahill – Fruit Street
Harold J. Forsander – High Street
Joan Tobin Manor – Maple Street
Joseph McDonald House – Old South Street

4. Nursing Homes / Assisted Living

Care One Nursing Home – Elm Street
Linda Manor / Zoe Life Retirement Community – Haydenville Road
Lathrop Retirement Community – South Street
Rockbridge – North King
River Valley Rest Home – Pine Street
Christopher Heights – Hospital Hill

5. Schools

Bridge Street School – Bridge Street

Jackson Street School – Jackson Street
John F Kennedy Middle School - Bridge Road
Lander Grinspoon Academy - Prospect Street
Leeds School – Florence Street
Montessori School of Northampton - Bates Street
New Directions School (Cutchins Program) - Pomeroy Terrace
Northampton High School – Elm Street
(RK Finn) Ryan Road School – Ryan Road
Smith College – Elm Street
Smith College Campus School - Prospect Street
Smith Vocational and Agricultural High School – Locust Street

6. Houses of Worship

Blessed Sacrament Church – Elm St
College Church – Pomeroy Terrace
Congregation B'Nai Israel – Prospect Street
Edwards Church – Main Street
Christ Science Society – 4 Center Street
First Churches – 129 Main Street
Kingdom Hall – Jehovah's Witness – Bridge Street
Northampton Friends Meeting 43 Center Street, 2nd Floor
St. Elizabeth Ann Seton – King Street
St. John's Episcopal Church – Elm Street
Unitarian Society – Main Street

7. Historic Buildings/Sites

Academy of Music - 274 Main St
Calvin Coolidge House – Massasoit Street
Dimmock Estate - Grove Hill Mansion - Front St
First Congregational Church – Main Street
Graves Avenue – 8—22 Graves Avenue
Hampshire County Court House – Gothic Street
Hotel Northampton – King Street
Memorial Hall – Main Street
Northampton VA Medical Center – North Main Street
Sylvester Graham House – Pleasant Street
The Manse – Prospect Street
Unitarian Church – Main Street
West Farms Church – West Farms Street
Elm Street Historic District
Fort Hill Historic District
Northampton Downtown Historic District

Pomeroy Terrace Historic District[23]

8. Employment Centers

Smith College – Elm Street
Cooley Dickinson Hospital – Elm Street
VA Medical Center – North Main Street
L-3 Harris – Prince Street/ State Route 66
Coca Cola – Industrial Drive
PCA Northampton – Mount Tom Road
Downtown — Routes 5 & 9

9. Mobile Home Parks

None in Northampton

10. Libraries

Forbes Library - 20 West Street
Lilly Library - 19 Meadow Street
Smith College Library – Elm Street

[23] Historic districts do not appear on the Critical Facilities map

Table 17. Critical Facilities and Evacuation Routes Potentially Affected by Hazard Areas			
Hazard Type	**Hazard Area**	**Critical Facilities Affected**	**Evacuation Routes Affected**
Flooding	Mill River Connecticut River	Should the levee system fail, the entire downtown would be flooded, including emergency operations from the police station; Part of Leeds Village Apartments senior housing is in flood zone; cell towers of Atwood Drive and Bridge Street	Route 10 in extreme conditions, Route 5; Route 66/ Rocky Hill Road at Ice Pond Road; Route 9.
Dam Failure/ Levee Breach	Varies depending on structure	Site Specific	Site Specific
Drought	Entire City	Firefighting operations	None
Extreme Temperatures	Entire City	None	None
Wildfire/Brushfire	Spring Street Ryan Rd. Chesterfield Rd.	Site Specific	Site Specific
Invasive Species	Conservation lands, forests	Potential for increased erosion, sedimentation, heat islands, disease vectors and disease, loss of street trees	None
Hurricane/ Tropical Storm	Mill River Connecticut River	Should the levee system fail, much of downtown would be flooded	Route 10 in extreme conditions, Route 5; Route 66; Route 9.
Severe Winter Storm/ Nor'easter	Entire City	Cooley Dickinson-possible power outage Nursing Homes-Rock Ridge	Route 10 in extreme conditions, Route 5; Route 66; Route 9.
Severe Thunderstorms / Wind / Tornadoes	Entire City	Site Specific	Site Specific
Earthquake	Entire City	Emergency operations; residential and commercial structures; emergency shelters; waste management and treatment plants	Route 91 in extreme conditions, Route 5; Route 66; Route 9.
Pandemic	Entire City	Staffing of certain critical facilities could be impacted by reduced willingness of volunteers to risk exposure.	None

(Critical Facilities Map Located In Appendix C)

5: MITIGATION STRATEGIES

One of the steps of this Hazard Mitigation Plan is to evaluate all of the City's existing policies and practices related to natural hazards and identify potential gaps in protection. After reviewing these policies and the hazard identification and assessment, the Hazard Mitigation Committee developed a set of hazard mitigation strategies it would like to have implemented moving forward.

The City of Northampton has developed the following goal to serve as a framework for mitigation of the hazards identified in this plan. The goal addresses present-day concerns of local residents, business owners, and officials in Northampton.

Goal Statement

To minimize injury and the loss of life, damage to property, and the disruption of governmental services and general business activities due to the following hazards: flooding, severe winter storm/nor'easter, severe thunderstorm/wind/tornado, hurricane/tropical storm, wildfire/brushfire, earthquake, dam failure/levee breach, extreme temperature, invasive species, drought, and pandemic.

Existing Mitigation Strategies

The City of Northampton had many mitigation strategies in place prior to the update of this Hazard Mitigation Plan in 2020. These strategies are included on the following pages and have been evaluated in the "Effectiveness" column.

Strategies that were completed since the last version of the plan are listed in bold. For a list of completed strategies that were previously identified as part of the prioritized implementation list, see the table of "Deleted and Completed Strategies" later in this section.

Flooding

The key factors in flooding are the water capacity of water bodies and waterways, the regulation of waterways by flood control structures, and the preservation of flood storage areas and wetlands. As more land is developed, more flood storage is demanded of the City's water bodies and waterways. The City currently addresses this problem with a variety of mitigation tools and strategies. Flood-related regulations and strategies are included in the City's zoning ordinance, and subdivision regulations. Infrastructure like dams and culverts are in place to manage the flow of water.

Management Plans

The Comprehensive Emergency Management (CEM) Plan for Northampton lists the following measures for flood planning:

- Identify areas in the community that are flood prone and define methods to minimize the risk. Review National Flood Insurance Maps.

- Disseminate emergency public information and instructions concerning flood preparedness and safety.
- Community leaders should ensure that Northampton continues to be enrolled in the National Flood Insurance Program.
- Strict adherence should be paid to land use and building codes, (e.g. Wetlands Protection Act), and new construction should not be built in flood-prone areas.
- Ensure that flood control works are in good operating condition at all times.
- Natural water storage areas should be preserved.
- Maintain plans for managing all flood emergency response activities including addressing potentially hazardous dams.

The Local Emergency Flood Plan for Northampton lists the following measures for flood planning that require action at various Connecticut River and Mill River elevations when a flood event occurs. A summary of actions include notifications to emergency dispatch, public works and closure of roads, etc. No flood planning strategies are outlined in this document.

Subdivision Rules and Regulations

Northampton's Subdivision Rules and Regulations govern the subdivision of land and were adopted for the purpose of "protecting the safety, convenience and welfare of the inhabitants of Northampton by regulating the laying out and construction of ways in subdivisions providing access to the several lots there [and]…for securing safety in the case of fire, flood, panic, and other emergencies." The Subdivision Rules and Regulations contain several provisions that mitigate the potential for, and impact of, flooding. The City's subdivision regulations explicitly offer standards for residential development seeking Low Impact Development (LID) option, in addition to requiring compliance to the Mass DEP Stormwater Handbook.

There is a range of regulatory techniques available to prevent flood damage in Northampton. These include:

- When a Definitive Plan is submitted, proponents must delineate natural waterways and floodways.
- All Definitive Plans must comply with the Massachusetts' Wetlands Protection Act (Chapter 131, Section 40) and Wetlands Protection Ordinance and retain all wetlands and flood lands.
- When permitting the subdivision, the planning board must ensure that the regulations of the Water Supply Protection District are met, when the development is located within the WSP. This works to retain flood and rainwater storage capacity in Northampton's critical waterways.
- Stormwater drainage and infiltration systems must be designed to withstand 1, 2, 10 and 100 year storms in Northampton.
- When a plan is developed and submitted to the Planning Board, all definitive plans must indicate, clearly, any floodplain lands and demonstrate compliance with the City's Floodplain District.

Northampton Zoning Ordinance

The City of Northampton has adopted several land use regulations that serve to limit or regulate development in floodplains, to manage stormwater runoff, and to protect groundwater and wetland resources, the latter of which often provide important flood storage capacity. To review the City of Northampton's Zoning Ordinance, visit www.northamptonma.gov/plan.

The City of Northampton has established a set of ordinances designed in part to "lessen congestion in the streets; to conserve health; to secure safety from fire, flood, panic, and other dangers" The Zoning Ordinance include several provisions that mitigate the potential for flooding, including:

- Any body of water or wet area that is proposed for filling and is proposed to receive 500 cubic yards of fill, or where the proposed area exceeds 10,000 s.f., must receive permission from the Conservation Commission and must: a) not be located within the Special Conservancy District, b) be executed within the context of existing plans, c) sufficiently document the impacts on downstream locations, d) be designed not to impair surface drainage or increase erosion, e) be designed to minimize off-site accumulation of fill materials, f) must not impair any septic disposal systems, and g) no filling shall cause water or other materials to intrude upon a neighboring property without the express permission of the neighbor.
- The site plan review process shall: have all stormwater systems approved, floodplains and water bodies must be delineated, an erosion control plan that prevents infill of water bodies must be approved, not result in water damage to surrounding properties, not result in an increase in surface water runoff from 1, 2 or 10 year storm events in the Central Business District.
- The Special Conservancy Zoning District has been created in Northampton to maintain the natural and safe flow of floodwaters, and to protect persons and property by ensuring that development does not interfere with flood storage capacity. The District also prevents the construction of residencies and the addition of fill; these preserve the natural hydrology of the City's watershed lands and provides storage areas for rain waters. Construction of new residential development is prohibited in this district within the 500-year flood plain. The 500-year flood plain is used as an estimate for the increased precipitation predicted due to climate change.
- The Farms, Forest and Rivers Overlay District (FFR) encourages the preservation of open space and caps impervious surface area at 25 percent of the total lot size. The FFR works to maintain open space and rainwater storage areas and, as such, makes the City less susceptible to damage from flooding.
- The Water Supply Protection District prohibits the use of toxic chemicals and restricts the excavation land within those lands that are critical to the City's drinking water supplies. This works to maintain natural hydrology.
- The Open Space Residential Development (OSRD) ordinance requires that 50 percent of a new subdivision (when ordinance is used) be preserved as open space. This preserves open space and can slow and store rain waters.

Open Space Acquisition Program

The City purchases land area for open space either in fee or by agriculture and conservation restrictions. A quarter of the City, including its only bog, is now protected land, with about 20 percent owned by the City and the balance owned by state or federal government, or farmers or forest owners who have agreed to property restrictions. This includes floodplain and flood prone areas. Specific actions involved in the City's Open Space Acquisition Program are identification of high-risk flooding areas, working with land owners, and acquiring land in conjunction with land owners and state conservation programs.

River and Stream Protection

The City of Northampton follows the standards established by the Wetlands Protection Act, which protects water bodies and wetlands through the city Conservation Commission. The City also has instituted its Wetlands Ordinance and Special Conservancy District, an overlay district that provides restrictions on use categories, the use of septic tanks and leach fields, as well as on the impacting of the flood storage capacity of the land. The City also has a Water Supply Protection District, which prohibits the use of septic tanks within the City's aquifer protection district and creates greater buffer distances from certain wetlands.

Stormwater Utility and Flood Control Ordinance

Passed by the City Council in 2014, the utility pays for necessary stormwater and flood control system construction and maintenance. Property owners in Northampton are billed based on the amount of stormwater runoff their land generates, with the calculation based on the amount of impervious and pervious surface on site.

Public Education and Outreach

The City conducts outreach to homeowners' associations to ensure they are maintaining culverts and stormwater management areas and getting them replaced as needed. The City has been especially active in working with the Ice Pond Neighborhood Association, whose detention pond caused significant damage to a nearby road, the Tinkham Woods Neighborhood Association, whose restrictive covenants and detention pond is 30 years old, and the Saw Mill Hills Neighborhood Association, who donated some of the common land to the city for permanently protected open space and to ensure no new development would occur there that would tax the stormwater system.

Code RED – City's Reverse 911 Program

Residents can sign up to receive Reverse-911 Emergency Notifications via landline, cell, text and/or email. City public safety officials send voice messages to thousands of residents and businesses within minutes with specific information about emergencies and time-sensitive local community issues including flooding, dam failure, extreme temperatures, wildfire, hurricanes and other natural disasters. Code RED has worked well for the City for more than 5 years since previous HMP. It is well utilized by emergency management and can now target certain neighborhoods with certain messaging.

National Flood Insurance Program

The National Flood Insurance Program has produced maps that identify floodways across America. Northampton is a participating member of the National Flood Insurance Program, and had the following NFIP policy and claim statistics as of 2020:

- Flood Insurance Maps (FIRMs) are used for flood insurance purposes and are on file with the Northampton Planning Board.
- FIRMs have been effective since May 31, 1974 with the current map in effect since April 3, 1978.
- Northampton has 88 in-force policies in effect for a total of $22,468,900 worth of insurance.
- There have been a total of 61 NFIP claims for which $603,372 has been paid, the most recent claim was made in 2011.
- As of 2018, there were 8 Repetitive Loss Properties in Northampton, all of which were residential. Between these 8 properties, there have been 23 claims made between the years 1982 and 2011.
- The City will maintain compliance with the NFIP throughout the next 5-year Hazard Mitigation Planning cycle by monitoring its Flood Plain Overlay District and ensuring that the district accurately reflects the 100-year flood plain and FEMA Flood Insurance Rate Map (FIRM).

The Flood Insurance Rate Maps in Hampshire County are scheduled to be updated by FEMA in the next few years. When these maps are updated, the City of Northampton will adjust its zoning to accommodate changes to the location of floodplains.

Community Rating System

Northampton currently participates in the National Flood Insurance Program's Community Rating System, a program based on incentivizing implementation of suggested floodplain management activities for communities who wish to more thoroughly manage or reduce the impact of flooding in their jurisdiction. Through use of the rating system (CRS rating), a community's floodplain management efforts can be evaluated for effectiveness. The rating, which indicates an above average floodplain management effort, is then factored into the premium cost for flood insurance policies sold in the community. The higher the rating achieved in that community, the greater the reduction in flood insurance premium costs for local property owners. Northampton currently has a CRS Class 8 rating, which confers up to a 20% discount on insurance premiums for NFIP policy holders in the City.

Flood Control Structures

FEMA has identified the following flood control structures in Northampton: Northampton Connecticut and Mill River Flood Control Levees, constructed by the U.S. Army Corps of Engineers. The City regularly maintains these levees, floodwalls and flood control pumping stations as per U.S. Army Corps of Engineers requirements. See the Dam Failure/Levee Breach section for more detail.

Capital Improvement Projects

The City routinely invests in capital improvement projects to minimize the impact of flooding. Since the last plan, DPW completed a bank stabilization of the Roberts Meadow Brook, and repaired a Mill River retaining wall near the Williamsburg Town line, among other projects.

Culvert Inventory and Prioritization

Northampton DPW began conducting culvert assessments in 2019 using the North Atlantic Aquatic Connectivity (NAACC) assessment protocol for aquatic organism passage. Culverts were prioritized for assessments based first on their location along a coldwater fishery (CWF), and second on perennial and intermittent streams. When the NAACC Condition Assessment manual was released later that year, DPW staff added condition assessments to their data collection process. Culverts for which sufficient data had been collected were then evaluated for geomorphic compatibility using a rapid assessment tool developed for the Vermont Agency of Natural Resources. As of the writing of this plan in the summer of 2020, most culverts on streams that are CWF have been assessed, and several of the culverts on non-CWF streams have been assessed, but more than 50 culverts throughout the City have not been evaluated.

Northampton Open Space, Recreation, and Multiuse Trail Plan 2018-2025

The Open Space, Recreation, and Multiuse Trail Plan inventories the City's natural features and promotes natural resource preservation in the City, including areas in the floodplain. Wetlands, aquifer recharge areas, farms, open space, rivers, streams, and brooks are addressed in the plan, which encourages forestland and farmland protection to help conserve the City's flood storage capacity.

Northampton Climate Resilience & Regeneration Plan

Since the last update to this Hazard Mitigation Plan, a draft of the Northampton Climate Resilience and Regeneration Plan from 2019, will be incorporated into the City's Master Plan, *Sustainable Northampton*. The Northampton Climate Resilience & Regeneration Plan lays out a pathway for the city and its dedication to mitigate climate change and to ensure the city builds the capacity to anticipate, adapt, and thrive in a changing climate and reduce the City's contribution to climate change. Many of these strategies include ways to plan for increased climate events, like flooding.

Table 18. Existing Flood Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
Comprehensive Emergency Management Plan	The CEM Plan lists the following measures for flood planning: Identify areas in the community that are flood prone, review National Flood Insurance Maps, disseminate emergency public information and instructions concerning flood preparedness and safety, adhere to land use and building codes, ensure that flood control works are in good condition, and preservation of natural are in good operating condition at all times.	Entire City.	Effective.	None.

Table 18. Existing Flood Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
Subdivision Rules and Regulations	• Definitive plan requires delineating natural waterways and floodways. • The subdivision regulations must comply with zoning protections for natural features. • Subdivision drainage must be designed to withstand 1, 2 10 and 100 year storms. • Utilities must be buried. • Stormwater management in new development must be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates. • If LID subdivision, must be compliant with DEP Stormwater Handbook and additional requirements.	Entire City.	Somewhat effective for mitigating or preventing localized flooding of roads and other infrastructure. Somewhat effective for controlling impacts from stormwater runoff. Prevents flood damage to infrastructure. Effective for preventing increased stormwater discharge.	None.

Table 18. Existing Flood Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
Zoning Ordinance: Site Plan Review	Requires the site plan to show erosion control, drainage facilities, stormwater runoff, no net change to water supply.	Entire City.	Somewhat effective.	None.
Special Conservancy	Preserves the floodplain through preventing new residential development in 500-year flood plain. Planning Board and Conservation Commission approval for construction, while allowing conservation by right. Commercial development is also severely restricted.	Area designated on Zoning Map.	Effective.	
Floodplain Overlay	Preserves and protects for various commercial areas not protected by Special Conservancy District.	Area designated on Zoning Map.	Somewhat effective.	
Farm, Forest and Rivers Overlay District	Protects vulnerable, sensitive and important ecosystems through requiring that all construction be sited to minimize a project's footprint on the land; allows clustering and sets a 25% maximum footprint for infrastructure.	Area designated on Zoning Map.	Somewhat effective.	
Water Supply Protection District	Preserves primary and secondary recharge areas through preventing the use of hazardous chemicals—either through strict conditions or outright prohibitions.	Area designated on Zoning Map.	Somewhat effective.	

Table 18. Existing Flood Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
Open Space Residential Development Ordinance	Allows development while conserving valuable open space.	Entire City.	Effective at maintaining flood storage land.	Consider adding more specific impacts to address including topographic change, removal of cover vegetation, risk of erosion or siltation and increased storm water runoff.
Open Space Acquisition Program	The City is currently purchasing about 0.5 percent of the City's land area either in fee or by agriculture and conservation restrictions. Specific actions involved in the City's Open Space Acquisition Program are identification of high-risk flooding areas, working with land owners, and acquiring land in conjunction with land owners and state conservation programs.	Areas within the 100-year Floodplain.	Effective.	None.
Wetlands Ordinance	Protects wetlands, including floodplains, rivers and wetlands.	All wetlands and floodplains.	Effective at limiting development that would harm these resources.	None.

Table 18. Existing Flood Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
Stormwater Utility and Flood Control Ordinance	Charges property owners for stormwater runoff based on amount of impervious and pervious surface on their land, in order to pay for improvements to stormwater system and flood control system.	Entire City.	Effective.	None.
Northampton Open Space, Recreation, and Multiuse Trail Plan 2018 – 2025	**Inventories natural features and promotes natural resource preservation in the City, including areas in the floodplain; such as wetlands, aquifer recharge areas, farms and open space, rivers, streams and brooks.**	**Entire City**	**Effective in identifying sensitive resource areas, including floodplains. Encourages forestland and farmland protection, which will help conserve the City's flood storage capacity.**	**Consider implementing the Seven-Year Action Plan strategies, particularly those dealing with protection of forests, farmland and floodplain forests.**
Participation in the National Flood Insurance Program	As of 2020, there were 88 homeowners with flood insurance policies.	Areas identified by the FEMA maps.	Somewhat effective, provided that the City remains enrolled in the National Flood Insurance Program.	The City should consider re-applying for Community Rating System status and continue to work with MEMA regarding flood mitigation requirements.

Table 18. Existing Flood Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
Participate in NFIP Community Rating System (CRS)	As of 2020, the City holds a Class 8 rating, which confers up to a 20% discount on insurance premiums for NFIP policy holders in the City.	**Entire City**	Effective in reducing insurance premiums for NFIP policy holders.	A **new Class 8 prerequisite** will require communities to adopt and enforce at least a 1-foot freeboard requirement for all residential buildings constructed, substantially improved, and/or reconstructed due to substantial damage, throughout its Special Flood Hazard Area (SFHA) where base flood elevations have been determined. This requirement may limit the feasibility of the City maintaining its Class 8 rating.
FEMA Risk Mapping Assessment & Planning	Discovery Report 01 inventoried local flood hazard and risks with help from City. Next phase of study includes study of riverine zones A and AE within Connecticut Watershed. Updates FIRMs.	Entire City.	Effective.	

Table 18. Existing Flood Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
Climate Resilience & Regeneration Plan	A component of the 2020 Update to *Sustainable Northampton* addressing climate adaptation and mitigation to make the City more resilient and regenerative. Provides for design standards and exploration of policies raising requirements for new design storm intensities and rainfall distributions, closed drainage systems, and increasing stormwater conveyance capacity through blue-green-gray infrastructure.	Entire City	Somewhat Effective, as the City will eventually include the document in their 2020 Master Plan Update	The City is currently on its way to adopting the plan and exploring implementation.
Maintenance of Northampton Connecticut and Mill River Flood Control Levees	The City regularly maintains the flood control levees along the Connecticut and Mill Rivers, as required by the U.S. Army Corps of Engineers. The City is currently completing studies to assess necessary improvements to this infrastructure to keep it in good maintenance.	Mill River and Connecticut River flood plains	Effective.	Improvements to flood control structures (see list of future strategies)
Maintenance of channel behind Fire Department	Department of Public Works maintains the channel behind the Fire Department to prevent the marsh from flooding the Fire Department building.	Fire Department and nearby marsh.	Effective.	None.

Table 18. Existing Flood Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
Hampshire County Shelter System Concept of Operations	Shelter System Concept of Operations outlines process of which a shelter would open in Northampton based on flooding or other natural disaster. Smith Vocational HS is identified as a Primary and Animal Facility and JFK Middle School as a Secondary Facility. Smith has limited generator capacity.	Entire City.	Somewhat effective.	
CodeRED – Reverse 911 System	Emergency Management can target messaging to certain areas or the entire city to inform of emergencies and time-sensitive community issues, like flooding.	Entire City.	Effective.	None.
Bank stabilization of the Roberts Meadow Brook	**A channel section immediately downstream of the Lower Roberts Meadow Reservoir Dam was historically constructed at a steep slope, resulting in significant bank erosion and channel meander over time, threatening bank stability and adjacent property. Reconstruction included bank stabilization and channel step pools to provide fish habitat and maintain channel stability.**	**Flooding**	**DPW with funding from FEMA's Hazard Mitigation Grant Program**	**Completed**

Table 18. Existing Flood Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
Repair of Mill River Retaining Wall	**A retaining wall along the Mill River near the Williamsburg Town line was poorly constructed and deterioration over time threatened flooding of the adjacent roadway and the integrity of the main sewer interceptor from Williamsburg to the Northampton WWTP. The new concrete retaining wall mitigated these threats.**	**Mill River near the Williamsburg Town line**		**Completed**

Dam Failure / Levee Breach

Dam or levee failure is a highly infrequent occurrence, but a severe incident could prove catastrophic. In addition, dam failure most often coincides with flooding, so its impacts can be multiplied, as the additional water has nowhere to flow.

Management Plans and Regulatory Measures

The Northampton Comprehensive Emergency Management (CEM) Plan contains the following mitigation measures for dam failure:

- Develop and conduct public education programs concerning dam hazards.
- Maintain up-to-date plans to deal with threat and actual occurrence of dam over-spill or failure.
- Emergency Management and other local government agencies should familiarize themselves with technical data and other information pertinent to the dams which impact Northampton. This should include determining the probable extent and seriousness of the effect to downstream areas.
- Dams should be inspected periodically and monitored regularly.
- Repairs should be attended to promptly.
- As much as is possible burdens on faulty dams should be lessened through stream re-channeling.
- Identify dam owners.
- Determine minimum notification time for downstream areas.
- Contaminate-laden waste (including dams that hold back pollution from traveling downstream).

Permits Required for New Dam Construction

Massachusetts State Law (M.G.L. Chapter 253 Section 45) regulates the construction of new dams. A permit must be obtained from the Department of Conservation and Recreation (DCR) before construction can begin. One of the permit requirements is that all local approvals or permits must be obtained. All new dams must adhere to seismic requirements set forth in the 8th Edition of the Massachusetts State Building Code.

Dam Inspections and Removal of Dams

The DCR requires that dams rated as Low Hazards are inspected every ten years and dams that are rated as Medium/Significant Hazards are inspected every five years. High Hazard dams must be inspected every two years. Of the three City-owned dams in Northampton, both Middle and Lower Roberts dams are designated as high hazard dams, and the South Street dam is medium hazard. The City dams are in good shape according to the DPW with the weak point being, data from private dam inspection is lacking.

Zoning

There is no mention made regarding the construction of new dams in Northampton.

Restrictions on Development

There are no City restrictions on dam locations. The DCR issues permits for new dams and does have the authority to deny a permit if it is determined that the design and/or location of the dam is not acceptable.

Levee Maintenance

The City regularly maintains the levee systems on the Mill River and Connecticut River in accordance with the U.S. Army Corps of Engineers requirements to ensure the flood control system is in good repair. It should be noted that vegetation management is usually a routine maintenance activity, however, the DPW identified that major vegetation management to maintain its levees included a significant amount of tree and wood growth removal where woody growth should not be present. The DPW is now more responsive to vegetation management after a period of time of deferred maintenance that led to the structural integrity of the earthen structures. Some other related repairs due to the deferred maintenance include concrete reinstallation to the floodwalls, raising the earthen levees in several areas, and other minor repairs to the both the Connecticut River and Mill River systems.

FEMA Levee Accreditation

Years after the current Northampton FIRM mapping was completed, FEMA promulgated a requirement that flood control systems be accredited in accordance with certain engineering evaluations that demonstrate adequate protection for the 1% probability flood event. Northampton's levees have never been accredited by FEMA, so once the map modernization process is completed the area behind the levees will be considered floodplain.

In 2018, the City initiated an engineering evaluation of its levees and flood control system to establish capital improvement priorities and prepare documentation to submit to FEMA for accreditation of the system in advance of map modernization.

Proactively, the City will be undertaking pre-disaster "brick and mortar" mitigation construction projects that are needed to advance the levee accreditation process. Projects for Levee Toe Drain Maintenance and Hockanum Flood Pumping Station Phase 1 Upgrades work have been funded and are going to bid in 2020. These projects are mainly paid for through the existing City stormwater enterprise fund, which is capped at $2 million. However, this stormwater enterprise fund supports personnel and routine maintenance as well as drainage capital projects and is not enough for all the capital projects that may be needed going forward for FEMA accreditation. Other funding sources are being explored for capital projects that may be needed to receive FEMA accreditation. The City has prioritized implementing recommendations from the engineering evaluations that would support a successful submission for FEMA accreditation.

Table 19. Existing Dam Failure and Levee Breach Hazard Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
Comprehensive Emergency Management Plan	The CEM Plan includes a variety of public education and regular maintenance initiatives for dam and levee safety.	Entire City.	Effective.	None.
Permits required for new dam construction	State law requires a permit for the construction of any dam.	Entire City.	Effective. Ensures dams are adequately designed.	None.
Dam Inspections	DCR has an inspection schedule that is based on the hazard rating of the dam (low, medium, high hazard).	Entire City.	Dams located on private land must be inspected by property owner. The City's Conservation Commission is responsible for inspecting two City-owned dams and DPW for three City-owned dams.	None.
Evacuation Plans	Comprehensive evacuation plans ensure the safety of the citizens in the event of dam failure.	Inundation areas in City.	Effective.	None.
Identification of inundation zones	Mapped inundation zones identify areas where dam breaches would result in a loss of life and damage to property.	Inundation areas in City.	Effective.	None.
Emergency Action Plans	EAPs are in place for the three Roberts Meadows dams, which	Inundation areas in	Effective.	None.

Table 19. Existing Dam Failure and Levee Breach Hazard Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
	includes identification of City inundation areas	City.		
Local Emergency Flood Plan	Plan lists measures that require action at various Connecticut River and Mill River elevations when a flood event occurs.	Inundation areas in City.	Effective.	None.
Levee maintenance	The City regularly maintains the levee systems on the Mill River and Connecticut River in accordance with the U.S. Army Corps of Engineers requirements to ensure the flood control system is in good repair.	Inundation areas in City.	Effective.	None.
Remove unnecessary dams and other manmade structures where feasible: **1. Upper Roberts Dam removal** **2. Fitzgerald Lake Dam Repair**	**1. The City removed the Upper Roberts Reservoir Dam in 2018.** **2. DPW repaired the Fitzgerald Lake Dam after determining that the dam presented a low enough hazard that it did not need to be removed.**	**Dam failure**	**1. DPW with funding from the Executive Office of Energy and Environmental Affairs** **2. EEA Dam Safety Grant, City Capital Improvement Program**	**Completed/Discontinued Remaining dams on the Mill River are under private ownership and therefore not priority projects for the City.**
CodeRED – Reverse 911 System	Emergency Management can target messaging to certain areas or the entire city to inform of emergencies and time-sensitive community issues, like dam failure.	Entire City.	Effective.	None.

Drought

Although Massachusetts does not face extreme droughts like many other places in the country, it is susceptible to dry spells and drought. Drought can most likely be effectively mitigated in regions like the Pioneer Valley if measures are put into place, such as ensuring that groundwater is recharged.

State Regulations

The City of Northampton follows the state's Water Management Act, which limits the amount of water consumption during a state-issued Water Emergency Declaration. For more information visit: www.mass.gov/eea/agencies/massdep/water/drinking/the-massachusetts-water-management-act-program.html.

City Operations

The City of Northampton routinely works to identify and repair water system leaks. Current water loss due to leakage is less than 10 percent of the total consumption. In addition, the City is considering the installation of an irrigation well at Florence Field, and is also working with Smith College to determine the feasibility of irrigation wells on campus, which would further conserve the City's water supply.

Table 20. Existing Drought Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
Massachusetts Water Management Act	Regulates amount of water that can be used during a Water Emergency Declaration.	Entire City.	Effective.	None.
Identification and reduction of water system leaks	The Department of Public Works routinely inspects and repairs water system leaks.	Entire City.	Effective.	None.
Water System Emergency Response Plan	Plan includes information about what City will do in response to water emergencies, including droughts.	Entire City.	Effective.	None.

Extreme Temperatures

A Continuity of Operations Plan outlines City government's functions and responsibilities in a natural disaster, which includes extreme temperatures, and relocation of services during these declared disasters.

Zoning Ordinance

In 2016, the City adopted a Zoning Ordinance (§350-12.3 Significant Trees) requiring that projects that meet site plan approval thresholds must replace any trees that are cut which are deemed "significant", which is any tree of 20 inches diameter breast height (DBH) or larger or any other tree specifically identified as a specimen tree on any Tree Inventory Plan adopted by the Planning Board.

Northampton Community & Resilience Hub

A Community & Resilience Hub is being explored as an effort to support Northampton residents who face chronic and acute stress due to natural and human-caused disasters, climate change, and social and economic challenges. This Hub is proposed to coordinate the distribution of various resources and services during normal times to more challenged populations through partnership with local service providers, public private partnerships, etc.; however, during major disruptions like a future disaster or pandemic, the Hub would provide the service and resource distribution citywide to all residents as now the Hub would play a role in the planning of preparing and responding to disaster. The Community & Resilience Hub would also potentially serve as a cooling and warming shelter in the case of extreme temperatures.

City Resilience Projects

In 2019, the Public Shade Tree Commission adopted a planting plan and planting list based on tree species that would be able to accommodate climate change and invasive species pressure. The Public Shade Tree Commission works in collaboration with the City Tree Warden and a private citizens' group, Tree Northampton. Together they promote ecological stewardship, volunteering to support Northampton's tree program by caring and planting trees all over the City.

In addition to the tree planting plan and revised planting list, the City continues to participate in resilient activities, such as replanting and reforesting an 80 acre golf course with money from the Significant Tree Fund and MVP grant. Additional tree planting projects for resilience include at Connecticut River Park, where Northampton Community Rowing serves as a partner in doing ongoing watering of newly planted trees.

Overall, the City budget for tree purchase and installation has increased in the past few years.

Table 21. Existing Extreme Temperatures Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
Relocation of public safety operations	The Police and Fire Departments have a relocation plan in the case of an emergency	Entire City	Effective	None.
Zoning Ordinance	The City adopted a significant tree zoning ordinance in 2016	Entire City	Effective	None.
CodeRED – Reverse 911 System	Emergency Management can target messaging to certain areas or the entire city to inform of emergencies and time-sensitive community issues, like extreme temperatures.	Entire City.	Effective.	None.

Wildfires/Brushfires

Wildfire and brushfire mitigation strategies involve educating people about how to prevent fires from starting, as well as controlling burns within the City.

Management Plans

The Northampton Comprehensive Emergency Management Plan does not include any specific information on wildfires.

Regulatory Measures

Burn Permits: The City of Northampton does allow open burning under the guidelines of the Department of Environmental Protection. Open Burning is authorized from January 15 to May 1. Burning is permitted between the hours of 10 a.m. and 4 p.m. The Officer in Charge of the Fire Department will determine if burning will be allowed at the beginning of the shift and can suspend burning if weather conditions change.

Subdivision Review: The procedures for the submission of preliminary and definitive subdivision plans require that the fire department be an active participant in the review of proposed subdivision plans. This involves verifying that proficient water supplies exist and that access routes to and from a given subdivision adequately meet public safety needs.

Public Education/Outreach: The Northampton Fire Department maintains a public outreach program that targets children and seniors with the intention of spreading information about fire safety within these two populations. Furthermore, the City has a safety inspection program that works to ensure that fire safety standards are being met.

Restrictions on Development

There are currently no restrictions on development that are based on the need to mitigate the hazards of wildfires and brushfires.

Table 22. Existing Wildfire/Brushfire Hazard Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
Burn Permits	Residents are permitted to obtain burn permits over the phone. State police personnel provide information on safe burn practices.	Entire City.	Effective.	None.
Subdivision Review: Fire Safety	The Fire Department is involved in the review of subdivision plans. The City of Northampton has extensive public water supplies and all residents are within the City's fire prevention operations. Regulations allow lower water flows above certain elevations for sprinkler systems and water storage in houses that are not connected to city water lines.	Entire City.	Effective. Would be effective in providing for an increase in fire suppression capacity. Effective.	None.
Public Education/Outreach	The Fire Department has an ongoing educational program in the schools.	Entire City.	Effective.	None.

Invasive Species

The spread of invasive species is a serious concern as species ranges shift with a changing climate. People can also carry invasive plant species on their clothing if walking through trails that may be present in soils.

Management Plans

The Open Space, Recreation & Multi-use Trails Plan offers a strategy of using volunteers to remove invasive species when exotics and non-native plants compete with local plants and degrade animal life. In 2012-2013, DCR approved Forest Management Plans for watershed forests in Northampton that identified invasive species as a threat to forest regeneration and overall forest health. Those plans provide a roadmap for future efforts to control invasive plant populations in the watershed to reduce the amount of forest cover lost to invasive plants. Among other things, the plans recommended managing invasives (bittersweet, etc.) to ensure a resilient forest that continues to provide a sustained supply of high quality water.

Regulatory Measures

Plants and trees invasive to Massachusetts are not allowed in the Highway Business Zone, per the Zoning Ordinance. Additionally, replacement trees shall be noninvasive deciduous or coniferous trees (as defined by the City's Tree List and Planting Guidelines) planted on or off site, as approved as part of a site plan or administrative site plan, or on any City-owned property with approval by the Office of Planning and Sustainability. The City Planning and Sustainability Department supports the Boards that oversee many of the regulatory requirements of tree planting, like requirements in site plan approval, subdivision regulation, or zoning relief.

Table 23. Existing Invasive Species Mitigation Measures

Existing Action	Description	Area Covered	Effectiveness	Potential Changes
Open Space, Recreation & Multi-Use Trails Plan	**Invasive plant species removal via volunteer and City collaboration**	**Entire City**	**Effective**	**None**
Zoning Ordinance	Requirement of non-invasive trees to be planted in HB Zoning District **Replacement trees shall not be noninvasive deciduous or**	HB Zoning District **Entire City**	Effective **Effective**	None **None**

Table 23. Existing Invasive Species Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
	coniferous trees as defined by the City's Tree List.			
Subdivision Regulations	Definitive Plan requirement for a tree inventory identifying significant groups of trees or any tree over 12 inches in diameter, including species Standards for planting include a tree list for shade trees within a subdivision	Entire City	Effective	None

Hurricane / Tropical Storm AND Severe Thunderstorm / Wind / Tornado

Hurricanes, severe thunderstorms, and tornadoes all generate high winds that can fell trees, down electrical wires, and generate hurtling debris. This common characteristic means that the same set of mitigation strategies applies equally to all four hazards. For example, current land development regulations, such as restrictions on the height of telecommunications towers, can help prevent wind damages from all four types of hazards. In addition to wind damage, hurricanes can generate significant flooding that damages buildings, infrastructure and threatens human lives. All of the existing mitigation measures listed in the Flooding section are also hurricane mitigation measures.

Management Plans

The Comprehensive Emergency Management (CEM) Plan for Northampton includes the following mitigation measures for hurricanes, severe thunderstorms, wind, and tornadoes:

- Develop and enforce building codes to enhance structural resistance to high winds.
- Develop and disseminate emergency public information and instructions concerning disaster safety, especially guidance regarding in-home protection and evacuation procedures, and locations of public shelters.

Zoning

The Telecommunications Facilities Zoning Ordinance requires that telecommunications towers be setback from adjacent property lines. This requirement prevents telecommunications facilities and ice on those facilities from falling and damaging neighboring properties.

Restrictions on Development

The City's Subdivision Ordinance requires that all new subdivisions have buried utility lines.

Mobile Homes

According to the Northampton Zoning Ordinance, mobile homes are not an allowed use. However, all regulations and legal protections given to victims of fires or other natural disasters must be followed, and such regulations are located in M.G.L. Chapter 40A.

State Building Code

For new or recently built structures, the primary protection against wind-related damage is construction that adheres to the State Building Code, which, when followed, results in buildings that withstand high winds. The City of Northampton employs a building inspector for all inspection duties and responsibilities.

Flood Mitigation Strategies

Because one of the primary impacts of hurricanes and severe thunderstorms is intense rainfall that generates flooding, all of the flood mitigation strategies discussed above are also mitigation strategies for hurricanes and severe thunderstorms.

Table 24. Existing Hurricane / Tropical Storm / Severe Thunderstorm / Wind / Tornado Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
Comprehensive Emergency Management Plan	The CEM includes the following mitigation measures: 1) Develop and enforce building codes to enhance structural resistance to high winds and 2) develop and disseminate emergency public information and instructions concerning disaster safety, especially guidance regarding in-home protection and evacuation procedures, and locations of public shelters.	Entire City.	Effective.	None.
Zoning regulations for tele-communications facilities	No facility shall exceed 220 feet in height as measured from the mean finished grade at facility base. No tower, exclusive of any attachments, shall be erected nearer to any property line than a distance equal to twice the vertical height.	Entire City.	Effective.	Consider adding safety and prevention of wind-related damage as a stated purpose.

Table 24. Existing Hurricane / Tropical Storm / Severe Thunderstorm / Wind / Tornado Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
Subdivision Regulations – Utilities (electric and telephone)	The City requires all utilities for new subdivisions to be underground.	Entire City.	Somewhat effective for ensuring that utility service is uninterrupted by severe storms in new areas of residential development.	Work with utility companies to underground new utility lines in general and existing utility lines in locations where repetitive outages occur.
Zoning Regulations regarding new mobile homes	Mobile homes are not an allowed use in all districts.	Entire City.	Does not address the potential for wind-related damage to mobile homes.	None.
State Building Code	The City of Northampton has adopted the Massachusetts State Building Code.	Entire City.	Effective.	None.
CodeRED – Reverse 911 System	Emergency Management can target messaging to certain areas or the entire city to inform of emergencies and time-sensitive community issues, like hurricanes and severe weather events.	Entire City.	Effective.	None.

Severe Winter Storm / Nor'easter

Winter storms can be especially challenging for emergency management personnel. The Massachusetts Emergency Management Agency (MEMA) serves as the primary coordinating entity in the statewide management of all types of winter storms and monitors the National Weather Service (NWS) alerting systems during periods when winter storms are expected. Even though the storm has usually been forecast, there is no certain way for predicting its length, size or severity. Therefore, mitigation strategies must focus on preparedness prior to a severe snow/ice storm.

The City's current mitigation tools and strategies focus on preparedness, with many regulations and standards established based on safety during storm events. To the extent that some of the damages from a winter storm can be caused by flooding, flood protection mitigation measures also assist with severe snowstorms and ice storms.

Management Plans

The Comprehensive Emergency Management (CEM) Plan for Northampton lists the following mitigation measure for severe winter storms:

- Develop and disseminate emergency public information concerning winter storms, especially material which instructs individuals and families how to stock their homes, prepare their vehicles, and take care of themselves during a severe winter storm.

To the extent that some of the damages from a winter storm can be caused by flooding, all of the flood protection mitigation measures undertaken by the City can also be considered as mitigation measures for severe snowstorms/ice storms.

Restrictions on Development

There are no restrictions on development that are directly related to severe winter storms. However, the Subdivision Rules and Regulations do set grade limits on driveways and address frontage variances for flag lots to ensure that roads and driveways will be passable in the winter.

The City of Northampton Subdivision Rules and Regulations set grade limits on streets that are included in Section 7:01: Streets and Ways and as part of Section 7:22: Underground Utility Systems, which, although not specified as weather hazard mitigation, can serve to minimize accident potential and power loss from severe winter storms. The City of Northampton Zoning Ordinance also regulates common driveways.

State Building Code

For new or recently built structures, the primary protection against snow-related damage is construction according to the State Building Code, which addresses designing buildings to withstand snow loads. Northampton has a full-time, professional building inspector on its staff.

Improvements to Backup Power Supply

The City continues working to improve the electrical resiliency of its emergency facilities, in case of power loss from hazards such as snowstorms. As part of this work, the City commissioned a study by Rivermoor Systems to make recommendations for improvements, such as adapting current buildings to backup power generators and photovoltaic facilities. The City is also working to improve the resiliency of the energy grid that serves emergency services and critical facilities.

In the draft Climate Resilience & Regeneration Plan to be included in the update to the City's Master Plan, the City is seeking a pathway to retrofit, upgrade and require new constructions of buildings and energy systems that can better withstand floods, heat waves, or extreme storms. Some recommendations include the development of microgrids and distributed energy systems with battery storage, particularly to power emergency services, providing backup power if the grid fails.

Table 25. Existing Severe Winter Storm / Nor'easter Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
Comprehensive Emergency Management Plan	The CEM Plan lists the following mitigation measure for severe winter storms: Develop and disseminate emergency public information concerning winter storms, especially material which instructs individuals and families how to stock their homes, prepare their vehicles, and take care of themselves during a severe winter storm.	Entire City.	Effective.	None.
Subdivision Regulations – Design Standards for Roads Standards for Flag Lots	Standards include street grade regulations (five to eight percent maximum). Requires that snow management strategy be a clear part of the conditions to permit a flag lot.	Entire City.	Effective.	None.
Subdivision Regulations – Utilities (electric and telephone)	The City requires all utilities for new subdivisions to be underground.	Entire City.	Somewhat effective for ensuring that utility service is uninterrupted by severe storms in new areas of residential development.	Work with utility companies to underground existing utility lines in locations where repetitive outages occur.

Table 25. Existing Severe Winter Storm / Nor'easter Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
State Building Code	Northampton follows the Massachusetts State Building Code.	Entire City.	Effective.	None.
Resiliency of electrical grid	Implementing improvements to electrical systems of emergency facilities.	Entire City.	Effective.	None.
Electrical grid for emergency services	Working to ensure resiliency of microgrid for emergency service facilities, and reviewing Smith College as a model.	Entire City.	Effective.	None.
Stretch Energy Code	The City adopted the Stretch Energy Code which is more aggressive than base code, allowing for buildings to achieve more energy savings and increase their passive survivability.	Entire City	Effective	None.

Earthquake

Although there are five mapped seismological faults in Massachusetts, there is no discernible pattern of previous earthquakes along these faults nor is there a reliable way to predict future earthquakes along these faults or in any other areas of the state. Consequently, earthquakes are arguably the most difficult natural hazard for which to plan.

Most buildings and structures in the state were constructed without specific earthquake resistant design features. In addition, earthquakes precipitate several potential devastating secondary effects such as building collapse, utility pipeline rupture, water contamination, and extended power outages. Therefore, many of the mitigation efforts for other natural hazards identified in this plan may be applicable during the City's recovery from an earthquake.

Management Plans

The Northampton Comprehensive Emergency Management Plan lists the following mitigation measures for earthquakes:

- Community leaders in cooperation with Emergency Management Personnel maintain an assessment of structures and land areas that are especially vulnerable to earthquake.
- Strict adherence should be paid to land use and earthquake resistant building codes for all new construction.
- Periodic evaluation, repair, and/or improvement should be made to older public structures.
- Emergency earthquake public information and instructions should be developed and disseminated.

State Building Code

State and local building inspectors are guided by regulations put forth in the Massachusetts State Building Code. The first edition of the Massachusetts State Building Code went into effect on January 1, 1975 and included specific earthquake resistant design standards. These seismic requirements for new construction have been revised and updated over the years and are part of the current, 8th edition of the Massachusetts State Building Code. Given that most structures in Massachusetts were built before 1975, many buildings and structures do not have specific earthquake resistant design features. In addition, built areas underlain by artificial fill, sandy or clay soils are particularly vulnerable to damage during an earthquake.

The City has since adopted the stretch code as it became a Green Community.

Restrictions on Development

There are no seismic-related restrictions on development beyond that in the building code.

Table 26. Existing Earthquake Mitigation Measures				
Existing Action	**Description**	**Area Covered**	**Effectiveness**	**Potential Changes**
Comprehensive Emergency Management Plan	The CEM Plan includes measures for earthquake preparation that include keeping an assessment of structures and land areas that are especially vulnerable to earthquakes, strict adherence to building code, periodic evaluation, repair, and/or improvement to older public structures, and dissemination of public information about how to prepare for earthquakes.	Entire City.	Effective.	None.
State Building Code	The City of Northampton has adopted the 9th Edition of the State Building Code.	Entire City.	Effective for new buildings only.	Evaluate older structures to be used as shelters and determine if they are earthquake resistant as per 9th Edition of the State Building Code.

Pandemic

The Comprehensive Emergency Management (CEM) Plan for Northampton includes the following mitigation measures for pandemics:

- Develop and disseminate emergency public information and instructions concerning personal health, hygiene, and sanitation.
- Developing epidemic intelligence, evaluation, prevention and detection of communicable diseases and disease control operations.
- Collection of vital statistics.

Northampton Resilience Hub

A Resilience Hub is being explored as an effort to support Northampton residents who face chronic and acute stress due to natural and human-caused disasters, climate change, and social and economic challenges. It will serve the 1% (homeless and others under the most severe chronic stress), the 15% (below the poverty line), the 40% (housing-burdened and under chronic stress) and the 100% (those at risk of acute, but not regular, adverse events), by providing access to resource, developing a network of neighbors, and building social resilience. This Hub is proposed to coordinate the distribution of various resources and services during normal times to more challenged populations through partnership with local service providers, public private partnerships, etc.; however, during major disruptions like a future disaster or pandemic, the Hub would provide the service and resource distribution citywide to all residents as now the Hub would play a role in the planning of preparing and responding to disaster.

Table 27. Existing Pandemic Mitigation Measures

Existing Action	Description	Area Covered	Effectiveness	Potential Changes
Comprehensive Emergency Management Plan	The CEM Plan includes measures for pandemics that include development and dissemination of public information regarding personal health and hygiene, developing epidemic intelligence and disease control operations, and collecting vital statistics.	Entire City.	Effective.	None.

Discontinued or Completed Mitigation Strategies

Several mitigation strategies listed in the 2015 version of the Northampton Hazard Mitigation Plan have been removed or completed in the time since this 5-year update. Deleted and completed strategies, and their status, are indicated in the table below. Mitigation strategies from the 2015 plan that were partially complete and are ongoing are presented with detailed status reports in the following section.

Table 28. Discontinnued or Completed Mitigation Strategies

Action Name	Description	Hazards Mitigated	Responsible Agency	Status
Remove unnecessary dams and other manmade structures where feasible: 1. Upper Roberts Dam removal 2. Fitzgerald Lake Dam Repair	1. The Upper Roberts Meadow Reservoir Dam was a High Hazard dam that the Office of Dam Safety (ODS) ordered the City to remove or repair. The dam was removed in 2018, eliminating the risk of dam failure and associated downstream flooding, and restoring the channel for unobstructed fish passage and natural flow. 2. DPW repaired the Fitzgerald Lake Dam after determining that the dam presented a low enough hazard that it did not need to be removed	Dam failure	1. DPW with funding from the Executive Office of Energy and Environmental Affairs 2. Capital Budget	Completed
Bank stabilization of the Roberts Meadow Brook	The City stabilized the banks of Robert Meadows Brook	Flooding	DPW with funding from FEMA's Hazard Mitigation Grant Program	Completed

Table 28. Discontinnued or Completed Mitigation Strategies				
Action Name	**Description**	**Hazards Mitigated**	**Responsible Agency**	**Status**
Repair of Mill River Retaining Wall	A retaining wall along the Mill River near the Williamsburg Town line was poorly constructed and deterioration over time threatened flooding of the adjacent roadway and the integrity of the main sewer interceptor from Williamsburg to the Northampton WWTP. The new concrete retaining wall mitigated these threats.	Flooding	DPW with funding from FEMA's Hazard Mitigation Grant Program	Completed
Upgrade flood control system to replace wooden battens with aluminum battens.	The DPW has reviewed quotes for current pricing to replace the wooden stop logs for the West Street closure structure and determined that current costs are prohibitive for the benefit gained.	N/A	N/A	Discontinued. The wooden stop logs for the Route 5 and railroad closure structures were replaced with high quality, grade-stamped timbers.

Prioritized Implementation Plan

Several of the action items previously identified in the 2015 Hazard Mitigation Plan are currently continuing, either because they require more time to secure funding or their construction process is ongoing. In addition, the Hazard Mitigation Committee identified several new strategies that are also being pursued. These new strategies are based on experience with currently implemented strategies, as well as the hazard identification and risk assessment in this plan. Overall mitigation strategy priorities have not changed since the last version of this plan, with specific mitigation strategies addressing all identified hazards through a combination of planning, public outreach, and infrastructure improvements.

Prioritization Methodology

The Northampton Hazard Mitigation Planning Committee reviewed and prioritized a list of previously identified and new mitigation strategies using the following criteria:

Application to multiple hazards – Strategies are given a higher priority if they assist in the mitigation of several natural hazards.

Time required for completion – Projects that are faster to implement, either due to the nature of the permitting process or other regulatory procedures, or because of the time it takes to secure funding, are given higher priority.

Estimated benefit – Strategies which would provide the highest degree of reduction in loss of property and life are given a higher priority. This estimate is based on the Hazard Identification and Analysis Chapter, particularly with regard to how much of each hazard's impact would be mitigated.

Cost effectiveness – in order to maximize the effect of mitigation efforts using limited funds, priority is given to strategies low-cost that would require low-cost investments by the CIty. For example, regular tree maintenance is a relatively low-cost operational strategy that can significantly reduce the length of time of power outages during a winter storm. Strategies that have identified potential funding streams, such as the Hazard Mitigation Grant Program, that would off-set the cost of an expensive project are also given higher priority.

Eligibility Under Hazard Mitigation Grant Program – The Hazard Mitigation Grant Program (HMGP) provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. Funding is made available through FEMA by the Massachusetts Emergency Management Agency. Municipalities apply for grants to fund specific mitigation projects under MEMA requirements

The following categories are used to define the priority of each mitigation strategy:

Low – Strategies that would not have a significant benefit to property or people, address only one or two hazards, or would require funding and time resources that are impractical

Medium – Strategies that would have some benefit to people and property and are somewhat cost effective at reducing damage to property and people

High – Strategies that provide mitigation of several hazards and have a large benefit that warrants their cost and time to complete

Several hazard mitigation strategies identified in the previous Hazard Mitigation Plan have not yet been completed, but were changed in priority during the update of this plan by the Hazard Mitigation Committee. The Committee changed priorities by evaluating the entire list of mitigation strategies in a comprehensive manner according to the factors listed above. For strategies that have changed in priority, the previous priority is provided in parenthesis in the "Priority" column.

Cost Estimates

Each of the following implementation strategies is provided with a cost estimate. Projects that already have secured funding are noted as such. Where precise financial estimates are not currently available, categories were used with the following assigned dollar ranges:

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

Cost estimates take into account the following resources:

- City staff time for grant application and administration (based on estimated average hourly rate of City staff)
- Consultant design and construction cost (based on estimates for projects obtained from City and general knowledge of previous work in City)
- City staff time for construction, maintenance, and operation activities (based on estimated average hourly rate of City staff)

Project Timeline

Each strategy is provided with an estimated length of time it will take for implementation. Where funding has been secured for the project, a specific future date is provided for when completion will occur. However, some projects do not currently have funding and thus it is difficult to know exactly when they will be completed. For these projects, an estimate is provided for the amount of time it will take to complete the project once funding becomes available.

Table 29. Mitigation Strategies to be Implemented									
	Mitigation Action	**Status**	**Mitigation Category**	**Hazards Mitigated**	**Responsible Department/Board**	**Timeline**	**Potential Funding Source(s)**	**Estimated Cost**	**Priority**
1	Continue current improvement strategies for flood control facility and implement recommendations.	Continue	SIP	Flooding, Hurricanes, Thunderstorms	City Council, Mayor's Office, Department of Public Works	2 years	MVP grant, HMGP, CIP, Stormwater Utility	$1M	High
	Status: Continuing. Contract engineers conducting assessments and improvements on behalf of the City, in line with requirements of US Army Corps of Engineers and FEMA accreditation. Initial assessment of Hockanum Road flood control pump station completed. Future needs include, but are not limited to, vegetation management at Mill and Connecticut River levees, condition assessment and repair of some sections of toe drains, refabricate stop logs for the railroad and Pleasant Street closure structures, and restoration of stop log buildings.								
2	Retrofit existing back-up government buildings to supplement existing fuel sources with external generators and photovoltaic cells.	Ongoing	SIP	All hazards	Central Services, Emergency Management Director, Department of Public Works, Fire Department	4 years	HMGP, CIP	<$500,000	High (formerly medium)
	Status: Backup generator installed for the Police Department radio tower at the landfill in 2017. Continuing as two sub-projects.: 1. Planning for islandable microgrid at DPW, Smith Vocational School, and Cooley Dickinson Hospital underway 2. PV/battery backup at Fire HQ: new parking lot design complete; procuring designer services for PV/battery system, waiting on grant extension								
3	Evaluate and make needed improvements to King Street Brook drainage area from Round Hill through Barrett Street marsh to the Connecticut River	Ongoing	SIP, NSP	Flooding, Hurricanes, Thunderstorms	Department of Public Works	4 years	MVP, HMGP	High	High

Table 29. Mitigation Strategies to be Implemented									
	Mitigation Action	**Status**	**Mitigation Category**	**Hazards Mitigated**	**Responsible Department/Board**	**Timeline**	**Potential Funding Source(s)**	**Estimated Cost**	**Priority**
	Status: City completed evaluation of potential for and initial design of nature-based design at Jackson Street School to hold back some water completed using MVP funds. Short term improvements at the Barrett Street marsh beaver dam and downgradient stream completed by DPW. DPW continues to implement short-term improvements to the King Street Brook area of flooding including cleaning out of the culverts and removing beaver dams and impediments to minimize flooding to residential areas on State Street and Church Street. An assessment and conceptual design has been completed for the construction of a berm to improve flow through the culvert under the Northampton Bikeway but funding has not been determined. Additional evaluation of other improvements may be necessary.								
4	Evaluate feasibility and design options to install automated debris racks at the stone arch structure in the King Street Brook Drainage Area	Continue	SIP	Flooding, Hurricanes, Thunderstorms	Department of Public Works	3 years	HMGP funds	High	High
5	Make needed improvements to address flooding of Elm Street Brook and Williams Street Brook	Continue	SIP, NSP	Flooding, Hurricanes, Thunderstorms	Department of Public Works	4 years	HMGP funds	High	High
	Status: Incremental steps have been completed, including an evaluation of potential nature-based solutions at Elm Street and elsewhere along the stream. Elm Street Brook flooding will be addressed by a new strategy to build infiltration trenches and other structures on City right of way and properties to reduce flows in the watershed. Drainage improvements in the Bridge Street and Williams Street Brook areas have shifted to assessment and repair/upgrade of the Day Avenue Brook drainage system in conjunction with improvements as part of the Damon Road reconstruction project. Much work remains to be done to mitigate the flood problem.								

Table 29. Mitigation Strategies to be Implemented									
	Mitigation Action	**Status**	**Mitigation Category**	**Hazards Mitigated**	**Responsible Department/Board**	**Timeline**	**Potential Funding Source(s)**	**Estimated Cost**	**Priority**
6	Develop a more formalized beaver management strategy to build upon current process	Continue. Solutions are unique to each site and it was determined that an overall checklist or management strategy will need to provide a unique framework for each site.	LPR, NSP	Flooding, Hurricanes, Thunderstorms	Conservation Commission, Planning and Sustainability	4 years	Department of Public Works	Low	Medium (previously high)
7	Public education outreach for floodplain related information	Ongoing	EAP	Flooding, Hurricanes, Thunderstorms.	Planning and Sustainability	Every year	Operating budget	Low	Medium
	Status: The City distributes floodplain related information at the Forbes Library and does annual mailing outreach to repetitive loss areas of the floodplain and to banking and real estate services.								
8	Develop an outreach program to ensure that owners of private stormwater systems are maintaining culverts, floodwater storage areas and other stormwater management structures.	Continue	EAP	Flooding, Hurricanes, Thunderstorms	Department of Public Works	2 years	Department of Public Works / Volunteers	Low	Medium (previously low)

Table 29. Mitigation Strategies to be Implemented									
	Mitigation Action	**Status**	**Mitigation Category**	**Hazards Mitigated**	**Responsible Department/Board**	**Timeline**	**Potential Funding Source(s)**	**Estimated Cost**	**Priority**
	Status: The DPW and Office of Planning and Sustainability will continue to monitor the status of maintenance of private stormwater systems and reach out to homeowners' associations and other owners of private stormwater systems to educate about on-going operation and maintenance responsibilities.								
9	Conduct on-going review of impacts of climate change on people, property, and critical facilities in Northampton	Ongoing.	LPR	All hazards	Planning and Sustainability	3 years	HMGP funds	Low	Medium
	Status: Periodic assessments as part of Northampton Resilience strategy, MVP applications, FEMA hazard mitigation plans, primarily focused on downscaling regional climate data supplementing by local information when needed. In addition the City's planning for a community and resilience hub includes understanding impacts on frontline communities. Potential for a partnership between the City, State, and other municipalities to build on the ongoing map modernization FEMA study of the watershed projecting floodplain limits in 1, 2, 10 year storms.								
10	Complete recently initiated inventory and prioritization of culverts throughout the City. Once complete, upgrade and repair undersized stormwater drainage system.	Revised and ongoing.	SIP	Flooding, Hurricanes, Thunderstorms	City Council, Mayor's Office, Department of Public Works, Department of Planning and Sustainability	5-20 years	Department of Public Works, Planning and Sustainability, HMGP	Very high	Medium
	Status: Upgrades and repairs of stormwater systems and culverts are ongoing based on specific needs, condition assessments and in coordination with the schedule for roadway reconstruction. The 2012 *Stormwater and Flood Control System Assessment and Utility Plan* provides guidance for upgrades and sizing of the stormwater system in the downtown area. In 2017, the City installed rain gardens on Pleasant Street as part of a MassDOT complete streets project and replace a circa 140 year old storm sewer with a $1 million in funding from MassWorks. In 2019, the City initiated a six year design project to redesign Main Street and improve green infrastructure to retain water longer, and added rain gardens to Pulaski Park to catch some Main Street stormwater. Additionally, the 2018 *Technical Memorandum-Infrastructure Resilience Strategy Recommendations for the Northampton Climate and Resiliency Plan* provides guidance on the specific design storm to use for determining stormwater infrastructure sizing. In 2019, Planning and Sustainability's *Design with Nature* project assessed opportunities for nature-based solutions to hold stormwater before it reaches stormwater systems and causes flooding.								

Table 29. Mitigation Strategies to be Implemented									
	Mitigation Action	**Status**	**Mitigation Category**	**Hazards Mitigated**	**Responsible Department/Board**	**Timeline**	**Potential Funding Source(s)**	**Estimated Cost**	**Priority**
11	Investigate opportunities for incentivizing utility companies for undergrounding utilities. Conduct background research of similar approaches in other communities.	Ongoing.	LPR	All hazards	Planning and Sustainability, PVPC	3 years	MVP, HMGP funds	Medium	Medium
12	Work with local building official and Hampshire county emergency response providers to identify an earthquake-resilient regional shelter to comply with latest version of the building code.	Ongoing, revised	LPR	Earthquake	Building Inspector, EMD, WRSHAC	2 years	FEMA, WRSHAC, Hampshire County Emergency Shelter	Low	Low
13	Educate homeowners on how to prepare for a tornado or hurricanes.	Ongoing	EAP	Tornadoes, hurricanes	Emergency Management Director, DPW, Fire Department	2 years	Western Region Homeland Security Advisory Council, Capital Budget	Low	Low
	Status: The City's Emergency Management Coordinator is active in the Western Region Homeland Security Advisory Council, which regularly conducts public outreach programs for preparedness. These efforts will continue moving forward.								

Table 29. Mitigation Strategies to be Implemented									
	Mitigation Action	**Status**	**Mitigation Category**	**Hazards Mitigated**	**Responsible Department/Board**	**Timeline**	**Potential Funding Source(s)**	**Estimated Cost**	**Priority**
14	Achieve FEMA Accreditation of flood control system. Borings and full analysis of flood control levees underway (funded by MVP grant and stormwater utility)	New strategy, related to strategy #1 above.	SIP, LPR	Flooding, Hurricanes, Thunderstorms	City Council, Mayor's Office, Department of Public Works, Planning and Sustainability, MVP	2 years, based on FEMA mapping modernization project for the Middle Connecticut watershed	MVP, HMGP, CIP, Stormwater Utility	< $750,000 - $2M	High
15	Upgrades to the Hockanum Pumping Station including an evaluation study to inform engineering design and construction for three phases of upgrades. Phase 1 includes major electrical upgrades, fuel storage tank replacement, and sewer line replacement.	New strategy, related to strategy #1 above.	SIP	Flood	Department of Public Works	10 years	Department of Public Works	Approx. $6M	High
16	Complete the inspections of the toe drains that was started in 2016, install new access manholes, and spot repair collapsed segments of toe drain, as needed.	New strategy, related to strategy #1 above.	SIP	Flood	Department of Public Works	2 years	Department of Public Works, EEA Dam and Seawall Repair Grant Program	$680,000	High

Table 29. Mitigation Strategies to be Implemented									
	Mitigation Action	**Status**	**Mitigation Category**	**Hazards Mitigated**	**Responsible Department/Board**	**Timeline**	**Potential Funding Source(s)**	**Estimated Cost**	**Priority**
17	Wastewater Treatment Plant (WWTP) upgrades in accordance with the 2016 Comprehensive Wastewater Management Plan (CWMP)	New strategy	SIP	Flood, Hurricane/Tropical Storm/ Severe Wind	Department of Public Works	20 years	Department of Public Works, Clean Water State Revolving Funds (CWSRF)	FY18, $900,000	High
18	Rehabilitate the Francis P. Ryan Reservoir Dam and the West Whately Reservoir Dam to meet Office of Dam Safety requirements	New strategy	SIP	Flood, Dam/ Levee Failure	Department of Public Works	5 years	Department of Public Works, EEA Dam and Seawall Repair Grant Program	Approx. $6M	High
19	New: Develop Community & Resilience Hub as a downtown physical facility with a coordinated program for frontline communities and all residents who face chronic and acute stress due to disasters, pandemics, climate change, and other social and economic challenges.	New strategy	SIP	Pandemic, All Hazards	Planning and Sustainability	5 years	HMGP, MVP, other state grants		High

Table 29. Mitigation Strategies to be Implemented									
	Mitigation Action	**Status**	**Mitigation Category**	**Hazards Mitigated**	**Responsible Department/Board**	**Timeline**	**Potential Funding Source(s)**	**Estimated Cost**	**Priority**
20	Restore Rocky Hill Greenway-Pine Grove Golf Course: Restore former golf course to a natural system, removing catch basins, reservoirs, concrete blocks and other fill, and grass cover, and restoring wetlands, floodplain, natural riparian channel, and floodplain.	New strategy. First $300,000 phase (catch basins, grass cover, start of natural forest) completed in 2020 with MVP funds.	NSP, SIP	Flood	Planning and Sustainability	5 years	HMGP, MVP, other state grants	$1.5M	High
21	Replace Ice Pond outlet structure. Combination of natural systems enhancement and reconstruction of outlet structure to capture stormwater that is threatening and has already damaged Rocky Hill Road/Route 66.	New strategy. Design phase, necessary easement, and FEMA grant application are complete as of June, 2020.	NSP, SIP	Flood	Planning and Sustainability	3 years	MVP for design, HMGP	$350,000	High

Table 29. Mitigation Strategies to be Implemented									
	Mitigation Action	**Status**	**Mitigation Category**	**Hazards Mitigated**	**Responsible Department/Board**	**Timeline**	**Potential Funding Source(s)**	**Estimated Cost**	**Priority**
22	Purchase at risk properties in floodplain. Purchase and remove structures from floodplain. Purchase other flood prone properties for permanently protected open space preservation.	New strategy, already in progress. For example, the City, through Planning and Sustainability, purchased Pine Grove Golf Course (2020), and donated land to Conte Fish and Wildlife Refuge (2020),	LPR, NSP	Flood	Planning and Sustainability	10 years	HMGP, LAND, FLWCF	$1 M	High
23	Public education to minimize the impact of invasive species. Continue growing an existing volunteer program to mechanically manage invasive plant populations.	New strategy	EAP	Invasive Species	Planning and Sustainability, Conservation Commission, DPW	2 years	Staff time, CPA	Low	Low

Table 29. Mitigation Strategies to be Implemented									
	Mitigation Action	**Status**	**Mitigation Category**	**Hazards Mitigated**	**Responsible Department/Board**	**Timeline**	**Potential Funding Source(s)**	**Estimated Cost**	**Priority**
24	Conduct annual forest surveys on conservation lands to identify new invasive infestations and initiate rapid response efforts to control those infestations before they become established populations	New	NSP	Invasive Species	Planning and Sustainability, Conservation Commission, DPW	5 years	Staff Time, MVP, DCR	Low-Medium	Medium
25	Public education campaigns to minimize the impact of extreme temperature events (1) promote utility and state-funded residential insulation and air sealing incentive programs (2) promote increased use of high-efficiency air source heat pumps for residential heating and cooling, particularly to populations sensitive to extreme temperatures.	New	EAP	Extreme temps	Central Services / Energy & Sustainability Commission	Annually, biannually or triannually as funding and staff time allows	Massachusetts Clean Energy Center, operating budget (staff time), utility partnership(s), resident volunteers	Low	Low
26	Increase shade trees for cooling	New	NSP	Extreme temps	DPW	Short and long term	DPW Budget, significant tree mitigation fund.	Medium	Medium

Table 29. Mitigation Strategies to be Implemented									
	Mitigation Action	**Status**	**Mitigation Category**	**Hazards Mitigated**	**Responsible Department/Board**	**Timeline**	**Potential Funding Source(s)**	**Estimated Cost**	**Priority**
27	Review city and regional emergency response plans to better prepare for pandemics, recognizing how design of place for social distancing leading up to any event can impact risk levels for vulnerable populations during a pandemic. Also, review and update HMP through a new lens based on our experience with COVID-19.	New	LPR	All hazards, pandemic	Emergency Management, Planning and Sustainability, Board of Health	2 years	HMGP, FEMA	Low	High

Notes: "All Hazards" indicates all hazards profiled in this plan.

Acronyms and Abbreviations:

COA	Council on Aging
DPW	Department of Public Works
DLTA	District Local Technical Assistance
FEMA	Federal Emergency Management Agency
FPA	Floodplain Administrator
HMA	Hazard Mitigation Assistance
N/A	Not applicable
NFIP	National Flood Insurance Program
MEMA	Massachusetts Office of Emergency Management
MVP	Municipal Vulnerability Preparedness Program

Timeline:

Short	1 to 5 years
Long	5 years or greater
OG	On-going program
DOF	Depending on funding

Costs:

Where actual project costs have been reasonably estimated:

Low	< $50,000
Med	$50,000 to $100,000
High	> $100,000

Where actual costs cannot reasonably be established at this time:

Low	Possible to fund under existing budget. Project is part of, or can be part of an existing on-going program.
Med	Could budget for under existing work plan, but would require a reapportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
High	Would require an increase in revenue via an alternative source (i.e., bonds, grants, fee increases) to implement. Existing funding levels are not adequate to cover the costs of the proposed project.

Mitigation Category:

Local Plans and Regulations (LPR) – These actions include government authorities, policies, or codes that influence the way land and buildings are being developed and built.

Structure and Infrastructure Project (SIP) - These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This action could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct manmade structures to reduce the impact of hazards.

Natural Systems Protection (NSP) – These actions minimize damage and losses and also preserve or restore the functions of natural systems.

Education and Awareness Programs (EAP) – These actions inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. These actions may also include participation in national programs, such as StormReady and Firewise Communities

6: PLAN REVIEW, EVALUATION, IMPLEMENTATION, AND ADOPTION

Plan Adoption

Upon completion of the draft Hazard Mitigation Plan, a public meeting was held on June 22th to receive comments. The Hazard Mitigation Plan was then submitted to the Massachusetts Emergency Management Agency (MEMA) and the Federal Emergency Management Agency for their review. Upon receiving conditional approval of the plan by FEMA, the plan was presented to the Northampton City Council and adopted.

Plan Implementation

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

Incorporation with Other Planning Documents

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

- ***Northampton Comprehensive Emergency Management Plan*** (particularly the Critical Infrastructure Section) – the Critical Infrastructure section was used to identify those infrastructure components in Northampton that have been identified as crucial to the function of the Northampton; also, this resource was used to identify special needs populations as well as potential emergency shortcomings.
- ***Northampton*** **Open Space, Recreation, and Multiuse Trail Plan 2018-2025**– this Plan was used to identify the natural context within which the Northampton mitigation planning would take place. This proved useful insofar as it identified water bodies, rivers, streams, infrastructure components (i.e. water and sewer, or the lack thereof), as well as population trends. This was incorporated to ensure that the City's mitigation efforts would be sensitive to the surrounding environment. During the OSRP update, Northampton incorporated the work of the Hazard Mitigation Plan update in 2015 to incorporate identified hazard areas into open space and recreation planning. This could either take the form of acquiring parcels of land that are currently un-developed, but situated within an identified hazard area, as permanent open space, thereby minimizing the likelihood that critical infrastructure components will be constructed in an area prone to damage from natural hazards.

- ***Northampton Zoning Ordinance*** - The City's Zoning was used to gather identify those actions that the City is already taking that are reducing the potential impacts of a natural hazard (i.e. floodplain regulations) to avoid duplicating existing successful efforts.
- ***Massachusetts' State Hazard Mitigation and Climate Adaptation Plan*** - This plan was used to insure that the City's HMP was consistent with the State's Plan.
- **The *Flood and Natural Hazard Mitigation Plan for the City of Northampton*** was used to gather information on those actions and activities that the City is already undertaking in regards to pre-disaster mitigation for the City's greatest threat, flooding. This included incorporating statistical research, existing mitigation measures, and project rankings for Northampton.
- **The Sustainable Northampton Comprehensive Plan** – actions from the Hazard Mitigation Plan that promote a sustainable Northampton are incorporated.
- **Northampton Climate Resilience and Regeneration Plan (2019)** Draft will be incorporated into the *Sustainable Northampton* Comprehensive Plan in the next update. The document identifies the dedication of city-wide systems and policies to mitigate climate change and build resilience and regenerative programming for the future.
- **Summary of Findings, City of Northampton Community Resilience Building Workshop, updated March 2020** – priorities and actions identified per hazard confirming community commitment through the MVP program's Community Resilience Building workshop to promote building resilient systems and processes
- **Discovery Report for the Middle Connecticut Watershed, HUC-8 01080201, FEMA product** prioritizes areas and infrastructure of concern within the watershed. A product of this planning process will the remapping of the floodplain.

Guided by the resources identified above and other best practices, the Committee made a number of changes to this Hazard Mitigation Plan Update. The most notable include:

- Adding Extreme Temperatures, Invasive Species, and Pandemic to the list of profiled Hazards of Concern
- Expanding the description of the sectors assessed for the vulnerability analysis
- Adding a section on Climate Change and Natural Hazards to the beginning of the Risk Assessment Chapter, and redistributing the discussion of climate change considerations formerly included at the end of the Risk Assessment Chapter into each hazard profile.
- Reorganizing the Critical Facilities list to more clearly delineate the buildings and infrastructure which have been determined to be critical to providing emergency services to the planning area. Features of these facilities, such as whether or not they are equipped with back-up power, are included as notes or elsewhere in the plan.
- Reprioritized all of the new and existing mitigation strategies to reflect current financial, legal, political, and post-disaster conditions.

The Hazard Mitigation Plan will also be incorporated into updates of the following plans:

- Comprehensive Emergency Management Plan
- Open Space, Recreation, and Multiuse Trail Plan updates
- Flood and Natural Hazard Mitigation Plan for the City of Northampton
- Sustainable Northampton Comprehensive Plan
- Future updates of the City of Northampton Community Resilience Building Workshop Summary of Findings
- Northampton Climate Resilience and Regeneration Plan

During regular update meetings for the Hazard Mitigation Plan, the Hazard Mitigation Committee will review whether any of these plans are in the process of being updated. If so, the Hazard Mitigation Committee will provide copies of the Hazard Mitigation Plan to relevant City staff and brief them on the content of the Hazard Mitigation Plan. The Hazard Mitigation Committee will also review current City programs and policies to ensure that they are consistent with the mitigation strategies described in this plan.

Plan Monitoring and Evaluation

The measure of success of the Northampton Hazard Mitigation Plan will be the number of identified mitigation strategies implemented. In order for the City to become more disaster resilient, there must be a coordinated effort between elected officials, appointed bodies, City employees, regional and state agencies involved in natural hazard mitigation, and the general public.

The Northampton Hazard Mitigation Committee will meet on an annual basis or as needed (i.e., following a natural disaster) to monitor the progress of implementation, evaluate the success or failure of implemented recommendations, and brainstorm for strategies to remove obstacles to implementation. As the Hazard Mitigation Plan is monitored and evaluated, the Committee will add information about hazard events / disasters that have occurred in the prior planning year in order to avoid missing them in the next update.

Following these discussions, it is anticipated that the committee may decide to reassign the roles and responsibilities for implementing mitigation strategies to different City departments and/or revise the estimated costs, timelines for implementation, or priority of one or more proposed action. The committee will review and update the plan every year, beginning in the spring of 2021. The meetings of the committee will be organized and facilitated by Planning and Sustainability. Public participation will be a critical component of the Hazard Mitigation Plan maintenance process. The Hazard Mitigation Committee will hold all meetings in accordance with Massachusetts open meeting laws. Hard copies of the plan will be available in City Hall and at Forbes Library. Any proposed amendments resulting from annual Committee meetings will be advertised and posted on the city's website and the Planning and Sustainability listserve newsletter. Any changes will be preceded by a public hearing and solicitation of public comments.

7: APPENDICES

Appendix A – Documentation of the Planning Process

Invitation to Participate in the Planning Process

From: Wayne Feiden
To: Chris Mason; David Pomerantz; David Veleta, PE; Donna LaScaleia; Doug McDonald; Duane Nichols; Emily Slotnick; Jody Kasper; Jon Davine; Kelly Banister Schuetze; Sarah LaValley; Wayne Feiden, FAICP; Wayne Feiden, FAICP
Subject: Invitation to serve on FEMA Multi-Hazard Mitigation Plan Steering Committee
Date: Tuesday, October 29, 2019 6:26:48 PM

Our FEMA Multi-Hazard Mitigation Plan is expiring soon and we need to revise it. This plan helps us reduce the risks from hazards and makes us eligible for certain FEMA funds (e.g., removing remove the Upper Roberts Meadow Dam, repairing the wall on River Road, and upgrades the Ice Pond site on Route 66).

Because we just did our Municipal Vulnerability assessment last year, the plan update will be relatively easy this year. We have hired PVPC, through Emily Slotnik, to put the plan together.

Are you willing to serve on the steering committee, attending a **maximum of 8 meetings?**
David Veleta, City Engineer, Public Works
Doug McDonald, Stormwater Coordinator, Public Works
(Donna LaScalia on the cc list but not expected to attend)
Duane Nichols, Fire Chief and/or Jon Davine, Deputy Fire Chief/Emergency Management
Jody Kasper, Police Chief, or her designee
David Pomerantz, Central Services Director and/or Chris Mason, Central Services Energy
Wayne Feiden, Director of Planning & Sustainability (project manager)
Sarah LaValley, Land Use and Environmental Planner (Planning's representative to the committee)
Kelly Schuetze, Dispatch

Wayne

Wayne Feiden, FAICP, Director Planning & Sustainability
City of Northampton
210 Main St, City Hall, Northampton, MA 01060
(413) 587-1265
www.NorthamptonMA.gov/PLAN

Committee Meeting Agendas and Records of Attendance

Northampton Hazard Mitigation Plan Update Steering Committee
Meeting #1 Agenda
Virtual Zoom Meeting
April 2, 2020, 9:00 a.m.

1. Introductions and Roll Call
2. Overview of Hazard Mitigation Planning Process (see HMP Overview.doc)
    a. What is Hazard Mitigation Planning
    b. Planning process and requirements
        i. Items to be reviewed/ updated from current HMP
            1. Value of all property in city
            2. Recent and planned development projects
            3. History of natural hazards in last 5 years
            4. Hazard identification map (including culverts)
            5. Critical facilities inventory and map
            6. Hazard risk assessments
            7. Status of previously identified mitigation strategies
            8. New mitigation strategies
        ii. Build on the lessons learned from recent planning
            1. MVP planning grant
            2. MVP Northampton Designs with Nature action grant
            3. Northampton Climate Resiliency and Regeneration Plan
3. Our tasks Today:
    a. Select hazards to include in the plan (see hazards matrix handout)
    b. Confirm/Update Planning Goal: To minimize the loss of life, damage to property, and the disruption of governmental services and general business activities due to the following hazards: flooding, severe snowstorms/ice storms, severe thunderstorms, hurricanes, tornadoes, wildfires/brushfires, earthquakes, dam failures, and drought.
    c. Agree on future meeting schedule (see below)
    d. Develop outreach strategy (refer to HMP Overview.doc)
4. Questions?
5. Next Steps
    a. Review Draft Press Release (Emily to distribute), submit to local media
    b. Complete hazard events worksheet (Emily to distribute)
    c. Next committee meeting agenda:
        i. Review of Hazards/Critical Facilities
        ii. Identify Unique Local Hazards (past and potential) on Base Map
        iii. Identify Local Critical Facilities

2020 City of Northampton Hazard Mitigation Plan Update (FEMA)

Committee Meeting Sign-In Sheet

Meeting Date: April 2, 2020

Steering Committee Core Member	**Position**	**Representing**	**Present**
David Veleta, PE	City Engineer	Public Works	y
Doug McDonald	Stormwater	Public Works	y
Jon Davine	Fire Chief	Emergency Management	n
Jody Kasper	Police Chief	Police	y
David Pomerantz	Director	Central Services	y
Sarah LaValley	Environmental Planner	Planning and Sustainability	y
Kelly Schuetze	Director	Dispatch	y
Attending and Consulting as needed			
Specialty Member	**Position**	**Representing**	
Wayne Feiden, FAICP	Planning Director	Planning and Sustainability	y
Chris Mason	Energy & Sustainability Officer	Central Services	y
Donna LaScalia	Director	Public Works	n
Andrew Pelis	Deputy Fire Chief	Fire, Emergency Management	y
Merridith O'Leary	Director	Public Health	n
PVPC staff			
Lead Staffer	Title	Notes	
Emily Slotnick	Senior Planner	Project manager	y
Ken Comia	Land Use Planner		y
Jake Dolinger	GIS		n
Members of the Public			
None			

Northampton Hazard Mitigation Plan Update Steering Committee

Meeting #2 Agenda

Virtual Zoom Meeting

April 28, 2020, 7:30 p.m.

1. Introductions and Roll Call
    a. All participants to type names into Zoom chat feature to indicate attendance
2. Our tasks Today:
    a. Review Local Critical Facilities
    b. Identify locations of unique local hazards (past and potential)
    c. Request updated list of problem culverts
    d. Identify/Update Potential New Development Sites
3. Questions?
4. Next Steps
    a. Complete capabilities assessment worksheet (Emily to distribute)
    b. Next committee meeting agenda:
        i. Review capabilities assessment
        ii. Review existing mitigation strategies and "integration actions"
        iii. Review other recommended mitigation measures from 2015 plan

Upcoming schedule

1. CM #3: Thursday May 21, 9:00 – 11:00 am
2. CM #4: Thursday June 4, 9:00 – 11:00 am
3. Complete draft HMP update the week of June 15th
4. PM #2 and CM #5: Monday, June 22, 6:30-8:30 pm
    a. Present draft plan at PM#2
    b. Send draft plan to City Council for reading at their June 18th or July 9th meeting
5. Submission to MEMA for review – First week of July
6. Current plan expires August, 2020

Attendees

Committee Members	Kelly Schuetze
David Pomerantz	Wayne Feiden
Chris Mason	Sarah LaValley
Emily Slotnick	David Veleta

Northampton Hazard Mitigation Plan Update Steering Committee

Meeting #3 Agenda

Virtual Zoom Meeting

May 22, 2020, 9:00 a.m.

1. Introductions and Roll Call
    a. All participants to type names into Zoom chat feature to indicate attendance
2. Our tasks Today:
    a. Review capabilities assessment
    b. Review existing mitigation strategies and "integration actions"
    c. Review other recommended mitigation measures from 2015 plan, as time allows
3. Questions?
4. Next Steps
    a. Complete mitigation strategy worksheet (Emily to distribute)
    b. Next committee meeting agenda:
        i. Review proposed mitigation strategy
        ii. Prepare for Public Meeting #2
        iii. Plan Review, Evaluation, Implementation, and Adoption, if time allows

Upcoming schedule

7. CM #4: Thursday June 4, 9:00 – 11:00 am
8. Complete draft HMP update the week of June 15th
9. PM #2 and CM #5: Monday, June 22, 6:30-8:30 pm
    a. Present draft plan at PM#2
    b. Send draft plan to City Council for reading at their June 18th or July 9th meeting
10. Submission to MEMA for review – First week of July
11. Current plan expires August, 2020

Attendees

Committee Members
Wayne Feiden
Sarah LaValley
Kelly Schuetze
David Veleta
Doug McDonald
Chris Mason
David Pomerantz

PVPC
Emily Slotnick
Kenneth Comia

Northampton Hazard Mitigation Plan Update Steering Committee

Meeting #4 Agenda

Virtual Zoom Meeting

June 4, 2020, 9:00 a.m.

1. Introductions and Roll Call
    a. All participants to type names into Zoom chat feature to indicate attendance
2. Review Completed, Deleted, and Proposed Mitigation Strategies
    a. Costs
    b. Prioritization
    c. Responsible entities
    d. Funding sources
3. Prepare for Public Meeting #2
4. Plan Review, Evaluation, Implementation, and Adoption
5. Next Steps: Complete draft HMP update the week of June 15th
6. Next meeting date: PM #2 and CM #5: Monday, June 22, 6:30-8:30 pm
    a. Present draft plan at PM#2
    b. Send draft plan to City Council for reading at their June 18th or July 9th meeting

Attendance

Committee Members

Andrew Pelis

David Pomerantz

Wayne Feiden

Sarah LaValley

Chris Mason

Doug McDonald

Josh Stanley

David Veleta

PVPC

Emily Slotnick

Northampton Hazard Mitigation Committee

Meeting Agenda

Northampton City Hall

June 22, 2020, 7:30 p.m. – 8:30 p.m.

1. Review of revisions required based on public input
2. Next Steps
    a. Send draft plan to City Council for reading at their June 18th or July 9th meeting
    b. Submission to MEMA for review – First week of July
3. Current plan expires August, 2020

Attendance

Committee Members
Andrew Pelis
David Pomerantz
Wayne Feiden
Sarah LaValley
Chris Mason
Doug McDonald
Josh Stanley
David Veleta
PVPC
Kenneth Comia

Public Meeting Agendas, Records of Attendance, Press Releases, and Presentations

Northampton Hazard Mitigation Plan Update
Public Meeting #1
Virtual Zoom Meeting
April 28, 2020, 6:30 p.m.

Agenda

1. Welcome and introductions
2. Overview of hazard mitigation planning process
3. Hazard identification and risk assessment
    a. Types of hazards affecting Northampton
    b. Previous occurrences, extent, location, impact, future probability, and vulnerability of each hazard
2. Next steps

Attendees

Committee Members
David Pomerantz
Chris Mason
Emily Slotnick
Kelly Schuetze
Wayne Feiden
Sarah LaValley
David Veleta

Members of the Public

Alex Jarrett, Ward 5 City Councilor
Sarah Howard
Molly Moss, Forbes Library
Linda Danube
Jenn Guetti Slocum, Head Start
Alisa Klein, Grow Food Northampton
Sharon Moulton
Jamie Kaplan
Debin Bruce
Rowan Cignoni
Bruce Stedman, Conway School of Landscape Design
Jonathan Danube
George Kohout, Planning Board
Ed Skroski
Marianna Zak

MEDIA RELEASE / NOTICE

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FOR IMMEDIATE RELEASE
April 3, 2020

City of Northampton to Hold Public Engagement Event for its Hazard Mitigation Plan Update

Northampton residents, businesses, and surrounding community representatives are invited to learn about the City of Northampton Hazard Mitigation Plan (HMP) Update and provide comments at a Zoom meeting on April 28 from 6:30-7:30 pm. Individuals can connect to the meeting using the Zoom desktop client, Zoom mobile app, landline, or cell phone. The meeting will include an overview of the hazard mitigation planning process and a discussion of existing mitigation initiatives addressing natural hazards in Northampton. Members of the HMP steering committee, municipal officials and PVPC staff will be available to answer questions and receive input on the impacts of natural hazards on the City. All members of the public, representatives from surrounding communities and other interested parties are welcome to attend the event.

https://tinyurl.com/HampHMP

Meeting ID: 306 528 007; Password: 027571 or dial in at +1-301-715-8592

This planning effort is being undertaken to help Northampton assess the risks faced from natural hazards, identify action steps that can be taken to prevent injury, loss of life, and damage to property, and prioritize funding for mitigation efforts. A mitigation action is any action taken to reduce or eliminate the long-term risk to human life and property from hazards. Past Hazard Mitigation Plans have made the City eligible for grant-funded construction projects (e.g., bank stabilization along Roberts Meadow Brook, flood control measures along River Road, and elevating a house on Island Road) and advanced regulatory reform (e.g., revising the City's floodplain regulations).

To facilitate the HMP update process, the City has established a steering committee to update its HMP with assistance from the Pioneer Valley Planning Commission and funding from the Federal Emergency Management Agency (FEMA) and the Massachusetts Emergency Management Agency (MEMA). All steering committee working meetings will be posted on the City's website and are open to the public. Individuals interested in the HMP update process who are unable to attend a meeting can submit questions and comments to the Pioneer Valley Planning Commission.

For more information, please contact PVPC's Emily Slotnick at eslotnick@pvpc.org or (413) 285-1188.

Emily Slotnick

From: Northampton Planning & Sustainability <slavalley@northamptonma.gov>
Sent: Wednesday, April 22, 2020 5:50 PM
To: Emily Slotnick
Subject: Northampton Hazard Mitigation Plan Public Virtual Meeting

Follow Up Flag: Follow up
Flag Status: Flagged

Northampton Planning & Sustainability | 210 Main St. City Hall, Planning & Sustainability, Northampton, MA 01060

Unsubscribe eslotnick@pvpc.org

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Sent by slavalley@northamptonma.gov in collaboration with

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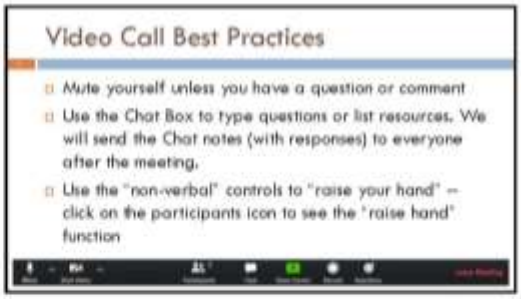
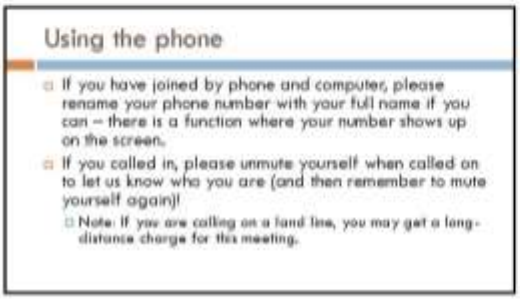
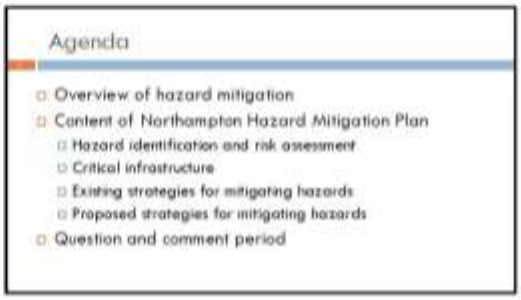
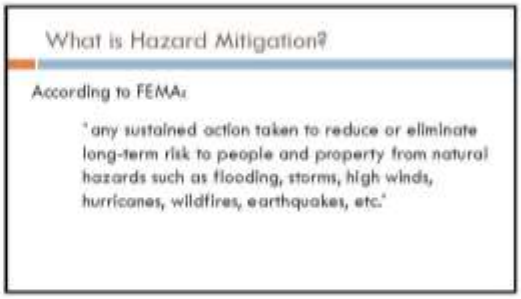
Slides from Public Outreach Presentation on April 28, 2020









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What is Hazard Mitigation?

FEMA

"Any sustained action taken to reduce or eliminate long-term risk to people and property from natural hazards."

Examples:

- Limiting development in high-risk areas
- Retrofitting structures to protect them from floods, high winds, etc.
- Drainage and flood control projects
- Increase tree plantings around buildings to shade parking (extreme heat)

Where does mitigation fit?

Historic Flood Events

Benefits of Hazard Mitigation

- Makes community eligible to apply for Hazard Mitigation funds from FEMA
- Mitigation is less expensive than disaster clean up
- Having a plan provides an approach for using limited resources more effectively

Overview of a Hazard Mitigation Plan

Purpose of plan:
Lessen the long-term consequences of natural disasters

Key plan components:

1. Hazard identification and assessment
2. Identification of critical infrastructure
3. Existing and proposed mitigation strategies
4. Proposed schedule for implementation of strategies

Hazard Assessment

Flooding	Medium	High		2 - High risk
	Large	High	Limited	3 - Medium risk
	Small	Severe thunderstorms: Moderate Winds: Moderate Tornadoes: Very low	Limited	Severe thunderstorms: 3 – High Risk Winds: 3 – High Risk Tornadoes: 4 – Low risk
Hurricanes	Large	Low	Limited	3 - High risk
Wildfire / Brushfire	Medium	Low	Minor	4 - Low risk
Earthquakes	Large	Very low	Critical	4 - Low risk
Dam Failure / Levee Breach	Medium	Very low	Critical	5 - Very low risk
Drought	Large	Low	Minor	5 - Very low risk

Recent Natural Hazard Events

2020 Hazard Assessment

2020 Hazard Assessment

Critical Infrastructure Inventory

An inventory of critical infrastructure in the City is underway, which includes:

- Emergency service buildings
- City offices
- Water, sewer, and road infrastructure
- Communications towers
- Emergency shelters

Other structures identified include elderly housing and assisted living residences, schools and places of worship

Critical Infrastructure Affected by Hazards

Existing and New Mitigation Strategies

- **Northampton's current HMP includes a list of existing mitigation strategies, as well as strategies to be pursued in the future (see link to 2015 Plan on next slide)**
- **The HMP Committee will**
  - Evaluate the effectiveness of each identified mitigation strategy
  - Assess and describe strategy integration with other municipal plans
  - Re-prioritize the list of strategies and determine if any new strategies should be added

Next Steps in Planning Process

- 2015 Plan is posted at http://www.pvpc.org/sites/default/files/Northampton HMP2015.pdf
- Future Meetings
  - Committee Meeting #2: Tuesday April 28th, 7:30-8:30 pm
  - CM #3: Thursday May 21, 9:00 – 11:00 am
  - CM #4: Thursday June 4, 9:00 – 11:00 am
  - PM #2 and CM #5: Monday, June 22, 6:30-8:30 pm

Next Steps in Planning Process

- Draft of revised plan, based on public feedback and input from Hazard Mitigation Steering Committee, will be released at a public meeting on June 22 at 6:30 p.m.
- Final Draft Plan will then be submitted to MEMA and FEMA

Question and Comments

Questions?

- Contact information:

Emily Slotnick
Senior Planner, Pioneer Valley Planning Commission
E-mail: [redacted]
Phone: 413-781-6045

Northampton Hazard Mitigation Plan Update
Public Meeting #2
Virtual Zoom Meeting
June 22, 2020, 6:30 p.m.

Agenda

1. Welcome and introductions
2. Presentation of Draft Hazard Mitigation Plan Update
    a. Review of Mitigation Strategy
3. Next Steps

Attendance

Media and Press Release

PIONEER VALLEY PLANNING COMMISSION

City of Northampton, PVPC Hold Public Engagement Event for Local Hazard Mitigation Plan Update

View Edit

- Unpublish
- Add article

29 May 2020

Northampton residents, businesses, and surrounding community representatives recently had the opportunity to learn about the City of Northampton Hazard Mitigation Plan (HMP) Update and provide comments at a Zoom meeting held on April 28.

The meeting included an overview of the hazard mitigation planning process and a discussion of existing mitigation initiatives addressing natural hazards in Northampton. Members of the HMP steering committee, municipal officials and PVPC staff were present and available to answer questions and receive input on the impacts of natural hazards on the City.

All interested parties are encouraged to attend the second and final public meeting via Zoom (link to be provided by the City) on June 22nd, at 6:30 pm to review the draft plan update and provide input of future mitigation actions.

This planning effort is being undertaken to help Northampton assess the risks faced from natural hazards, identify action steps that can be taken to prevent injury, loss of life, and damage to property, and prioritize funding for mitigation efforts.

A mitigation action is any action taken to reduce or eliminate the long-term risk to human life and property from hazards. Past Hazard Mitigation Plans have made the City eligible for grant-funded construction projects (e.g., bank stabilization along Roberts Meadow Brook, flood control measures along River Road, and elevating a house on Island Road) and advanced regulatory reform (e.g., revising the City's floodplain regulations).

To facilitate the HMP update process, the City has established a steering committee that is working with assistance from the Pioneer Valley Planning Commission and funding from the Federal Emergency Management Agency (FEMA) and the Massachusetts Emergency Management Agency (MEMA). All steering committee working meetings will be posted on the City's website and are open to the public. Individuals interested in the HMP update process who are unable to attend a meeting can submit questions and comments to the Pioneer Valley Planning Commission.

HMPs have to be updated on a 5-year cycle to maintain FEMA approval/eligibility for certain grants. Within that 5 year period, the plan participants (municipal government and departments) are eligible to apply for mitigation-related FEMA grant funding opportunities to reduce their natural hazard vulnerabilities.

For more information on Northampton's HMP or to engage PVPC in HMP work on behalf of your community, please contact PVPC's Emily Slotnick at eslotnick@pvpc.org or (413) 285-1188.

Slides from Public Outreach Presentation on July 22, 2020

Location of Draft Hazard Mitigation Plan on Website of Pioneer Valley Planning Commission

http://www.pvpc.org/plans/city-northampton-hazard-mitigation-plan

City of Northampton Hazard Mitigation Plan

View Edit

Add plan

This City of Northampton Hazard Mitigation Plan Update is being completed to help the City of Northampton assess the risks faced from natural hazards, identify action steps that can be taken to prevent damage to property and loss of life, and prioritize funding for mitigation efforts. Additionally, mitigation actions identified in the 2015 Hazard Mitigation Plan were reviewed to track implementation and level of effectiveness.

The Hazard Mitigation Plan Update is being produced by the City, along with the Pioneer Valley Planning Commission, with funding provided by the Federal Emergency Management Agency and assistance from the Massachusetts Emergency Management Agency.

Documents

DRAFT NORTHAMPTON 2020 HAZARD MITIGATION PLAN UPDATE

DRAFT Northampton 2020 Hazard Mitigation Plan Update for public review

Northampton_HMP_u_061320.pdf

Appendix B – List of Acronyms

CCRP	Northampton Climate Resilience and Regeneration Plan
CDC	Center for Disease Control
CEM	Community Emergency Management
CIS	FEMA Community Information System
COVID-19	Coronavirus Disease
CRB	Community Resilience Building
CRS	Community Rating System – Page 117
DCR	Department of Conservation and Recreation – Page 7
DPW	Northampton Department of Public Works – Page 13
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
FEMA	Federal Emergency Management Agency
FFR	Farms, Forest and Rivers Overlay District
FIRM	Flood Insurance Rate Maps
FMA	Flood Mitigation Assistance Program
FRTA	Franklin Regional Transit Authority
HMGP	Hazard Mitigation Grant Program
LEP	Limited English Proficiency
LID	Low Impact Development
MassDEP	Massachusetts Department of Environmental Protection – Page 13
MassDOT	Massachusetts Department of Transportation – Page 7
MassGIS	Massachusetts Bureau of Geographic Information
MAVEN	Massachusetts Viral Epidemiological Network
MEMA	Massachusetts Emergency Management Agency
MVP	Municipal Vulnerability Preparedness

NAACC	North Atlantic Aquatic Connectivity
NE CASC	Northeast Climate Adaptation Science Center
NFIP	National Flood Insurance Program
NOAA	National Oceanographic and Atmospheric Administration
OSRD	Open Space Residential Development
PDM	Pre-Disaster Mitigation Program
PVPC	Pioneer Valley Planning Commission
PVTA	Pioneer Valley Transit Authority
RiskMAP	FEMA Risk Mapping, Assessment, and Planning
SFHA	Special Flood Hazard Area
SHMCAP	State Hazard Mitigation and Climate Adaptation Plan
SRO	Single Room Occupancy
THIRA	Threat Identification and Risk Assessment
WHO	World Health Organization
WRHSAC	Western Region Homeland Security Advisory Council

Appendix C – Past and Potential Hazards / Critical Facilities Map

Appendix D – Natural Hazard Profiling Methodology

In order to adeptly profile each of the hazards, a Hazard Identification and Analysis Matrix was prepared to organize the information that was gathered for this project.

The matrix is organized into the following sections: Type of Hazard, Location of Occurrence, Extent of Impacts, Previous Occurrences, Probability of Future Occurrence, and Hazard Index. The Hazard Index was completed to rank the hazards according to the frequency of occurrence and the amount of potential damage likely to occur. The Hazard Index forms the basis for concentrating the future mitigation efforts outlined in this plan. A description of each of the matrix categories is provided below. The completed Matrix is shown as Table 2. Hazard Identification and Analysis for Northampton (Section 3, page 20).

Location of Occurrence

The classifications are based on the area of the Town of West Springfield that would potentially be affected by the hazard. The following scale was used:

Table D.1: Location of Occurrence, Percentage of Town Impacted of Given Natural Hazard

Location of Occurrence	Percentage of Town Impacted
Large	More than 50% of the town affected
Medium	10 to 50% of the town affected
Small	Less than 10% of the town affected

Extent of Impacts

The extent of direct impacts an affected area could potentially suffer were classified according to the following scale:

Table D.2: Extent of Impacts, Magnitude of Multiple Impacts of Given Natural Hazard	
Extent of Impacts	Magnitude of Multiple Impacts
Catastrophic	Multiple deaths and injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of facilities for 30 days or more.
Critical	Multiple injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of facilities for more than 1 week.
Limited	Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of facilities for more than 1 day.
Minor	Very few injuries, if any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of facilities.

Previous Occurrences

Whether or not previous hazard events had occurred is also included, with detailed descriptions of specific previous occurrences within the hazard identification and vulnerability assessments, if necessary.

Probability of Future Occurrence

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

Table D.3: Frequency of Occurrence and Annual Probability of Given Natural Hazard	
Frequency of Occurrence	Probability of Future Event
Very High	70-100% probability in the next year
High	40-70% probability in the next year
Moderate	10-40% probability in the next year
Low	1-10% probability in the next year
Very Low	Less than 1% probability in the next year

Hazard Index

The hazard index ratings were determined after assessing the frequency, location and impact classifications for each hazard. The hazard index ratings are based on a scale of 1 (highest risk) through 5 (lowest risk). The ranking is qualitative and is based, in part, on local knowledge of past experiences

with each type of hazard. The size and impacts of a natural hazard can be unpredictable however; many of the mitigation strategies currently in place and many of those proposed for implementation can be applied to the expected natural hazards, regardless of their unpredictability.

The Hazard Ratings are labeled as follows:

1 – High Risk
2 – Medium-High Risk
3 – Medium Risk
4 – Medium Low Risk
5 – Low Risk

Appendix E – Technical Resources

1) Agencies

Massachusetts Emergency Management Agency (MEMA)……..508/820-2000

Hazard Mitigation Section ……..617/626-1356

Federal Emergency Management Agency (FEMA) 617/223-4175

MA Regional Planning Commissions:

Berkshire Regional Planning Commission (BRPC)……..413/442-1521

Cape Cod Commission (CCC)……..508/362-3828

Central Massachusetts Regional Planning Commission (CMRPC)…….. 508/693-3453

Franklin Regional Council of Governments (FRCOG)……..413/774-3167

Martha's Vineyard Commission (MVC)……508/693-3453

Merrimack Valley Planning Commission (MVPC)……..978/374-0519

Metropolitan Area Planning Council (MAPC)……..617/451-2770

Montachusett Regional Planning Commission (MRPC)……978/345-7376

Nantucket Planning and Economic Development Commission (NP&EDC)……508/228-7236

Northern Middlesex Council of Governments (NMCOG)……978/454-8021

Old Colony Planning Council (OCPC)……..508/583-1833

Pioneer Valley Planning Commission (PVPC)……..413/781-6045

Southeastern Regional Planning and Economic Development District (SRPEDD)……..508/823-1803

MA Board of Building Regulations & Standards (BBRS)……617/227-1754

MA Coastal Zone Management (CZM)……..617/626-1200

DCR Water Supply Protection……617/626-1379

DCR Waterways……617/626-1371

DCR Office of Dam Safety……..508/792-7716

DFW Riverways……617/626-1540

MA Dept. of Housing & Community Development……617/573-1100

Woods Hole Oceanographic Institute……508/457-2180

UMass-Amherst Cooperative Extension……413/545-4800

National Fire Protection Association (NFPA)……617/770-3000

New England Disaster Recovery Information X-Change (NEDRIX – an association of private companies & industries involved in disaster recovery planning)……781/485-0279

MA Board of Library Commissioners……617/725-1860

MA Highway Dept, District 2……413/582-0599

MA Division of Marine Fisheries……617/626-1520

MA Division of Capital & Asset Management (DCAM)……617/727-4050

University of Massachusetts/Amherst……413/545-0111

Natural Resources Conservation Services (NRCS)……413/253-4350

MA Historical Commission……617/727-8470

U.S. Army Corps of Engineers……978/318-8502

Northeast States Emergency Consortium, Inc. (NESEC)……781/224-9876

National Oceanic and Atmospheric Administration: National Weather Service; Tauton, MA……508/824-5116

US Department of the Interior: US Fish and Wildlife Service ……413/253-8200

US Geological Survey ……508/490-5000

2) Mitigation Funding Resources

404 Hazard Mitigation Grant Program (HMGP) ……Massachusetts Emergency Management Agency

406 Public Assistance and Hazard Mitigation ……Massachusetts Emergency Management Agency

Community Development Block Grant (CDBG)……DHCD, also refer to RPC

Dam Safety Program……MA Division of Conservation and Recreation

Disaster Preparedness Improvement Grant (DPIG) ……Massachusetts Emergency Management Agency

Emergency Generators Program by NESEC‡ ……Massachusetts Emergency Management Agency

Emergency Watershed Protection (EWP) Program……USDA, Natural Resources Conservation Service Flood Mitigation Assistance Program (FMAP) ……Massachusetts Emergency Management Agency

Flood Plain Management Services (FPMS)……US Army Corps of Engineers

Mitigation Assistance Planning (MAP).....Massachusetts Emergency Management Agency

Mutual Aid for Public Works.....Western Massachusetts Regional Homeland Security Advisory Council

Municipal Vulnerability Preparedness Program.....MA Executive Office of Energy and Environmental Affairs

National Flood Insurance Program (NFIP) † .....Massachusetts Emergency Management Agency

Power of Prevention Grant by NESEC‡ .....Massachusetts Emergency Management Agency

Roadway Repair & Maintenance Program(s).....Massachusetts Highway Department

Section 14 Emergency Stream Bank Erosion & Shoreline Protection .....US Army Corps of Engineers

Section 103 Beach Erosion.....US Army Corps of Engineers

Section 205 Flood Damage Reduction.....US Army Corps of Engineers

Section 208 Snagging and Clearing .....US Army Corps of Engineers

Shoreline Protection Program.....MA Department of Conservation and Recreation

Various Forest and Lands Program(s).....MA Department of Environmental Protection

Wetlands Programs .....MA Department of Environmental Protection

‡NESEC – Northeast States Emergency Consortium, Inc. is a 501(c)(3), not-for-profit natural disaster, multi-hazard mitigation and emergency management organization located in Wakefield, Massachusetts. Please, contact NESEC for more information.

† Note regarding National Flood Insurance Program (NFIP) and Community Rating System (CRS): The National Flood Insurance Program has developed suggested floodplain management activities for those communities who wish to more thoroughly manage or reduce the impact of flooding in their jurisdiction. Through use of a rating system (CRS rating), a community's floodplain management efforts can be evaluated for effectiveness. The rating, which indicates an above average floodplain management effort, is then factored into the premium cost for flood insurance policies sold in the community. The higher the rating achieved in that community, the greater the reduction in flood insurance premium costs for local property owners. MEMA can provide additional information regarding participation in the NFIP-CRS Program.

3) Internet Resources

Sponsor	Internet Address	Summary of Contents
Natural Hazards Research Center, U. of Colorado	http://www.colorado.edu/litbase/ha zards/	Searchable database of references and links to many disaster-related websites.
Atlantic Hurricane Tracking Data by Year	http://wxp.eas.purdue.edu/hurricane	Hurricane track maps for each year, 1886 – 1996
National Emergency Management Association	http://nemaweb.org	Association of state emergency management directors; list of mitigation projects.
NASA – Goddard Space Flight Center "Disaster Finder:	http://www.gsfc.nasa.gov/ndrd/dis aster/	Searchable database of sites that encompass a wide range of natural disasters.
NASA Natural Disaster Reference Database	http://ltpwww.gsfc.nasa.gov/ndrd/main/html	Searchable database of worldwide natural disasters.
U.S. State & Local Gateway	http://www.statelocal.gov/	General information through the federal-state partnership.
National Weather Service	http://nws.noaa.gov/	Central page for National Weather Warnings, updated every 60 seconds.
USGS Real Time Hydrologic Data	http://h20.usgs.gov/public/realtime.html	Provisional hydrological data
Dartmouth Flood Observatory	http://www.dartmouth.edu/artsci/g eog/floods/	Observations of flooding situations.
FEMA, National Flood Insurance Program, Community Status Book	http://www.fema.gov/fema/csb.html	Searchable site for access of Community Status Books
Florida State University Atlantic Hurricane Site	http://www.met.fsu.edu/explores/tropical.html	Tracking and NWS warnings for Atlantic Hurricanes and other links
The Tornado Project Online	http://www.tornadoroject.com/	Information on tornadoes, including details of recent impacts.
National Severe Storms Laboratory	http://www.nssl.uoknor.edu/	Information about and tracking of severe storms.
Independent Insurance	http://www.iiaa.iix.com/ndcmap.html	A multi-disaster risk map.

Sponsor	Internet Address	Summary of Contents
Agents of America IIAA Natural Disaster Risk Map		
Earth Satellite Corporation	http://www.earthsat.com/	Flood risk maps searchable by state.
USDA Forest Service Web	http://www.fs.fed.us/land	Information on forest fires and land management.