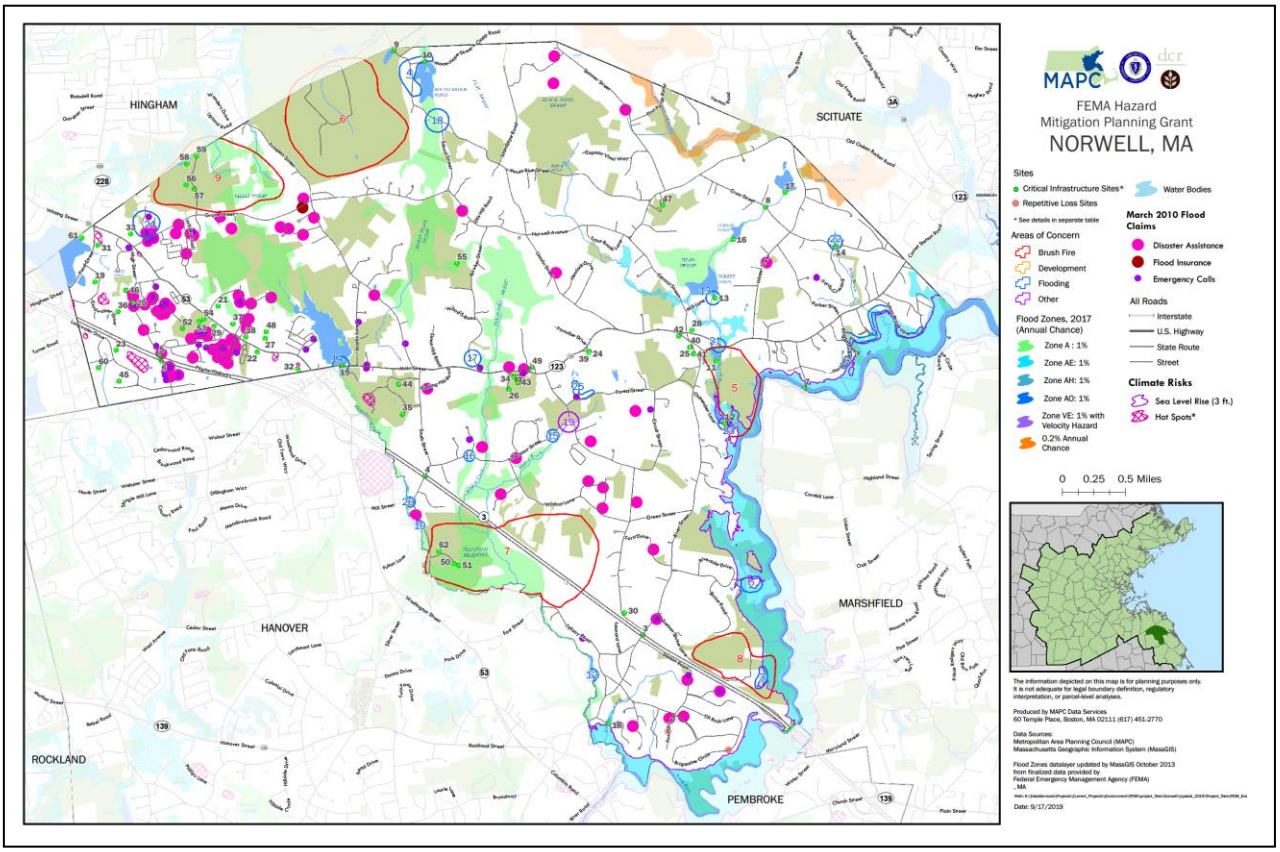
TOWN OF NORWELL
HAZARD MITIGATION PLAN
2020 UPDATE



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

Final Plan
FEMA Approval Pending Adoption
September 28, 2020

ACKNOWLEDGEMENTS & CREDITS

This plan was prepared for the Town of Norwell by the Metropolitan Area Planning Council (MAPC) under the direction of the Massachusetts Emergency Management Agency (MEMA) and the Massachusetts Department of Conservation and Recreation (DCR). The plan was funded by the Federal Emergency Management Agency's (FEMA) Pre-Disaster Mitigation (PDM) Grant Program and the Commonwealth's Municipal Vulnerability Preparedness program.

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TABLE OF CONTENTS

LIST OF TABLES & FIGURES

TABLES

FIGURES

SECTION 1: EXECUTIVE SUMMARY

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

PLANNING PROCESS

Planning for the Hazard Mitigation Plan update was led by the Norwell Local Hazard Mitigation Planning Team, composed of staff from a number of different town departments. The team also led a parallel planning process as part of the Massachusetts Municipal Vulnerability Preparedness (MVP) program focused on identifying climate risks and resilience strategies. In the joint effort, the team met on September 12, 2019, October 31, 2019, January 16, 2020 and May 14, 2020 and discussed where the impacts of natural hazards most affect the town, goals for addressing these impacts, updates to the Town's existing mitigation measures, and new or revised hazard mitigation measures that would benefit the town.

Public participation in this planning process is important for improving awareness of the potential impacts of natural hazards and to build support for the actions the Town takes to mitigate them. The Town's Local Hazard Mitigation Planning Team hosted two public meetings, the first on February 6, 2020 and the second on June 10, 2020 and, the draft plan update was posted on the Town's website for public review. Key town stakeholders and neighboring communities were notified and invited to review the draft plan and submit comments. As part of the MVP program, the town hosted an all-day workshop on November 7, 2019 where 40 participants identified climate resilience vulnerabilities and mitigation strategies. These strategies were also reviewed in the February 6 public meeting. See Public Comments for feedback.

RISK ASSESSMENT

The Norwell Hazard Mitigation Plan assesses the potential impacts to the town from flooding, high winds, winter storms, brush fire, geologic hazards, extreme temperatures, drought, and invasive species. For each risk, the assessment identifies the projected impacts of a warming climate. These are shown in the map series in Appendix B. The Norwell Local Hazard Mitigation Planning Team identified 71 Critical Facilities. These are also shown on the map series and listed in Table 29, identifying which facilities are located within the mapped hazard zones.

Hazards U.S. – Multihazards (HAZUS-MH) is a standardized methodology developed by FEMA that utilizes Geographic Information Systems (GIS) to estimate physical, economic, and social impacts of disasters. The HAZUS-MH analysis for Norwell estimates property damages from Hurricanes of category 2 and 4 ($17 million to $62 million), earthquakes of magnitudes 5 and 7 ($239 million to $1.8 billion), and the 1% and .2% chance of flooding ($10 to $14 million).

HAZARD MITIGATION GOALS

The Norwell Local Multiple Hazard Community Planning Team endorsed the following eleven hazard mitigation goals at the January 16, 2020 team meeting. The team added an eleventh goal focused on incorporating future climate change projections.

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

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

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

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

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

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

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

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

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

HAZARD MITIGATION STRATEGY

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

PLAN REVIEW & UPDATE PROCESS

The process for developing Norwell's Hazard Mitigation Plan 2020 Update is summarized in Table 1.

Table 1: Plan Review and Update Process

Section	Reviews and Updates
Section 3: Public Participation	The Local Hazard Mitigation Planning Team placed an emphasis on public participation for the update of the Hazard Mitigation Plan, discussing strategies to enhance participation opportunities at the first local committee meeting. During plan development, the plan was discussed at two public meetings hosted by the Hazard Mitigation Team and the Board of Selectmen. The plan was also available on the Town's website for public comment. See Public Comments for feedback.
Section 4: Risk Assessment	MAPC gathered the most recently available hazard and land use data and met with town staff to identify changes in local hazard areas and development trends. Town staff reviewed critical infrastructure with MAPC staff in order to create an up-to-date list. The Risk Assessment integrates projected climate impacts. MAPC also used the most recently available version of HAZUS and assessed the potential impacts of flooding using the latest data.
Section 5: Goals	The Hazard Mitigation Goals were reviewed and endorsed by the Norwell Local Hazard Mitigation Planning Team.
Section 6: Existing Mitigation Measures	The list of existing mitigation measures was updated to reflect current mitigation activities in the town.
Sections 7 and 8: Hazard Mitigation Strategy	Mitigation measures from the 2014 plan were reviewed and assessed as to whether they were completed, in progress, or deferred. The Local Hazard Mitigation Planning Team determined whether to carry forward measures into the 2020 Plan Update or modify or delete them. The Plan Update's hazard mitigation strategy reflects both new measures and measures carried forward from the 2014 plan. The Local Hazard Mitigation Team prioritized all of these measures based on current conditions.
Section 9: Plan Adoption & Maintenance	This section of the plan was updated with a new on-going plan implementation review and five year update process that will assist the Town in incorporating hazard mitigation issues into other Town planning and regulatory review processes and better prepare the Town for the next comprehensive plan update.

As indicated in Table 34, Norwell made good progress implementing mitigation measures identified in the 2014 Hazard Mitigation Plan. The Mill Pond and Tack Factory Dams were removed. The Peterson Dam has been partially breeched and is permitted for removal. The town has invested significant resources in infrastructure projects to address stormwater flooding and

comply with the MS4 permit. In addition, the town adopted a Stormwater Bylaw that requires incorporation of LID and Green Infrastructure. Additional requirements will be taken up at the next Town Meeting. Finally, the town has been successful in completing purchases of open space that improve stormwater and flood management.

Some projects were partially completed, and/or will be continued to the next plan for on-going maintenance. Maintenance and repair of existing infrastructure is an on-going priority. A snow load assessment was not completed, but the Town has developed a protocol for removing snow from municipal roofs when necessary.

Moving forward into the next five-year plan implementation period there will be many more opportunities to incorporate hazard mitigation into the Town's decision-making processes. As in the past, the Town will document any actions taken within this iteration of the Hazard Mitigation Plan on challenges met and actions successfully adopted as part of the ongoing plan maintenance to be conducted by the Norwell Hazard Mitigation Implementation Team, as described in Section 9 Plan Adoption and Maintenance.

SECTION 2: INTRODUCTION

PLANNING REQUIREMENTS UNDER THE FEDERAL DISASTER MITIGATION ACT

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

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

The Town of Norwell contracted with the Metropolitan Area Planning Council (MAPC), to assist the Town in updating its local Hazard Mitigation Plan. Norwell's first Hazard Mitigation Plan received conditional approval from FEMA in January 2014. It was never formally adopted by the Norwell Board of Selectmen. But as the plan was fully drafted, this plan is being developed as an update to the 2014 plan.

WHAT IS A HAZARD MITIGATION PLAN?

Natural hazard mitigation planning is the process of determining how to systematically reduce or eliminate the loss of life and property damage resulting from natural hazards such as floods, earthquakes, and hurricanes. Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries, and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, programs, projects, and other activities. This plan incorporates consideration of future risks due to projections for the increased frequency and severity of extreme weather fueled by a warming planet.

PREVIOUS FEDERAL/STATE DISASTERS

Since 1991, there have been 22 natural hazard events that triggered federal or state disaster declarations that included Plymouth County. These are listed in Table 2 below. The majority of these events involved flooding, while others were due to hurricanes or nor'easters, and severe winter weather.

Table 2: Presidentially Declared Disasters, 1991-2018

Disaster Name	Date of Event	Declared Areas
Hurricane Bob	August 1991	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk

Disaster Name	Date of Event	Declared Areas
Severe Coastal Storm No Name Storm	October 1991	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
Winter Coastal Storm	December 1992	Counties of Barnstable, Dukes, Essex, Plymouth, Suffolk
Blizzard	March 1993	Statewide
Blizzard	January 1996	Statewide
Severe Storms, Flood	October 1996	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
Heavy Rain, Flood	June 1998	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
Severe Storms, Flood	March 2001	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
Snowstorm	February 2003	Statewide
Snowstorm	December 2003	Barnstable, Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, Worcester
Snow	January 2005	Statewide
Hurricane Katrina	August 2005	Statewide
Severe Storms, Flooding	October 2005	Statewide
Severe Storms, Flooding	May 2006	Statewide
Severe Storm, Inland, Coastal Flooding	April 2007	Statewide
Severe Storms, Flooding	December 2008	Statewide
Severe Storms, Flooding	March/April 2010	Bristol, Essex, Middlesex, Suffolk, Norfolk, Plymouth, Worcester
Tropical Storm Irene	August 2011	Barnstable, Berkshire, Bristol, Dukes, Franklin, Hampden, Hampshire, Norfolk, Plymouth

Disaster Name	Date of Event	Declared Areas
Hurricane Sandy	October/November 2012	Barnstable, Bristol, Dukes, Nantucket, Plymouth, Suffolk
Severe Winter Storm, Snowstorm and Flooding	February, 2013	Statewide
Severe winter storm, snowstorm and flooding	April 2015	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester
Severe winter storm and flooding	March 2018	Barnstable, Bristol, Essex, Nantucket, Norfolk, Plymouth

Source: MA Hazard Mitigation and Climate Adaptation Plan, 2018

FEMA FUNDED MITIGATION PROJECTS

As Norwell's 2014 Hazard Mitigation Plan was never formally adopted by the Board of Selectmen, Norwell has not, to date, been eligible for FEMA funded mitigation projects.

COMMUNITY PROFILE

Norwell covers 21 square miles and is located 23 miles south of Boston. The town's eastern boundary is marked by the tidal North River. Norwell was previously part of the Town of Scituate and was established as the Town of Norwell in 1888. Shipbuilding was important to the economy of the area from the colonial period through the much of the 1800s. More recently, Norwell began to grow rapidly with the construction of the Southeast Expressway in the 1960's. This encouraged a transition from a community of small rural farms to the residential suburban community of today. The town has two large industrial parks facilitated by their easy access to Routes 3, 53 and 123.

Norwell is a relatively affluent community with high median annual income and a low poverty rate. The population is nearly 11,000 residents. Roughly 95% of residents are White; there are small but growing Asian and Latino populations. Notably, 17% of Norwell's population lives alone, and 50% of those living alone were over 65 years old. Residents value Norwell's rural character and natural beauty. The Town adopted the Community Preservation Act nearly twenty years ago and has been active in preserving open space.

The town maintains a website at https://www.townofnorwell.net/

Table 3: Norwell Characteristics

Population = 10,897 people

- 6.1% are under age 5
- 28.1% are under age 18
- 18.5% are over age 65
- .5% of households are limited English-speaking
- 1.8% of households have no vehicle available

- Over 96% of the population is White

Number of Housing Units = 3,799

- 5.8% are renter-occupied housing units
- 13.4% of housing units were built before 1940

Source: 2017 American Community Survey

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

- Norwell has been proactive in addressing the impact of climate on natural hazards. Norwell is in the process of becoming certified by the state as a Municipal Vulnerability Preparedness community.
- Norwell has the benefits of significant forest and tree cover. However, power outages and damage from falling trees, as well as the potential for forest fire are important concerns.
- While not located on the coast, Norwell will be subject to impacts from sea level rise as the North River is tidal for much of its length along Norwell's eastern boundary.
- Water quantity and quality are important concerns for both maintaining drinking water supply and the health of the many brooks and wetlands within the town.
- Records from flooding in 2010 highlight a cluster of areas in the northwest part of town that were particularly subject to flood damage.

SECTION 3: PLANNING PROCESS & PUBLIC PARTICIPATION

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

PLANNING PROCESS SUMMARY

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

1. **Map the Hazards** – MAPC relies on data from a number of different federal, state, and local sources in order to map the areas with the potential to experience natural hazards. This mapping represents a multi-hazard assessment of the municipality and is used as a set

of base maps for the remainder of the planning process. A particularly important source of information is the knowledge drawn from local municipal staff on where natural hazard impacts have occurred. These maps can be found in Appendix B.

2. **Assess the Risks & Potential Damages** – Working with local staff, critical facilities, infrastructure, vulnerable populations, and other features are mapped and contrasted with the hazard data from the first step to identify those that might represent particular vulnerabilities to these hazards. Land use data and development trends are also incorporated into this analysis. In addition, MAPC develops estimates of the potential impacts of certain hazard events on the community. MAPC drew on the following resources to complete the plan:

    - General Bylaws for the Town of Norwell
    - Town of Norwell Community Resilience Building Workshop Summary of Findings January 2020
    - Town of Norwell Open Space and Recreation Plan 2005-10 and 2012-2019
    - Norwell 2018 Economic Growth Plan
    - Blue Hill Observatory
    - FEMA, Flood Insurance Rate Maps for Norfolk County, MA, 2012
    - FEMA, Hazards U.S. Multi-Hazard
    - FEMA, Local Mitigation Plan Review Guide, October 2011
    - Fourth National Climate Assessment, 2018
    - Massachusetts Flood Hazard Management Program
    - Massachusetts Office of Coastal Zone Management Shoreline Change Data
    - Massachusetts Office of Dam Safety, Inventory of Massachusetts Dams 2018
    - Massachusetts State Hazard Mitigation Plan, 2013
    - Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 2018
    - Metropolitan Area Planning Council, GIS Lab, Regional Plans and Data
    - National Weather Service
    - Nevada Seismological Library
    - New England Seismic Network, Boston College Weston Observatory, http://aki.bc.edu/index.htm
    - NOAA National Climatic Data Center, http://www.ncdc.noaa.gov/
    - Northeast Climate Adaptation Science Center
    - Northeast States Emergency Consortium, http://www.nesec.org/
    - Tornado History Project
    - US Census, 2010 and American Community Survey 2017 5-Year Estimates
    - USGS, National Water Information System, http://nwis.waterdata.usgs.gov/usa/nwis

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

4. **Develop Mitigation Strategies** – MAPC works with the local municipal staff to identify new mitigation measures, utilizing information gathered from the hazard identification, vulnerability assessments, and the community's existing mitigation efforts to determine where additional work is necessary to reduce the potential damages from hazard events. Additional information on the development of hazard mitigation strategies can be found in Section 7.

5. **Plan Approval & Adoption** – Once a final draft of the plan is complete it is sent to MEMA for the state level review and, following that, to FEMA for approval. Typically, once FEMA has approved the plan the agency issues a conditional approval (Approval Pending Adoption), with the condition being adoption of the plan by the municipality. More information on plan adoption can be found in Section 9 and documentation of plan adoption can be found in Appendix D.

6. **Implement & Update the Plan** – Implementation is the final and most important part of any planning process. Hazard Mitigation Plans must also be updated on a five-year basis making preparation for the next plan update an important on-going activity. Section 9 includes more detailed information on plan implementation.

2014 PLAN IMPLEMENTATION & MAINTENANCE

The 2014 Town of Norwell Hazard Mitigation Plan contained a risk assessment of identified hazards for the town and mitigation measures to address the risk and vulnerability from these hazards. Since approval of the plan by FEMA, progress has been made on implementation of the measures. The Town has advanced a number of projects for implementation, including several dam removals, adoption of a Stormwater Bylaw, and land preservation.

THE LOCAL MULTIPLE HAZARD COMMUNITY PLANNING TEAM

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

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

Name	Title
Jeff Simpson	Deputy Fire Chief, Project Manager
Nancy Hemingway	Conservation Agent
Alison Demong	Selectman
Arthur Joseph	CERT Civilian Coordinator
Kenneth Kirkland	Planner
Ted Ross	Police Chief

Carol Brzuszek	Deputy Police Chief
Joseph Conlon	Assistant Director Highway/Tree Department
Glenn Ferguson	Director Highway/Tree Department
Jack McInnis	Superintendent Water Department
Ted Nichols	Facilities Manager
Allen Perlin	Water Treatment Facility Manager
Andrew Reardon	Fire Chief

The Norwell Planning Board and Conservation Commission are the primary entities responsible for regulating development in town. Feedback was assured through the participation of the Conservation Agent, the Town Planner, and a member of the Board of Selectmen. In addition, MAPC, the State-designated regional planning authority for Norwell, works with all agencies that that regulate development in the region, including the listed municipal entities and state agencies, such as the Department of Transportation and the Department of Conservation and Recreation.

The Local Hazard Mitigation Planning Team met on the following dates: September 12, 2019, October 31, 2019, January 16, 2020, and May 14, 2020 The purpose of the meetings was to introduce the Hazard Mitigation planning program, review and update hazard mitigation goals, and to gather information on local hazard mitigation issues and sites or areas related to these. The team also coordinated the Municipal Vulnerability Preparedness Workshop in early November. Earlier meetings focused on preparation for that event. Later meetings focused on verifying information gathered by MAPC staff and discussion of existing mitigation practices, the status of mitigation measures identified in the 2014 hazard mitigation plan, and potential new or revised mitigation measures. The agendas for these meetings are included in Appendix A.

PUBLIC MEETINGS

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

In addition to the two public meetings, Norwell held an all-day workshop attended by thirty-nine Norwell town staff, board and committee members, and representatives of local organizations. The workshop focused on climate impacts to natural hazards. The public had an opportunity to provide input to the Norwell hazard mitigation planning process during a public meeting held on February 6, 2020 at the Norwell Public Safety Building. The draft plan update was presented at a Board of Selectmen meeting on June 14, 2020 at a virtual meeting hosted on Zoom. Both

meetings were publicized in accordance with the Massachusetts Public Meeting Law. The attendance list for each meeting can be found in Table 4. See public meeting notices in Appendix C.

Table 4: Norwell Public Meetings

Meeting #1 February 6, 2020	
Total Attendance: 8	
Jeff Simpson	Deputy Fire Chief
Nancy Hemingway	Conservation Agent
Alison Demong	Selectman
5 members of the public	
Meeting #2 June 10, 2020	
Total Attendance:	
Name	**Representing**
Members of the Board of Selectmen	
Jeff Simpson	Deputy Fire Chief
Nancy Hemingway	Conservation Agent
Members of the public participating virtually	

LOCAL STAKEHOLDER INVOLVEMENT

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

- MA Coastal Zone Management
- Arbour Counselling
- Big Y
- Foxrock Properties
- National Grid
- Merrill Inc.
- Chessia Consulting
- North and South Rivers Watershed Assoc.
- Raveis Realty
- Royal Skilled Nursing
- Zildjian
- Town of Scituate
- Town of Marshfield
- Town of Pembroke
- Town of Rockland
- Town of Hingham
- Town of Hanover

See Appendix C for public meeting notices. The draft Norwell Hazard Mitigation Plan 2020 Update was posted on the Town's website for the second public meeting. Members of the public could access the draft document and submit comments or questions to the Town.

PUBLIC COMMENT

In the first public meeting participants expressed strong support for strategies that will address stormwater flooding. In the workshop that took place on November 7, 2019, participants

developed a robust list of priorities to increase resilience to climate-related natural hazards. Participants in the first public meeting reviewed the results of the workshop. The top priorities from the workshop are shown in Appendix E. At the second meeting participants expressed interest in potential funding sources for microgrids, interest in strategies for regional cooperation, and a question as to whether Scenic Roads designations might be hindering private homeowners in managing trees on their properties. One resident expressed support for the mitigation measure related to repairing culverts on Mt. Blue Street.

CONTINUING PUBLIC PARTICIPATION

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

PLANNING TIMELINE

September 12, 2019	Meeting of the Norwell Local Hazard Mitigation and MVP Planning Team
October 31, 2019	Meeting of the Norwell Local Hazard Mitigation and MVP Planning Team
November 7, 2019	All day MVP Workshop
January 16, 2020	Meeting of the Norwell Local Hazard Mitigation and MVP Planning Team
February 6, 2020	First Public Meeting at the Public Safety Building
May 14, 2020	Meeting of the Norwell Local Hazard Mitigation and MVP Planning Team
June 14, 2020	Second Public Meeting with the Norwell Board of Selectmen
June 26, 2020	Draft Plan Update submitted to MEMA
August 18, 2020	Draft Plan Update submitted to FEMA
September 28, 2020	Notice of Approvable Pending Adoption sent by FEMA
	Plan Adopted by the Norwell Board of Selectmen
	FEMA final approval of the plan for 5 years, until x date

SECTION 4: RISK ASSESSMENT

The risk assessment analyzes the potential natural hazards that could occur within the Town of Norwell as well as the relationship between those hazards and current land uses, potential future development, and critical infrastructure. This section also includes a vulnerability assessment that estimates the potential damages that could result from certain large-scale natural hazard events. In order to update Norwell's risk assessment, MAPC gathered the most recently available hazard and land use data and met with Town staff to identify changes in local hazard areas and development trends. MAPC also used FEMA's damage estimation software, HAZUS.

With the adoption of the Hazard Mitigation and Climate Adaptation Plan 2018 (SHMCAP), Massachusetts became the first state to integrate climate projections in a state hazard mitigation plan. Following the state model, the projected impacts of our warming climate on natural hazards are integrated throughout the risk assessment. Key impacts include rising temperatures, which in turn affect precipitation patterns, sea level, and extreme weather.

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

CLIMATE CHANGE OBSERVATIONS AND PROJECTIONS

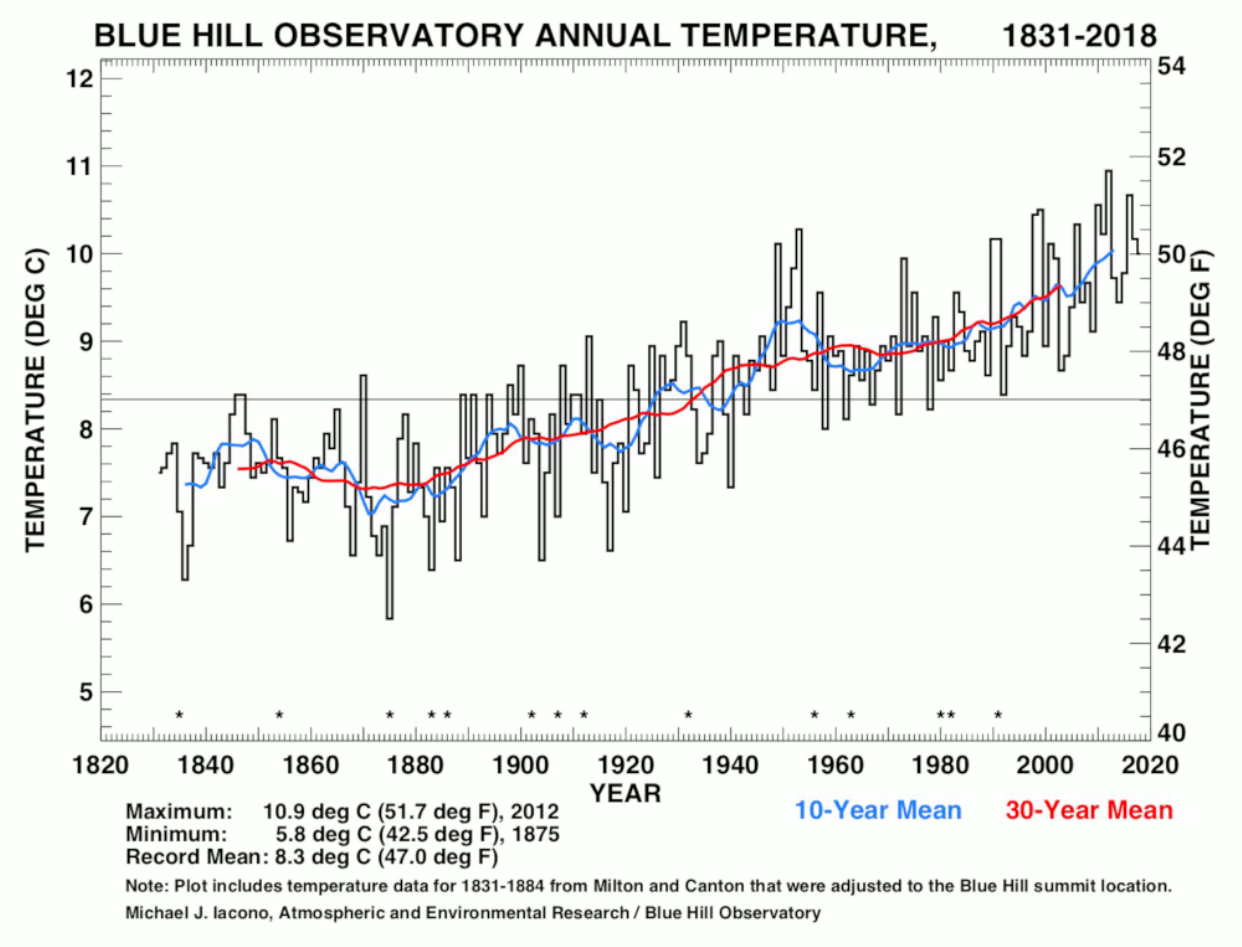
Climate change observations come from a variety of data sources that have measured and recorded changes in recent decades and centuries. Climate change projections, however, predict future climate impacts and, by their nature, cannot be observed or measured. As a result of the inherent uncertainty in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

Temperature

Our climate has always been regulated by gases, including carbon dioxide, methane, and nitrous oxide, that blanket the earth. These gases trap heat that would otherwise be reflected out to space; without them our planet would be too cold to support life. We refer to these gases as "greenhouse gases" (GHGs) for their heat trapping capacity. The combustion of fossil fuels, our primary energy source in the age of industrialization, releases GHGs into the atmosphere. In the past century, human activity associated with industrialization has contributed to a growing concentration of GHGs in our atmosphere.

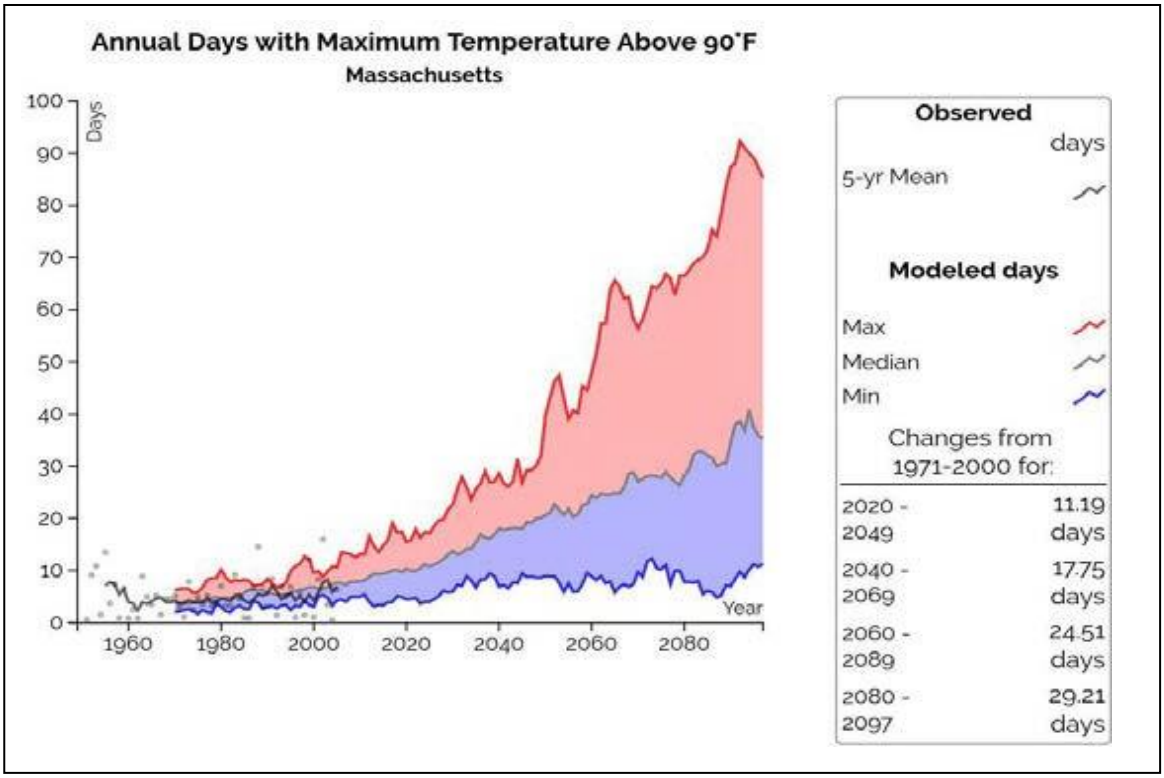
Records from the Blue Hill Observatory in Milton, MA show that average temperatures (30-year mean) have risen approximately 3 degrees (F) in the almost 200 years since record keeping began in 1831.

Figure 2: Observed Increase in Temperature



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

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



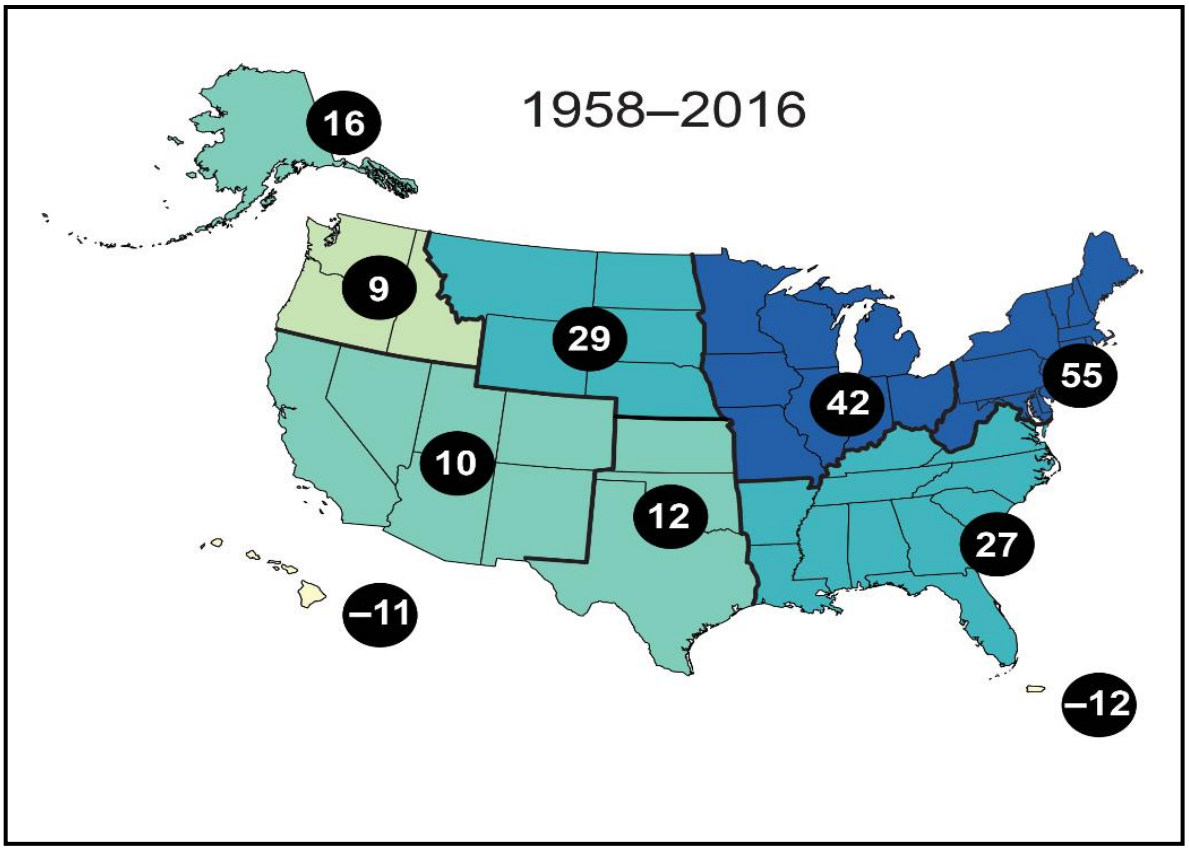
Source: Northeast Climate Adaptation Science Center

Precipitation Patterns

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

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

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

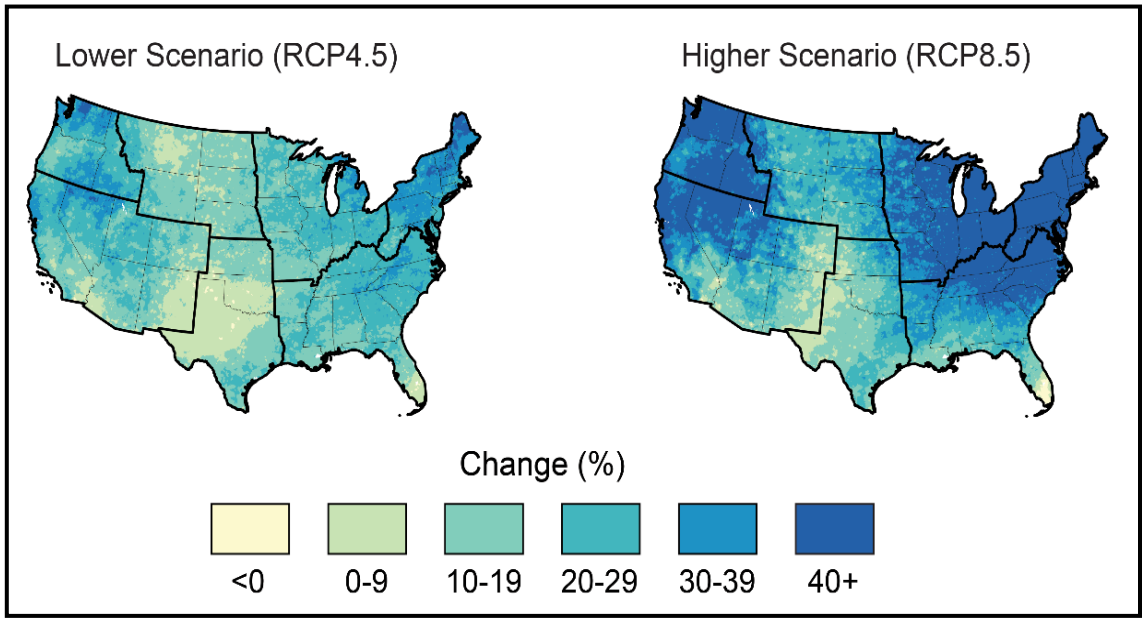


Source: Fourth National Climate Assessment, 2018

Numbers circled in black indicate % change.

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

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

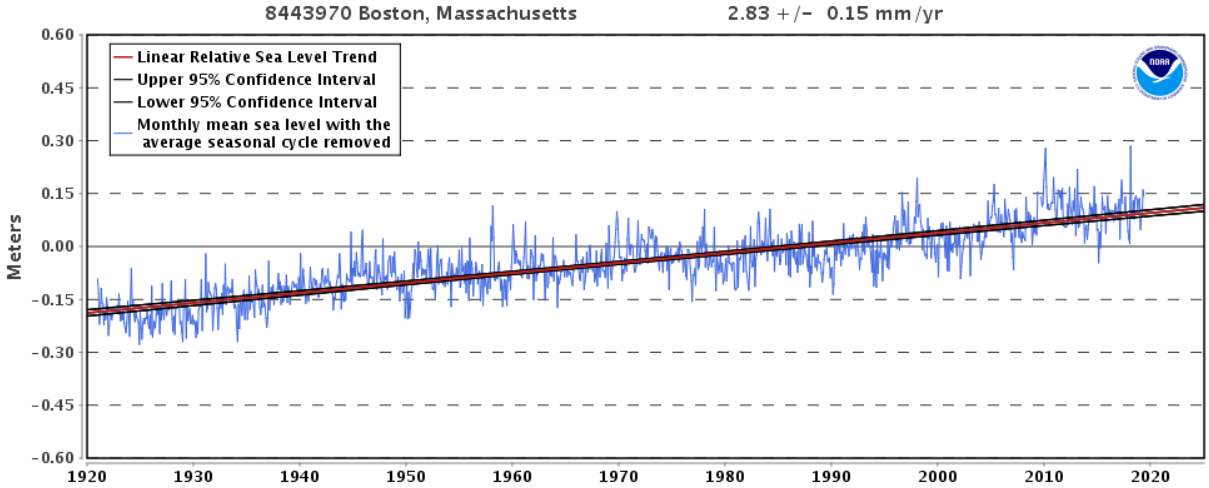


Source: Fourth National Climate Assessment, 2018

Sea Level Rise

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

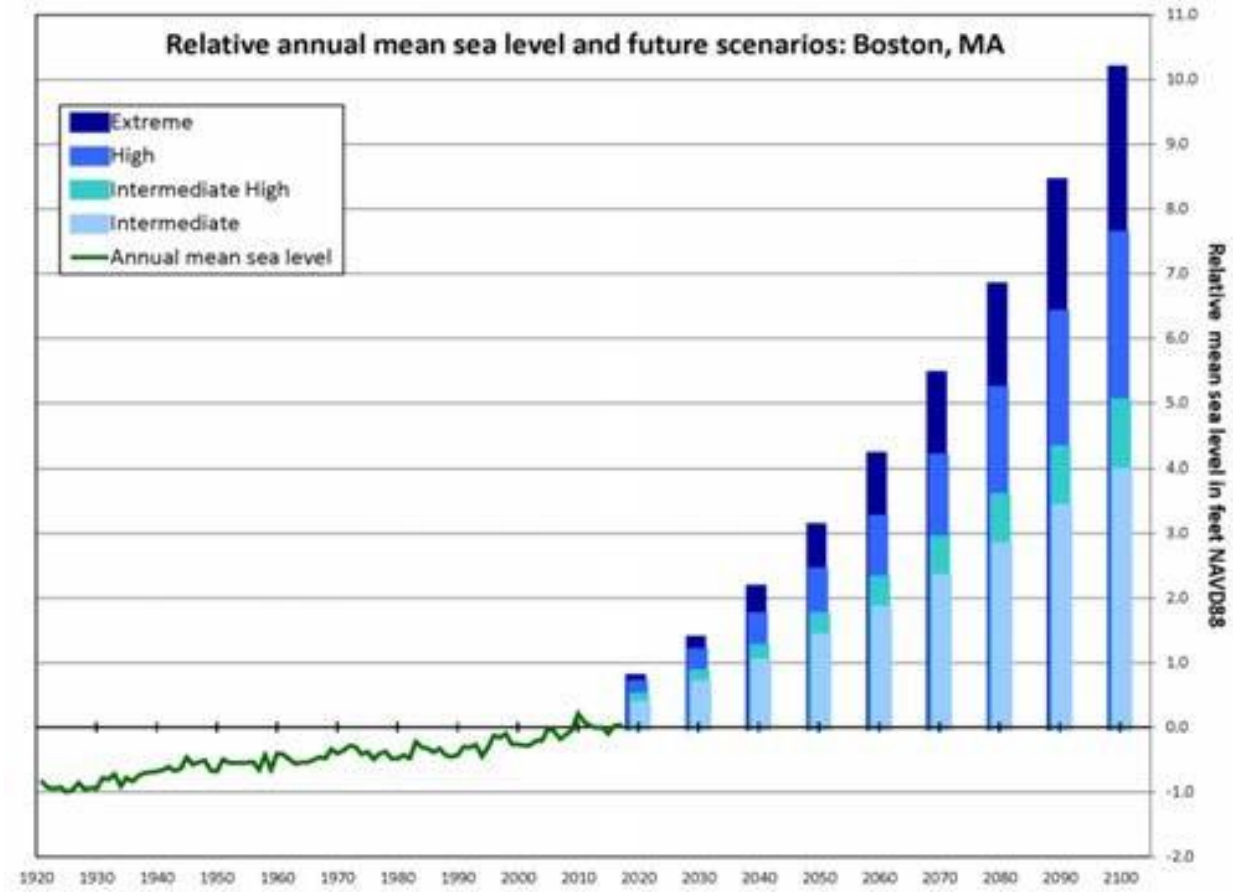
Figure 6: Observed Increase in Sea Level Rise



Source: NOAA

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

Figure 7: Recent and Projected Increase in Sea Level Rise



Source: SHMCAP

Following the general outline of the Massachusetts State Hazard Mitigation and Climate Adaptation Plan, this local hazard mitigation plan organizes consideration of natural hazards based on their relationship to projected climate changes. Table 5 below, from the SHMCAP, summarizes the natural hazards reviewed in this plan, climate interactions, and expected impacts.

Table 5: Climate Change and Natural Hazards

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

OVERVIEW OF HAZARDS AND IMPACTS

Table 6 summarizes the frequency and severity of hazard risks for Massachusetts and Norwell. The Massachusetts frequency assessment is based on data in the SHMCAP. The Norwell frequency assessment reflects data from the National Climatic Data Center (NOAA) for Norfolk County*, from the SHMCAP** and, from the local Hazard Mitigation Team***.

Table 6: Hazards Risk Summary

Hazard	Frequency		Severity	
	Massachusetts	Norwell	Massachusetts	Norwell
Inland Flooding	Substantial every 3rd year	2.9 per year*	Serious	Serious
Drought	1% any given month	1% any given month***	Minor	Minor
Landslides	Every other year	None recorded**	Minor	Minor
Coastal Flooding	6 events per year	4 per year*	Serious	Serious
Coastal Erosion	Highly variable	Stable****	Serious	Minor
Tsunami	1in every 39 years	1 in every 39 years***	Extensive	Extensive
Extreme Temperatures	2 heat events and 1 cold event event/year	1 heat events in 10 years/2 cold events in 10 years*	Minor	Minor
Brush Fires	One notable event per year	No notable event in recent years	Minor	Minor
Hurricane/Tropical Storm	One every two years	4 recorded events since 1876	Serious	Serious
Severe Winter Storms/Nor'easters	One notable event per year	1.5 per year*	Extensive	Extensive
Tornadoes	1.7 per year	None recorded	Serious	Serious
Other Severe Weather (Thunderstorms/High Winds)	20-30 thunderstorms annually; 43.5 high wind events annually	3 per year*	Minor	Minor
Earthquake	10 - 15% chance of Mag 5 in 10-year period	10 - 15% chance of Mag 5 in 10-year period***	Extensive	Extensive

Severity

- **Minor**: Limited and scattered property damage; limited damage to public infrastructure and essential services not interrupted; limited injuries or fatalities.
- **Serious:** Scattered major property damage; some minor infrastructure damage; essential services are briefly interrupted; some injuries and/or fatalities.

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

CHANGING PRECIPITATION PATTERNS

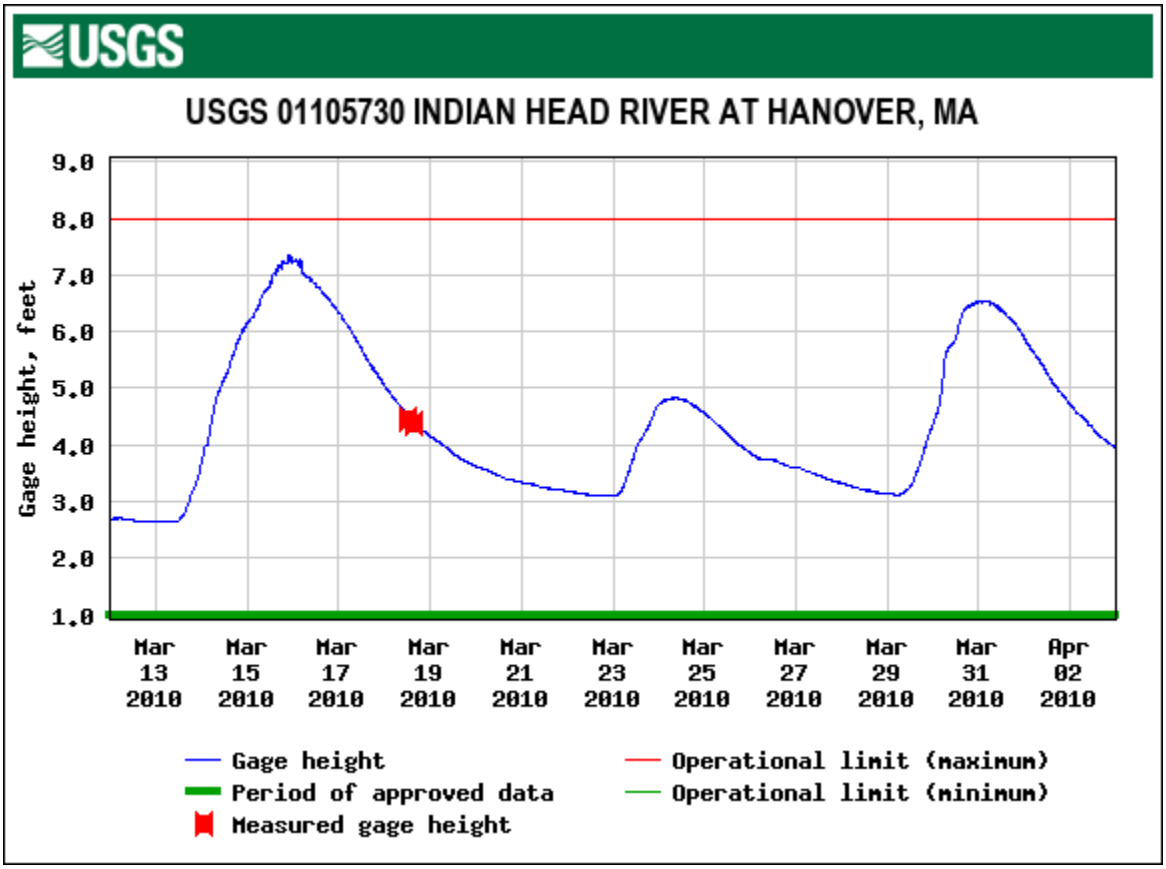
INLAND FLOODING

Inland flooding can be associated with overflowing rivers and streams, stormwater flooding due to impervious surfaces and inadequate stormwater infrastructure, and in more rare cases ice jams, ground failures (erosion), and in some communities beaver dams. Inland flooding is generally caused by hurricanes, nor'easters, severe rainstorms, and thunderstorms. Climate change is projected to exacerbate these issues over time due to increasing extreme rainfall events. Increase in average annual rainfall may also lead to more incidents of basement flooding and impacts on septic systems caused by high seasonal groundwater levels.

Flooding was the most prevalent serious natural hazard identified by local officials in Norwell. The Town of Norwell is subject to two kinds of flooding; coastal flooding (discussed further under Sea Level Rise) and inland flooding where the rate of precipitation or amount of water overwhelms the capacity of natural and structured drainage systems to convey water causing it to overflow the system. These two types of flooding may reinforce each other as inland flooding is prevented from draining by the push of wind and tide driven water.

The March 2010 rainstorms fit the profile of a type of event expected to increase in frequency as the climate warms. . That is, significant precipitation, falling in late winter as rain rather than snow, on frozen ground, and while vegetation is still dormant. The Blue Hill Observatory in Milton recorded 17.7 inches of rain from three storms in the 19 days from March 13 to 31. As shown in the USGS gages nearest to Norwell, the Indian Head River (North River) in Hanover, river levels surged with each storm (Figure 8). The March 2010 storms were a federally declared disaster making federal assistance available to property owners who did not carry flood insurance. Based on the claims, Norwell experienced extensive flood damage, with one flood insurance claim and eighty-seven disaster claims, 97% of which were located outside of FEMA Special Flood Hazard Areas. The claims were most concentrated in relatively flat areas in the northwest section of town. See Map 3 in Appendix B for claim locations.

Figure 8: March 2010 USGS Indian Head River Gage



Local data for previous flooding occurrences are not collected by the Town of Norwell. The best available local data is for Plymouth County through the National Climatic Data Center. Plymouth County, which includes the Town of Norwell, experienced 28 flood events from 2010 through 2019 (see Table 7). No deaths or injuries were reported and the total reported property damage in the county was $24 million dollars. Nearly all of the damage is attributed to the events in March 2010. This is an average of 2.9 flood events each year.

Table 7: Plymouth County Flood Events, 2010 through 2019

Date	Deaths	Injuries	Property Damage
3/14/2010	0	0	16,150,000
3/29/2010	0	0	8,070,000
4/1/2010	0	0	0
7/13/2011	0	0	5,000
8/10/2012	0	0	30,000
5/11/2013	0	0	0
5/11/2013	0	0	0
6/7/2013	0	0	0
9/3/2013	0	0	0
3/30/2014	0	0	0

10/22/2014	0	0	0
11/17/2014	0	0	0
05/31/2015	0	0	0
07/28/2015	0	0	15,000
09/10/2015	0	0	0
10/29/2015	0	0	0
05/30/2016	0	0	0
04/01/2017	0	0	5,000
04/06/2017	0	0	5,000
6/24/2017	0	0	1,000
10/25/2017	0	0	0
10/29/2017	0	0	0
1/12/2018	0	0	0
11/3/2018	0	0	1,000
4/15/2019	0	0	0
7/12/2019	0	0	0
7/22/2019	0	0	0
9/2/2019	0	0	2,000
	0	**0**	**24,282,000**

Source: NOAA, National Climatic Data Center

ICE JAMS

Ice jams occur in cold weather when normally flowing water begins to freeze effectively damming the waterway and causing localized flooding in the area. Flooding may also occur when ice jams break up and ice may pile up at culverts or around bridges. There is no recent history of ice jams leading to flooding in Norwell and town staff did not identify this hazard as an issue for the Town. As coastal Massachusetts experiences somewhat warmer winters than the western part of the state and tidal waters are less subject to freezing, this hazard is unlikely to be an issue in the North River.

DAM FAILURE OR OVERTOPPING

Dams can fail because of structural problems or age, independent of any storm event. Dam failure can follow an earthquake by causing structural damage. Dams can also fail structurally because of flooding arising from a storm or they can overspill due to flooding. In the event of a dam failure, the energy of the water stored behind even a small dam can cause loss of life and property damage if there are people or buildings downstream. The number of fatalities from a dam failure depends on the amount of warning provided to the population and the number of people in the path of the dam's floodwaters.

A concern for dams in Massachusetts is that many were built in the 19th century without the benefits of modern engineering or construction oversight. In addition, some dams have not been properly maintained. The increasing intensity of precipitation is the primary climate concern related to dams, as they were most likely designed based on historic weather patterns. The

SHMCAP indicates that changing precipitation patterns may increase the likelihood of overflow events. Dam failure is a highly infrequent occurrence, but a severe incident could result in loss of lives and significant property damage. According to the Association of State Dam Safety Officials, three dams have failed in Massachusetts since 1984, one of which resulted in a death.

Dams in Norwell are listed below:

Bound Brook Dam: This dam is located at Mt. Hope Street at the northern end of Bound Brook Pond. Downstream waters flow north through Wompactuck State Park to the Aaron River in Hingham.

Boundry Pond Dam: This dam is located in Wompatuck State Park at Union Street at the northern end of Boundry Pond. Downstream water flow north through the park to the Aaron River in Hingham.

Cranberry Bog Dam: This dam is located at Satsuit Meadow Pond. Downstream waters flow to Second Herring Brook through undeveloped land.

Galen Damon Pond Dam: This dam is located on Town of Scituate Water Supply land and owned by the Scituate Conservation Commission. Scituate would like to remove the dam to improve their water supply. Downstream waters flow to First Herring Brook through undeveloped land toward Scituate.

Jacob's Pond Dam: This dam is located at Main Road at the Southern end of Jacob's Pond. Downstream water flows to Third Herring Brook along the Norwell-Hanover town line.

Mill Pond Dam: Although identified as a dam in DCR's database, the dam has been breached, and there is no longer any impoundment at this location on Third Herring Brook.

Norris Pond Dam: This dam is located in the Norris Reservation on Second Herring Brook.

Peterson Pond Dam: This dam is located on Third Herring Brook. It has been permitted for removal, but funds for removal have not been identified. The dam is now partially breached due to lack of repair, as a result flooding risk is diminished.

Stony Brook Pond Dam: This dam is located at Cross Street. It creates a small impoundment on Stony Brook.

Tack Factory Dam: This dam was located on Third Herring Brook. It has been breached and no longer impounds water.

Talbot Pond Dam: This dam is located in Norris Reservation downstream from Norris Pond Dam. Also known as the Gordon Pond Dam it is located on Second Herring Brook. The dam is

considered to be in poor shape, but most of the property surrounding the dam is open land and the dam is not considered a high hazard dam. Additionally, the dam has the support of local residents, including those who live downstream of it and the Gordon Family has no intention or desire to make improvements or remove the dam.

Torrey Pond Dam: This dam is located at the southern end of Torrey Pond. Downstream waters flow through undeveloped land in Second Herring Brook.

Turner Pond Dam(13): This dam is on private property; it has been repaired since the previous Hazard Mitigation Plan. Downstream waters flow through undeveloped land in Second Herring Brook. If the dam was to fail, it would likely cause flooding at the culvert on Second Herring Brook at Main Street.

Data in this chart were provided by the DCR Office of Dam Safety, dated August 2018. According to their records, only Jacob's Pond Dam is considered to be a significant hazard. Most dams in Norwell are not classified by DCR.

Dam Name	River	Owner	Hazard Classification
Bound Brook Pond Dam	Bound Brook	Town of Norwell, Board of Selectmen	Low
Boundry Pond Dam	Tributary of Aaron River	DCR - Dept. of Conservation & Recreation	N/A
Cranberry Bog Dam	Second Herring Brook	Not Available for Unregulated small dams	N/A
Galen Damon Pond Dam	First Herring Brook	Town of Scituate, Conservation Commission	N/A
Jacob's Pond Dam	Third Herring Brook	Town of Norwell, Board of Selectmen	Significant
Mill Pond Dam	Third Herring Brook	Not Available for Unregulated small dams	N/A
Norris Pond Dam	Second Herring Brook	Not Available for Unregulated small dams	N/A
Peterson Pond Dam	Third Herring Brook	Not Available for Unregulated small dams	N/A
Stony Brook Pond Dam	Tributary of North River	Not Available for Unregulated small dams	N/A
Tack Factory Pond Dam	Third Herring Brook	Not Available for Unregulated small dams	N/A
Talbot Pond Dam	Second Herring Brook	Not Available for Unregulated small dams	N/A
Torrey Pond Dam	Second Herring Brook	Private Owner	Low

Turner Pond Dam	Second Herring Brook	Private Owner	Low

DCR Dam Hazard Classification

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

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

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

LOCALLY IDENTIFIED AREAS OF INLAND AND COASTAL FLOODING

Information on potential flood hazard areas was taken from two sources. The first is the National Flood Insurance Rate Maps. The FIRM flood zones are shown on Map 3 in Appendix B. The "Locally Identified Areas of Flooding" described below were identified by Town staff as areas where flooding is known to occur. These areas do not necessarily coincide with the flood zones on the FIRM maps. Flood sources include inadequate drainage systems, high groundwater, coastal storms, or other local conditions. The numbers correspond to the numbers on Map 8, "Local Hazard Areas."

Table 8: Locally Identified Areas of Flooding

Map ID	Name	Description
1	North River at Old Meeting House Lane	Extending to Arrowhead Lane and Harbor Lane, Harbor Lane is higher than the river. The flooding area continues down to Bridge Street, and Turner's Way also floods. The North River is actually a tidal estuary and flooding here occurs when there is tidal surge or with heavy rain during an extreme high tide event. Flooding in this area happens every five to ten years. Many of the homes are too close to the flood plain and consist mainly of old summer cottages that have since been turned into year-round homes. Flooding can be severe but is infrequent, with problems usually only occurring with major weather events.
2	Island View Circle	This is actually a small island in the middle of North River, containing two homes. The homes would not have been allowed to be built under current zoning requirements. The flooding issues here are the same as in Hazard 1. This is a high severity flooding area, but the potential for major damage is limited to the two homes.

3	Meadow Farm Way	Extending south to Route 3 and continuing to Brigantine Circle this area consists of flood plain on both sides of Route 3. There is salt marsh that can become saturated with water during high tides. Tidal surge or heavy rains at these times, including nor'easters and tropical storms, as well as lesser storms, can cause this area to flood as well. The homes nearby don't currently flood, but the marsh does. This area is also impacted by the North River, and future issues related to downstream drainage of the North River could make the current situation worse. The typical storm system goes west to east and in those cases, everything flows normally, and all streets and homes stay dry. However, local environmental and conservation officials note that the mouth of the nearby South River in Scituate has moved twice in less than a century, once in 1958 and again following the Blizzard of 1978. Again, this hazard is a high severity, low frequency hazard. Flooding here occurs every 20 years or less
4	Mount Hope Street at Bound Brook Pond	There is a potential for flooding here during heavy rain storm events. The pond is usually close to capacity and in heavy storms can flood its banks. This pond drains toward neighboring towns of Scituate and into Cohasset. The tributary waters here come from so-called Quaking Bog at Black Pond. The Quaking Bog is an old glacial deposit that has created a somewhat unusual phenomenon. The "Bog" is actually a fairly deep body of water, which exists beneath the surface of a thick mossy bog. The bog is strong enough to support the weight of a human walking on it, but can be pierced, for example with a long stick, and beneath the surface there is several feet of water. Thus, visitors to the bog can appear to be walking on water. The relevance of this is that it speaks to the volume of water that is already being stored here. Flooding here is less severe, but more frequent occurring every five or ten years.
13	Turner Pond Dam	The dam has been repaired since the previous Hazard Mitigation Plan. Failure would likely cause downstream flooding at the culvert on Second Herring Brook at Main Street.
14	Jacob's Pond Dam	Dam failure could have significant impacts at Main Road and downstream.
15, 16	Pleasant Street at Poles #15 &#32	This location experiences flooding to the point of near road closure and is undermined during periods of peak rain and snow melt. The location relies on undersized culverts or piping for drainage.
17	Bowker Street between	This location experiences flooding to the point of near road closure and is undermined during periods of peak rain and snow melt. The location relies on undersized culverts or piping for drainage.

	Poles #17 and #18	
18	Mount Blue Street Poles	There are approximately 13 drainage culverts or drainage pipe outlets along Mount Blue Street. There are several steel corrugated pipes of various sizes that should be investigated and replaced before repaving this street. Several of these pipes show signs of corrosion and a few pipes have begun to collapse due to minimal pipe cover which has led to pothole asphalt patches.
20	Mill Street Bridge culvert	The culvert condition and sizing at the Mill Street Bridge along the Third Herring Brook is unknown. The viability and sizing of this culvert and pipe is recommended for study.
21	Route 123 (Main Street) culvert at Second Herring Brook	Flooding at this location is somewhat less frequent than at other sites in town and work at Torrey Pond has reduce the risk. But flooding impacts a major thoroughfare in town. Town officials have determined that the culvert beneath Route 123 needs to be replaced with a larger culvert, at an estimated cost of about $250,000.
22	Cross Street Pond (Wheeler Pond)	The pond has a weir structure, but the stability of the structure is unknown and should be studied and assessed. Flooding here is a very low frequency problem and is considered a low priority.
24	Bay Path Lane	Flooding here during the Mach 2010 rain storms impacted four homes on Bay Path Lane and would have been much worse had the rain not abated.
25	Forest Street	This section of Forest Street was similarly impacted as Bay Path Lane by the March 2010 rains. Like Bay Path Lane, this area had not previously flooded in recent memory and water inundation played a major role in the flooding here. However, town officials also cited inadequate drainage as a culprit here and the need to keep surrounding vegetation trimmed down to manageable levels. Eight homes were impacted by the flooding here.
26	Ridge Hill Area	There were many damage claims in this area in March 2010. The location is relatively flat, leading to stormwater flooding.
27	Washington Park Area	There were many damage claims in this area in March 2010. The location is relatively flat, leading to stormwater flooding.
28	Brentwood Area	There were many damage claims in this area in March 2010. The location is relatively flat, leading to stormwater flooding.
29	Peterson Pond Dam	Flood risk here has diminished as the dam in now partially breached. When funds are secured, full removal is anticipated.

REPETITIVE LOSS STRUCTURES

As defined by FEMA, a repetitive loss property is a NFIP-insured structure that has had two or more paid flood losses of $1,000 or more in any given 10-year period since 1978. There are 2 repetitive loss properties, both single-family homes, in Norwell. The properties are shown on the maps in Appendix A. These repetitive loss properties had a total of 4 losses from 1978 to 2019, totaling $46,054 in damages. For more information on repetitive losses see https://www.fema.gov/txt/rebuild/repetitive_loss_faqs.txt and https://www.fema.gov/repetitive-flood-claims-grant-program-fact-sheet.

Table 9 summarizes the number and location of loss structures located within Norwell and the number of losses and total claims associated with them.

Table 9: Summary of Repetitive Losses and Claims

	A, AE, AO, AH Zones	VE Zone	B, C, X Zones	Total
Number of Properties	1	0	1	2
Number of Losses	2	0	2	4
Total Claims	$17,052	0	$29,002	$46,054

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

DROUGHT

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

Droughts are projected to increase in frequency and intensity in the summer and fall as weather patterns change. Drought impacts can include reduced groundwater and surface water levels, affecting water quality and quantity, and the organisms that rely on aquatic resources. Drought also increases stress on plant communities and, the likelihood of forest and brush fires. Communities may be affected by water use restrictions, affecting drinking water supply and outdoor water use. Economic sectors impacted could include recreation, agriculture, and forestry.

Five levels of drought have been developed to characterize drought severity: Normal, Advisory, Watch, Warning, and Emergency. These drought levels are based on the conditions of natural resources and are intended to provide information on the current status of water resources. The levels provide a basic framework from which to take actions to assess, communicate, and respond to drought conditions.

Norwell does not collect data relative to drought events. Because drought tends to be a regional natural hazard, this plan references state data as the best available data for drought. The

SHMCAP using data collected since 1850, calculates that statewide there is a 1% chance of being in a drought emergency in any given month. For drought warning and watch levels, the chance is 2% and 8% respectively in any given month (Table 10).

Table 10: Frequency of Massachusetts Drought Levels

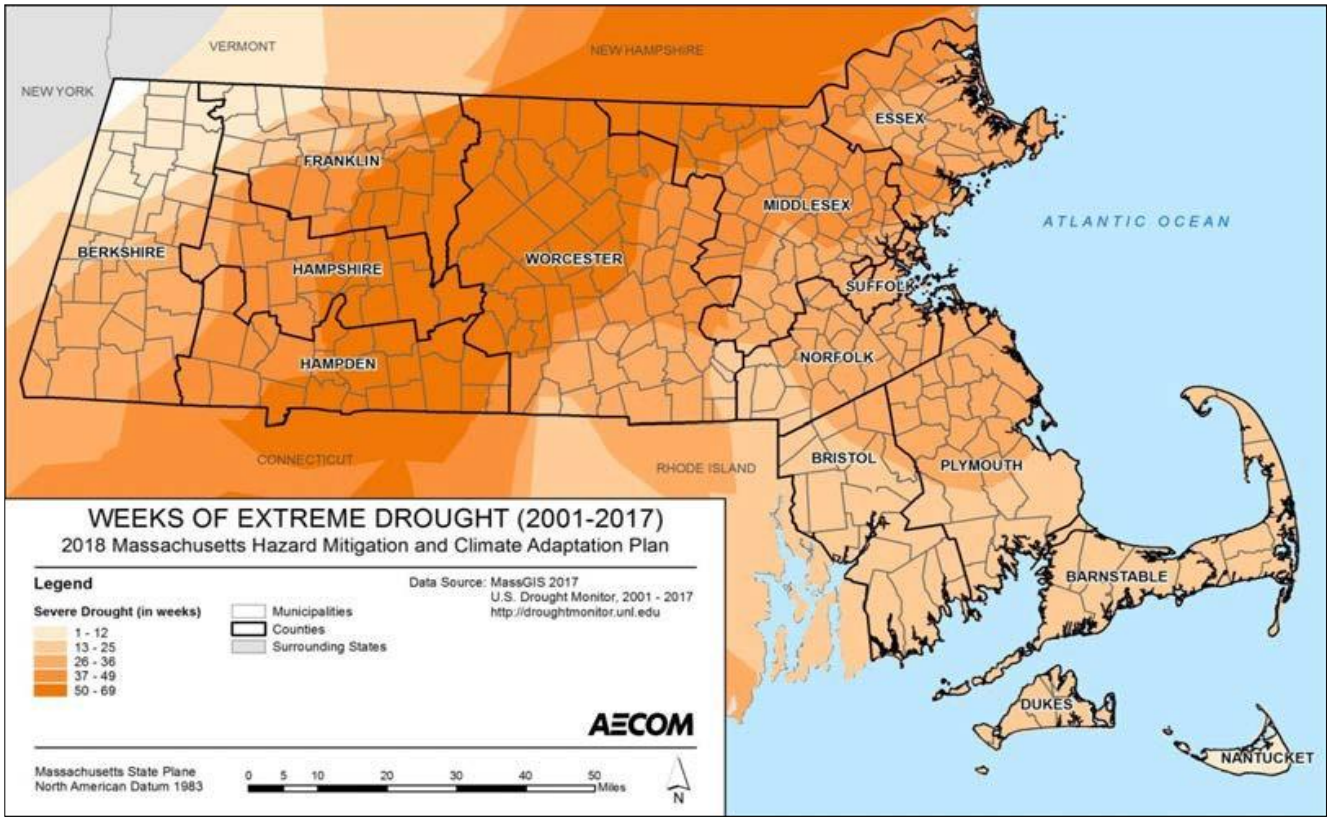
Drought Level	Frequency Since 1850	Probability of Occurrence in a Given Month
Drought Emergency	5 occurrences	1% chance
Drought Warning	5 occurrences	2% chance
Drought Watch	46 occurrences	8% chance

Source: SHMCAP

Drought emergencies have been reached infrequently, with five events occurring between 1850 and 2012: 1883, 1911, 1941, 1957, and 1965 to 1966. Due to its long duration, the drought from 1965 to 1966 is viewed as the most severe drought to have occurred in Massachusetts in modern times. The drought that extended from July 2016 to April 2017 reached the Drought Warning level. Determinations regarding the end of a drought or reduction of the drought level focus on two key drought indicators: precipitation and groundwater levels. These two factors have the greatest long-term impact on stream flow, water supply, reservoir levels, soil moisture, and the potential for forest fires.

The U.S. Drought Monitor characterizes droughts as moderate, severe, extreme, or exceptional. Severe drought is characterized by likely crop and pasture losses, water shortages, and water restrictions. As shown in Figure 9 below, Norwell experienced between 26 and 36 weeks of severe drought between 2001 and 2017. In Norwell, drought can impact drinking water supply and cause low streamflow with severe negative effects on aquatic ecosystems.

Figure 9: Weeks of Severe Drought (2001-2017)



Source: SHMCAP

LANDSLIDES

According to the U.S. Geological Survey, "The term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors." Among the contributing factors are: erosion by rivers or ocean waves over steepened slopes; rock and soil slopes weakened through saturation by snowmelt or heavy rains; earthquake created stresses that make weak slopes fail; excess weight from accumulation of rain or snow; and stockpiling of rock or ore from waste piles or man-made structures. In Massachusetts, according to the SHMCAP, the most common cause of landslides are geologic conditions combined with steep slopes and/or heavy rains. Landslides associated with heavy rains typically occur on steep slopes with permeable soils underlain by till or bedrock.

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

events may increase the chance of landslides as saturated soils are conducive to landslides. Drought may also increase the likelihood of landslides if loss of vegetation decreases soil stability.

The SHMCAP, utilizing data from the MA Department of Transportation from 1986 to 2006 estimates that, on average, roughly one to three known landslides have occurred each year. A slope stability map published by the MA Geological Survey and UMass-Amherst indicates that the most significant risk of landslide is in western Massachusetts.

Norwell is classified as having low susceptibility and a low incidence of landslides (see Map 4, Appendix B). Should a landslide occur in the future, the type and degree of impacts would be highly localized. The town's vulnerabilities could include damage to structures, damage to transportation and other infrastructure, and localized road closures. Injuries and casualties, while possible, would be unlikely given the low extent and impact of landslides in Norwell. There are no recorded instances of landslides having occurred in the Town of Norwell.

SEA LEVEL RISE

COASTAL FLOODING

Coastal flooding is most often associated with severe coastal storms that, through the combination of winds and tides, drive tidal waters to higher levels than normally experienced, leading to the inundation of low-lying land areas and the overtopping of sea walls. In low-lying areas coastal flooding can also be associated with routine tidal flooding or higher astronomic tides. Fueled by the warming climate, coastal flooding will become more frequent and severe due to the combination of sea level rise and more frequent and intense storms.

Norwell is not located directly on the coast. However, the North River is tidal for much of the portion that forms Norwell's eastern border. The town has identified several locations along the North River that have been subject to flooding due to storm surge and may be exacerbated by heavy rains.

Local data for previous coastal flooding occurrences are not collected by the Town of Norwell. The best available local data is for Plymouth County through the National Climatic Data Center. Eastern Plymouth County, which includes the Town of Norwell, experienced 40 coastal flood events from 2010 through 2019 (see Table 11). No deaths and two injuries were reported and the total reported property damage in the county was $15.03 million dollars. Nearly two-thirds of the property damage occurred during the winter of 2013. This is an average of 4 coastal floods each year.

Table 11: Eastern Plymouth County Coastal Floods, 2009-2019

DATE	DEATHS	INJURIES	PROPERTY DAMAGE
10/18/2009	0	0	0
1/2/2010	0	0	0
2/25/2010	0	0	0

3/4/2010	0	0	0
3/15/2010	0	0	0
10/6/2010	0	0	0
11/8/2010	0	0	1.000
12/27/2010	0	0	2.200.000
10/30/2011	0	0	10,000
11/23/2011	0	0	0
6/3/2012	0	1	35,000
6/4/2012	0	0	0
6/4/2012	0	0	40,000
10/29/2012	0	0	645,000
10/29/2012	0	0	322,000
12/27/2012	0	0	0
12/27/2012	0	0	0
2/9/2013	0	0	9,200,000
3/7/2013	0	0	500,000
12/15/2013	0	0	0
1/2/2014	0	0	0
1/2/2014	0	0	0
1/3/2014	0	0	0
3/26/2014	0	0	0
10/22/2014	0	0	75,000
10/23/2014	0	0	0
11/2/2014	0	0	0
1/27/2015	0	1	1,500,000
2/15/2015	0	0	0
10/2/2015	0	0	0
1/23/2016	0	0	0
1/24/2016	0	0	3,000
2/8/2016	0	0	0
1/4/2018	0	0	500,000
1/30/2018	0	0	0
3/2/2018	0	0	0
3/8/2018	0	0	0
10/27/2018	0	0	0
11/25/2018	0	0	0
1/20/2019	0	0	0
	0	**2**	**15.03M**

COASTAL EROSION

Coastal shorelines change constantly in response to storms, seasons, sea level, and human alterations. Coastal erosion is measured as a rate of change over time. According to the SHMCAP frequency of erosion cannot be measured. Risings seas and more frequent and intense storms will tend to increase erosion, although some areas may actually accrete material. Erosion may be exacerbated by efforts to protect shoreline as engineered structures can reduce sediment sources to downdrift areas or, increase erosion seaward of structures due to interaction with waves.

Massachusetts Coastal Zone Management (CZM) in cooperation with the U. S. Geological Survey (USGS) provides shoreline change data for the Massachusetts coast. While the North River is tidal along part of Norwell's border, and may experience erosion, CZM data does not extend inland from the coast. Erosion has not been identified as a concern in Norwell, although it may be possible for some shoreline erosion to occur along the North River salt marshes.

TSUNAMI

A tsunami is a surge of water typically caused by an offshore earthquake. Tsunamis can cause wave heights of 100 feet or more. According to the SHMCAP, Massachusetts has never experienced a significant tsunami, although two tsunamis have occurred with no deaths or damages recorded. Damage from a tsunami could be very significant, but it is a low likelihood event, having occurred approximately once every 39 years along the entire east coast. No tsunami has impacted Massachusetts since 1950. Norwell does not have coastal shoreline, but a tsunami could cause flooding along the North River due to surging tidal waters.

RISING TEMPERATURES

AVERAGE AND EXTREME TEMPERATURES

Extreme temperatures occur when either high temperature or low temperatures relative to average local temperatures occur. These can occur for brief periods of time and be acute, or they can occur over long periods of time where there is a long stretch of excessively hot or cold weather. Norwell has four well-defined seasons. The seasons have several defining factors, with temperature one of the most significant. Extreme temperatures can be defined as those that are far outside of the normal seasonal ranges for Massachusetts.

EXTREME COLD

Extreme cold temperature is typically measured using the Wind Chill Temperature Index, which is provided by the National Weather Service (NWS). The wind chill is the apparent temperature felt on exposed skin due to the combination of air temperature and wind speed. The index is provided in Figure 11 below. Extreme cold is a dangerous situation that can result in health emergencies for susceptible people, such as those without shelter, those who are stranded, or those who live in homes that are poorly insulated or without heat.

Figure 10 Wind Chill Temperature Index and Frostbite Risk

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

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

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

Where, T= Air Temperature (°F) V= Wind Speed (mph) *Effective 11/01/01*

Source: National Weather Service

The Town of Norwell does not collect data for previous occurrences of extreme cold. The best available local data are for Plymouth County, through the National Climatic Data Center (NCDC). There have been two extreme cold events in the past ten years, which caused no deaths, no injuries, or property damage. This is an average of one event every 5 years. Extreme cold is a town wide hazard.

Table 12: Plymouth County Extreme Cold and Wind Chill Occurrences 2010 through 2019

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

Source: NOAA, National Climatic Data Center

EXTREME HEAT

A heat wave in Massachusetts is defined as three or more consecutive days above 90°F. Another measure used for identifying extreme heat events relies on the Heat Index. According to the National Weather Service (NWS), the Heat Index is a measure of how hot it really feels relative humidity is factored in with the actual air temperature. The NWS issues an advisory when the heat index (Figure 12) is forecast to exceed 100°F for two or more hours; an excessive heat advisory is issued if the forecast predicts the temperature will rise above 105°F.

Figure 11: Heat Index Chart

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

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

The Town of Norwell does not collect data on excessive heat occurrences. The best available local data are for Plymouth County, through the National Climatic Data Center. In the past ten years there has been one excessive heat day and no deaths, injuries, or property damage (see Table 13). This is an average of one extreme heat occurrence every ten years.

Table 13: Plymouth County Extreme Heat Occurrences 2010 through 2019

Date	Deaths	Injuries	Damage
7/6/2010	0	0	0

Source: NOAA, National Climatic Data Center

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

Older adults are often at elevated risk due to a high prevalence of pre-existing and chronic conditions. People who live in older housing stock and in housing without air conditioning have

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

Due to what is termed the "heat island effect", areas with less shade and more dark surfaces (pavement and roofs) will experience even hotter temperatures; these surfaces absorb heat during the day and release it in the evening, keeping nighttime temperatures warmer as well. Map 10 in Appendix B displays areas that are among the hottest 5% of land in the MAPC region based on land surface temperature derived from satellite imagery on July 13, 2016, when the high temperature at Logan Airport was 92°F. Norwell has extensive tree cover and only a few small locations along Route 3 and 123 that are in the top 5% "hot spots". Heat impacts are more likely to be felt by residents without air conditioning and by those who work outdoors.

WILDFIRE

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

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

A wildfire differs greatly from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to unexpectedly change direction, and its ability to jump gaps such as roads, rivers, and fire breaks. Wildfire season can begin in March and usually ends in late November. The majority of wildfires typically occur in April and May, when most vegetation is void of any appreciable moisture, making them highly flammable. Once "green-up" takes place in late May to early June, the fire danger usually is reduced somewhat. As the climate warms, drought and warmer temperatures may increase the risk of wildfire as vegetation dries out and becomes more flammable.

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

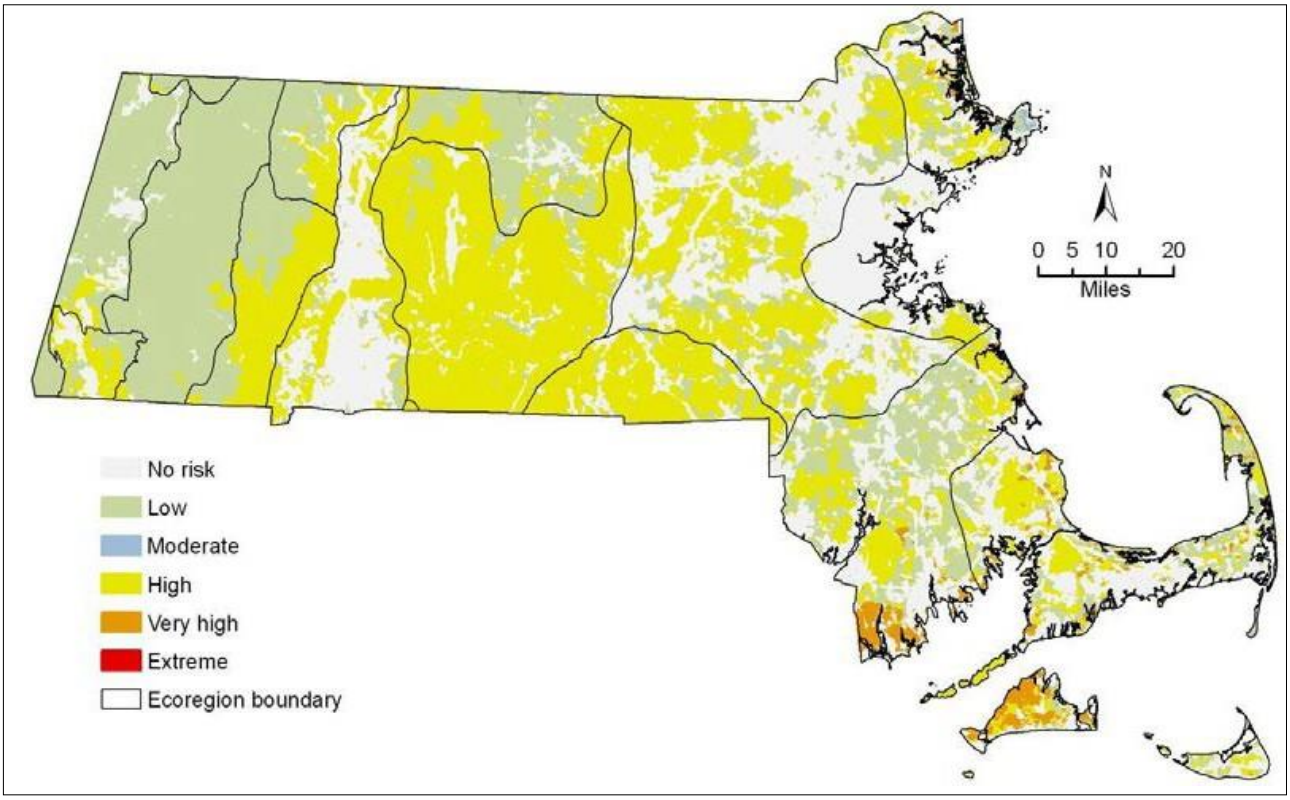
POTENTIAL BRUSHFIRE HAZARD AREAS

The SCHMCAP includes a graphic that depicts statewide fire risk incorporating three risk components: fuel, wildland-urban interface, and topography (Figure 12). The wildland-urban interface reflects communities where housing and vegetation intermingle, and fire can spread from structures to vegetated areas. The most susceptible fuels are pitch pine, scrub oak and oak forests. Topography can affect the behavior of fires, as fire spreads more easily uphill. Norwell is shown in a high-risk zone. Fire was not identified as a common occurrence; the Fire Chief indicated that records show no significant events in the past ten years. Nevertheless, concern was expressed that due to the amount of fuel in the form of downed trees, fire risk could be increasing. Access to forested fires could be a challenge in some locations in Norwell. The most common cause of wildfires is the careless disposal of smoking materials and untended campfires.

The following areas of town were identified as having the highest potential for brush fires. The numbers correspond to the numbers on Map 8, "Hazard Areas":

1) Norris Reservation: This protected natural open space is owned and maintained by the Massachusetts non-profit organization The Trustees of the Reservation and is bordered by Chittendon Lane to Dover and Main Streets. Frequency of fire events here is only low to medium frequency.
2) Wompatuck State Park: There are existing fire trails within this state park, which is the site of an average of two brush fires per year. As a state park, Norwell does receive firefighting help from the Department of Conservation and Recreation Fire District in the region.
3) South Street to Tiffany Road: This is a low severity and low frequency brush fire area covering hundreds of acres of town owned, water department property. There is currently no access for town and fire vehicles and the fire department suggested that a study may have to be done to see what could be done to make the area more accessible. However, making the area more accessible may also have the undesired effect of increasing the frequency of incidents, by increasing access and activity on the site.
4) Stetson Meadows: This is a piece of conservation land that is also largely inaccessible and only occasionally is the site of brush fires. Similar to the South Street to Tiffany Road site, this area needs additional study to determine if creating more access is needed or desirable.
5) Grove Street pits: This site to the north side of the town is another piece of town-owned water department property, but this site serves as the town's well field. The property abuts Wampatuck State Park, a large open space in the town of Hingham to the north and the other side of the Prospect Street fire hazard area. There is a low frequency of brush fires at this site but responding to the site is a challenge due to access issues.

Figure 12: Wildfire Risk Areas



Source: SHMCAP

INVASIVE SPECIES

The 2018 SHMCAP includes invasive species as a natural hazard for the first time. They are defined as "non-native species that cause or are likely to cause harm to ecosystems, economies, and/or public health". Species that may have negative impacts in Norwell include green crabs, purple loosestrife, garlic mustard, and phragmites. Phragmites are susceptible to wildfire.

EXTREME WEATHER

HURRICANES AND TROPICAL STORMS

A hurricane is a violent wind and rainstorm with wind speeds of 74 to 200 miles per hour. A hurricane is strongest as it travels over the ocean and is particularly destructive to coastal property as the storm hits land. A tropical storm has similar characteristics, but wind speeds are below 74 miles per hour. Climate models suggest that hurricanes and tropical storms will become more intense as warmer ocean waters provide more fuel for the storms. In addition, rainfall amounts associated with hurricanes are predicted to increase because warmer air can hold more water vapor. Since 1900, 39 tropical storms have impacted New England (NESEC). Massachusetts has experienced approximately 32 tropical storms, nine Category 1 hurricanes, five Category 2 hurricanes and one Category 3 hurricane.

Given its location near the coast, the Town of Norwell's entire area is vulnerable to hurricanes, which occur between June and November. As shown in the hazard mapping in Appendix B, a tropical depression tracked through Norwell in 1876, tropical storms tracked through Norwell in 1916 and 1923. Category 2 Hurricane Bob tracked through Norwell in 1991. A hurricane or storm track is the line that delineates the path of the eye of a hurricane or tropical storm. The town also experiences the impacts of the wind and rain from hurricanes and tropical storms regardless of whether the storm track passed through the town. The hazard mapping indicates that the 100-year wind speed in Norwell is 110 miles per hour.

Table 14: Hurricane Records for Massachusetts, 1938 to 2018

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

*Category 3
Source: National Oceanic and Atmospheric Administration

Hurricane intensity is measured according to the Saffir/Simpson scale, which categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure, and storm surge potential. These are combined to estimate potential damage. The following gives an overview of the wind speeds, surges, and range of damage caused by different hurricane categories:

Table 15: Saffir/Simpson Scale

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

Source: NOAA

Hurricanes typically have regional impacts beyond their immediate tracks. Falling trees and branches are a significant problem because they can result in power outages when they fall on

power lines or block traffic and emergency routes. Hurricanes are a town-wide hazard in Norwell. Potential hurricane damages to Norwell have been estimated using HAZUS-MH. Total damages are estimated at $17.9 million for a Category 2 hurricane and $67 million for a Category 4 hurricane.

SEVERE WINTER STORM/NOR'EASTER

A northeast storm, known as a nor'easter, is typically a large counterclockwise wind circulation around a low-pressure center. Featuring strong northeasterly winds blowing in from the ocean over coastal areas, nor'easters are relatively common in the winter months in New England occurring one to two times a year. The storm radius of a nor'easter can be as much as 1,000 miles and these storms feature sustained winds of 10 to 40 mph with gusts of up to 70 mph. These storms are accompanied by heavy rain or snow, depending on temperatures. Many of the historic flood events identified in the previous section were precipitated by nor'easters, including the "Perfect Storm" event in 1991. More recently, blizzards in February 2013, January 2015, and in March 2018 were large nor'easters that caused significant snowfall amounts.

Norwell is vulnerable to both the wind and precipitation that accompany nor'easters. High winds can cause damage to structures, fallen trees, and downed power lines leading to power outages. Intense rainfall can overwhelm drainage systems causing localized flooding of rivers and streams as well as urban stormwater ponding and localized flooding. Fallen tree limbs as well as heavy snow accumulation and intense rainfall can impede local transportation corridors, and block access for emergency vehicles. Nor'easters are also a cause of coastal flooding. Pleasant Street near Circuit Street is identified as a location where snow drifts are problematic. This location is identified as #19 on the maps in Appendix B.

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

The National Weather Service defines "heavy snow fall" as an event generating at least four inches of snowfall within a 12-hour period. The Northeast Snowfall Impact Scale (NESIS), developed by Paul Kocin of The Weather Channel and Louis Uccellini of the National Weather Service (Kocin and Uccellini, 2004), characterizes and ranks high impact northeast snowstorms. These storms have large areas of 10-inch snowfall accumulations and greater. NESIS has five categories: Extreme, Crippling, Major, Significant, and Notable. NESIS scores are a function of the area affected by the snowstorm, the amount of snow, and the number of people living in the path of the storm. The largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers. The NESIS categories are summarized below:

Table 16: NESIS 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+	Extreme

Source: Massachusetts State Hazard Mitigation Plan, 2013

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

Table 17: Severe Weather Major Disaster Declarations in Eastern MA

Storm Event	Date
Severe Winter Storm and Snowstorm	March 2018
Severe Winter Storm, Snowstorm, and Flooding	January 2015
Severe Winter Storm, Snowstorm, and Flooding	February 2013
Hurricane Sandy	October/November 2012
Severe Storm and Snowstorm	October 2011
Tropical Storm Irene	August 2011
Severe Winter Storm and Snowstorm	January 2011
Severe Winter Storm and Flooding	December 2008
Severe Storms and Inland and Coastal Flooding	April 2007
Severe Storm and Flooding	October 2005
Severe Storms & Flooding	March 2001
Blizzard	January 1966
Winter Coastal Storm	December 1992
Severe Coastal Storm	October 1991
Hurricane Bob	August 1991
Hurricane Gloria	September 1985
Coastal Storm, Flood, Ice, Snow	February 1978
Hurricane, floods	August 1955
Hurricanes	September 1954

Source: FEMA

As with hurricanes, warmer ocean water and air will provide more fuel for storms. According to the SHMCAP it appears that Atlantic coast nor'easters are increasing in frequency and intensity.

Winter storms, including heavy snow, blizzards, and ice storms, are the most common and most familiar of the region's hazards that affect large geographic areas. The majority of blizzards and ice storms in the region cause more inconvenience than they do serious property damage, injuries, or deaths. However, periodically, a storm will occur which is a true disaster, and necessitates intense large-scale emergency response. The impacts of winter storms are often related to the weight of snow and ice, which can cause roof collapses and also causes tree limbs to fall. This in turn can cause property damage and potential injuries. Power outages may also result from fallen trees and utility lines.

Winter storms are a potential town-wide hazard in Norwell. Map 6 in Appendix A indicates that the average annual average snowfall in Norwell is between 36 and 48 inches. A number of public safety issues can arise during snow storms. Impassible streets are a challenge for emergency vehicles and affect residents and employers. Snow-covered sidewalks force people to walk in streets, which are already less safe due to snow, slush, puddles, and ice. Large piles of snow can also block sight lines for drivers, particularly at intersections. Refreezing of melting snow can cause dangerous roadway conditions. In addition, transit operations may be impacted, as they were in the 2015 blizzards which caused the closure of the MBTA system for one day and limited services on the commuter rail for several weeks.

The Town of Norwell does not keep local records of winter storms. Data for Plymouth County, is the best available data to help understand previous occurrences and impacts of heavy snow events. According to National Climate Data Center (NCDC) records, from 2010 through 2019, Plymouth County experienced 15 heavy snowfall events, resulting in no injuries, deaths, or property damage (Table18).

Table 18: Heavy Snow Events and Impacts in Plymouth County, 2010 through 2019

DATE	DEATHS	INJURIES	PROPERTY DAMAGE
12/20/2010	0	0	0
1/26/2011	0	0	0
1/21/2012	0	0	0
2/8/2013	0	0	0
3/7/2013	0	0	0
1/2/2014	0	0	0
1/21/2014	0	0	0
2/5/2014	0	0	0
2/15/2014	0	0	5,000
2/2/2015	0	0	0
2/8/2015	0	0	0
3/5/2015	0	0	0

2/5/2016	0	0	100,000
4/4/2016	0	0	0
12/19/2019	0	0	0
Total	**0**	**0**	**105,000**

Source: NOAA, National Climatic Data Center

Heavy snow is considered to be high frequency events based on past occurrences, as there have been 15 events in the past ten year, for an average of 1.5 events each winter. As with nor'easters, warmer ocean water and air will provide more fuel for storms. According to the SHMCAP changing atmospheric patterns favor the development of winter storms.

TORNADOS

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

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

Tornado damage severity is measured by the Fujita Tornado Scale, in which wind speed is not measured directly but rather estimated from the amount of damage. As of February 1, 2007, the National Weather Service began rating tornados using the Enhanced Fujita-scale (EF-scale), which allows surveyors to create more precise assessments of tornado severity. The EF-scale is summarized below:

Table 19: Enhanced Fujita Scale

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

Source: Massachusetts State Hazard Mitigation Plan, 2013

The frequency of tornadoes in eastern Massachusetts is low; on average, there are six tornadoes that touchdown somewhere in the Northeast region every year. The strongest tornado in Massachusetts history was the Worcester Tornado in 1953 (NESEC). Recent tornado events in Massachusetts were in Springfield in 2011 and in Revere in 2014. The Springfield tornado caused significant damage and resulted in four deaths in June of 2011. The Revere tornado touched down in Chelsea just south of Route 16, moved north into Revere's business district along Broadway, and ended near the intersection of Routes 1 and 60. The path was approximately two miles long and 3/8 mile wide, with wind speeds up to 120 miles per hour. Approximately 65 homes had substantial damages and 13 homes and businesses were rendered uninhabitable.

Since 1958, there have been ten tornadoes in Plymouth County recorded by the Tornado History Project. There have been one F2, and four FI tornados. The ten tornadoes resulted in a total of one fatality and two injuries and $1.15 million in damages, as summarized in Table 20. This an average of one tornado every 6 years.

Table 20: Tornado Records for Plymouth County

Date	Fujita	Fatalities	Injuries	Width	Length	Damage
9/7/1958	0	1	1	10	0.1	$500-$5000
7/4/1964	1	0	0	10	2.3	$50K-$500K
6/9/1965	0	0	0	10	0.1	<$50
11/18/1967	2	0	0	17	.1	$50-$500
8/9/1968	1	0	0	100	1	$500-$5000
9/16/1986	1	0	0	50	.1	$50K-$500K
7/10/1989	1	0	1	23	.1	$5K-$50K
7/10/1989	0	0	0	23	.1	$5K-$50K
8/20/1997	0	0	0	10	0.1	$5K-$50K
7/24/2012	0	0	0	15	.03	$3K

Source: The Tornado History Project

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

Although tornadoes are a potential town-wide hazard in Norwell, tornado impacts are relatively localized compared to severe storms and hurricanes. Damages from any tornado in Norwell would greatly depend on the track of the tornado. Based on the record of previous occurrences

since 1958, tornado events in Norwell are a low frequency event as there is no record of tornado activity in Norwell. According to the SHMCAP, it is possible that severe thunderstorms which can include tornadoes may increase in frequency and intensity. However, scientists have less confidence in the models that seek to project future changes in tornado activity.

OTHER SEVERE WEATHER

SEVERE THUNDERSTORMS

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

The best available data on previous occurrences of thunderstorms in Norwell is for Plymouth County through the National Climatic Data Center (NCDC). For the years 2010 through 2019, NCDC records show 30 thunderstorm events in Plymouth County (Table 21). These storms resulted in a total of $342,600 in property damages. There were two injuries and no deaths reported. This is an average of 3 events per year.

Table 21: Plymouth County Thunderstorm Events, 2010 through 2019

DATE	DEATHS	INJURIES	PROPERTY DAMAGE
4/22/2010	0	0	25,000
6/20/2010	0	2	50,000
6/27/2010	0	0	500
8/5/2010	0	0	5,000
7/13/2011	0	0	15,000
7/18/2011	0	0	45,000
7/23/2011	0	0	60,000
6/23/2012	0	0	15,000
7/1/2012	0	0	10,000
7/18/2012	0	0	10,000
8/10/2012	0	0	15,000
10/30/2012	0	0	25,000
6/17/2013	0	0	3,000
7/20/2013	0	0	5,000
8/4/2015	0	0	5,000
2/25/2016	0	0	10,000
7/17/2016	0	0	5,000
7/18/2016	0	0	3,000
7/22/2016	0	0	5,000

7/23/2016	0	0	5,000
9/11/2016	0	0	1,000
6/13/2017	0	0	1,000
7/6/2018	0	0	1,000
7/17/2018	0	0	10,000
4/15/2019	0	0	4,000
6/29/2019	0	0	0
7/17/2019	0	0	1,500
7/31/2019	0	0	0
8/8/2019	0	0	300
8/19/2019	0	0	300
TOTAL	**0**	**2**	**342,600**

Source: NOAA, National Climatic Data Center

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

Based on the record of previous occurrences, severe thunderstorms in Norwell are high frequency events as this hazard has occurred an average of three times per year in the past ten years. As noted previously, the intensity of rainfall events has increased significantly, and those trends are expected to continue. The SHMCAP does not specifically address whether climate will affect the intensity or frequency of thunderstorms.

ICE STORMS

The ice storm category covers a range of different weather phenomena that collectively involve rain or snow being converted to ice in the lower atmosphere leading to potentially hazardous conditions on the ground. Hail size typically refers to the diameter of the hailstones. Warnings and reports may report hail size through comparisons with real-world objects that correspond to certain diameters:

Table 22: Hail Size Comparisons

Description	Diameter (inches)
Pea	0.25
Marble or mothball	0.50
Penny or dime	0.75
Nickel	0.88
Quarter	1.00
Half dollar	1.25
Walnut or ping pong ball	1.50
Golf ball	1.75

Hen's egg	2.00
Tennis ball	2.50
Baseball	2.75
Tea cup	3.00
Grapefruit	4.00
Softball	4.50

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

Town-specific data for previous ice storm occurrences are not collected by the Town of Norwell. The best available local data is for Plymouth County through the National Climatic Data Center. Plymouth County experienced nine events from 2010 through 2019, for an average of almost one event per year. There is some indication that if winters warm, temperatures may be more likely to produce icing conditions. Ice storms are a town wide hazard for Norwell.

Table 23: Plymouth County Hail Events, 2009 to 2019

DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE
5/26/2010	0.75	0	0	0
6/1/2011	1	0	0	0
9/15/2011	0.75	0	0	0
7/24/2012	1.75	0	0	0
8/7/2014	1	0	0	0
7/17/2016	0.88	0	0	0
6/13/2017	0.75	0	0	0
6/22/2019	0.75	0	0	0
6/30/2019	1	0	0	0
TOTAL		**0**	**0**	**0**

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

NON-CLIMATE INFLUENCED HAZARDS

EARTHQUAKES

Earthquakes are the sole natural hazard for which there is no established correlation with climate impacts. Damage in an earthquake stems from ground motion, surface faulting, and ground failure in which weak or unstable soils, such as those composed primarily of saturated sand or silts, liquefy. The effects of an earthquake are mitigated by distance and ground materials between the epicenter and a given location. An earthquake in New England affects a much wider area than a similar earthquake in California due to New England's solid bedrock geology (NESEC).

Seismologists use a magnitude scale known as the Richter scale to express the seismic energy released by each earthquake. The typical effects of earthquakes in various ranges are summarized below:

Table 24: Richter Scale and Effects

Richter Magnitudes	**Earthquake Effects**
Less than 3.5	Generally not felt, but recorded
3.5- 5.4	Often felt, but rarely causes damage
Under 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1-6.9	Can be destructive in areas up to about 100 km. across where people live.
7.0- 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or greater	Great earthquake. Can cause serious damage in areas several hundred meters across.

Source: Nevada Seismological Library (NSL), 2005

According to the State Hazard Mitigation Plan, New England experiences an average of five earthquakes per year. From 1668 to 2007, 355 earthquakes were recorded in Massachusetts (NESEC). Most have originated from the La Malbaie fault in Quebec or from the Cape Anne fault located off the coast of Rockport. The region has experienced larger earthquakes in the distant past, including a magnitude 5.0 earthquake in 1727 and a 6.0 earthquake that struck in 1755 off the coast of Cape Anne. More recently, a pair of damaging earthquakes occurred near Ossipee, NH in 1940. A 4.0 earthquake centered in Hollis, Maine in October 2012 was felt in the Boston area. Historic records of some of the more significant earthquakes in the region are shown in Table 25.

Table 25: Historical Earthquakes in Massachusetts or Surrounding Area

Location	Date	Magnitude
MA - Cape Ann	11/10/1727	5
MA - Cape Ann	12/29/1727	NA
MA - Cape Ann	2/10/1728	NA
MA - Cape Ann	3/30/1729	NA
MA - Cape Ann	12/9/1729	NA
MA - Cape Ann	2/20/1730	NA
MA - Cape Ann	3/9/1730	NA
MA - Boston	6/24/1741	NA
MA - Cape Ann	6/14/1744	4.7
MA - Salem	7/1/1744	NA
MA - Off Cape Ann	11/18/1755	6
MA - Off Cape Cod	11/23/1755	NA
MA - Boston	3/12/1761	4.6
MA - Off Cape Cod	2/2/1766	NA

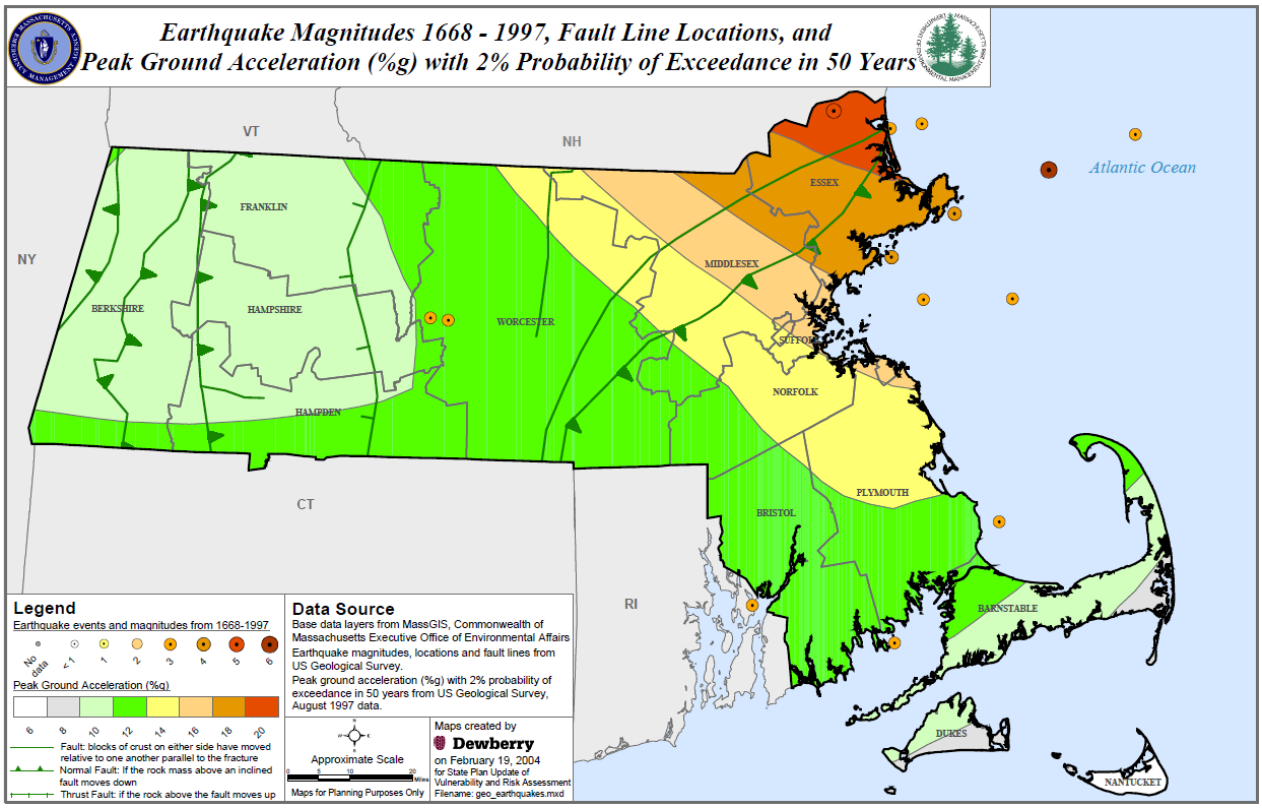
Location	Date	Magnitude
MA - Offshore	1/2/1785	5.4
MA - Wareham/Taunton	12/25/1800	NA
MA - Woburn	10/5/1817	4.3
MA - Marblehead	8/25/1846	4.3
MA - Brewster	8/8/1847	4.2
MA - Boxford	5/12/1880	NA
MA - Newbury	11/7/1907	NA
MA - Wareham	4/25/1924	NA
MA - Cape Ann	1/7/1925	4
MA - Nantucket	10/25/1965	NA
MA - Boston	12/27/74	2.3
MA - Nantucket	4/12/12	4.5
ME - Hollis	10/17/12	4.0

Source: Boston HIRA

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

Although New England has not experienced a damaging earthquake since 1755, seismologists state that a serious earthquake occurrence is possible. There are five seismological faults in Massachusetts, but there is no discernible pattern of previous earthquakes along these fault lines. Earthquakes occur without warning and may be followed by aftershocks. The majority of older buildings and infrastructure were constructed without specific earthquake resistant design features.

Figure 13: State of Massachusetts Earthquake Probability Map



Earthquakes are a hazard with multiple impacts beyond the obvious building collapse. Buildings may suffer structural damage which may or may not be readily apparent. Earthquakes can cause major damage to roadways, making emergency response difficult. Water lines and gas lines can break, causing flooding and fires. Another potential vulnerability is equipment within structures. For example, a hospital may be structurally engineered to withstand an earthquake, but if the equipment inside the building is not properly secured, the operations at the hospital could be severely impacted during an earthquake. Earthquakes can also trigger landslides.

According the SHMCAP there is a 10-15% chance of a magnitude 5 earthquake in a given ten-year period. Earthquakes are a potential town-wide hazard in Norwell. Although new construction under the most recent building codes generally will be built to seismic standards, much of the development in the town pre-dates the most recent building code. Potential earthquake damages to Norwell have been estimated using HAZUS-MH. Total building damages are estimated at $285 million for a 5.0 magnitude earthquake and $2 billion for a 7.0 magnitude earthquake. Other potential impacts are detailed in Table 31.

LAND USE AND DEVELOPMENT TRENDS

Existing Land Use

The most recent land use statistics available from the state are from aerial imagery completed in 2016. Table 26 shows the acreage and percentage of land in 14 categories. If the primary

residential categories are aggregated, residential uses make up 43% of the area of the town. Commercial and industrial uses combined make up 4% of the town. Agriculture, Forest, Water, Open Land, and Recreation total a little over 21% of the land. However, the tax-exempt category represents another fifth of Norwell's land. Most of this land is additional open space.

Table 26: Town of Norwell, MA 2016 Land Use

Land Use Type	Acres	Percentage
Residential - single family	5729	42.2
Residential - multi-family	152	1.1
Mixed use, primarily commercial	4	0
Commercial	381	2.8
Mixed use, other	262	1.9
Industrial	161	1.2
Agriculture	228	1.7
Forest	43	0.3
Water	179	1.3
Open land	2295	16.9
Recreation	120	0.9
Unknown	653	4.8
Right-of-way	721	5.3
Tax exempt	2656	19.6
Total	**13,585**	**100.0**

For more information on how the land use and land cover data were developed and the definitions of the categories, please go to https://docs.digital.mass.gov/dataset/massgis-data-2016-land-coverland-use

Economic Elements

Norwell is a suburban bedroom community. Residential taxes account for 85% of Norwell's tax base. Commercial activity is located primarily in the Assinippi and Accord Industrial parks located at the junction of Routes 3 and 228. Other commercial areas include Queen Anne's Plaza and the town center. These locations were not identified as ones particularly subject to damage from natural hazards.

NATURAL, CULTURAL, AND HISTORICAL RESOURCE AREAS

Norwell takes great pride in its scenic vistas including beautifully maintained colonial homes, the historic village district, the North River, open fields, stone walls, and forests. More than a dozen roads have been designated through the state Scenic Roads Designation Program. Protected lands comprise more than 25% of the total land in Norwell. Significant properties include Wompatuck State Park, Norris Reservation, Black Pond Bog Reserve, Stetson Meadows, Jacobs

Pond Recreational Areas, Donovan Farm and extensive acreage protected for the Town of Norwell water supply.

Norwell sites on the State Register of Historical Places include the Historic Norwell Village area and Jacob's Farmhouse. The Village area includes the Cushing Center, the James Library, fire station, police station, several restaurants and small shops, a church and cemeteries, several homes, the Town Common and patriotic monuments. The South Shore Natural Science Center is run under the auspices of the YMCA and is dedicated to educating the public about the natural and cultural environments of the South Shore through a variety of programs for people of all ages.

DEVELOPMENT TRENDS

Development trends throughout the metropolitan region are tracked by MassBuilds, MAPC's Development Database, which provides an inventory of new development over the last decade. The database tracks both completed developments and those currently under construction. The database includes seven completed projects in the Town of Norwell since 2014.

The database also includes several attributes of the new development, including housing units, and commercial space. The seven developments in Norwell include a total of 165 housing units and 45,760 square feet of commercial space.

Table 27: Summary of Norwell Developments, 2014-2018

Name	Status	Year	Housing Units	Commercial Square Feet	Project Type
Tiffany Hill	Under construction	2019	24	0	Residential
Damon Farms	Under construction	2109	28	0	Residential
Washington Woods	Complete	2015	44	0	Residential
Wildcat Subdivision	Complete	2017	47	0	Residential
South Shore Medical Center	Complete	2015	0	45,760	Commercial
Cowings Cove	Complete	2015	7	0	Residential
Norwell Estates	Nearly complete	2020	15	0	Residential

POTENTIAL FUTURE DEVELOPMENT

MAPC consulted with the Local Hazard Mitigation Planning Team to determine areas that may be developed in the future, based on the Town's comprehensive planning efforts and current trends and projects. These areas are listed below with their flood risk, heat, sea level rise risk, and heat risk outlined in Table 28. In order to characterize any change in the town's vulnerability associated with new developments, a GIS mapping analysis was conducted which overlaid the

development sites with the FEMA Flood Insurance Rate Map. sea level rise and high heat areas. Potential future development projects:

A) Simon Hill Village: 80 townhomes are proposed, the Wetlands Order of Conditions is under appeal with Mass DEP.
B) White Barn Village: 40 townhomes are proposed, the developer has appealed the Zoning Board of Appeals approval.
C) Autumn Woods: a proposal for 24 units was approved, no current activity.
D) Norwell Commons: 198 rental units were proposed in 2008, no current development activity.
E) Wildcat Lane: this is town-owned currently under review for future development.
F) Schooner Estates: a 9-lot subdivision, construction anticipated in 2020.
G) Old Oaken Bucket Estates: a 26-lot subdivision, no construction start date yet.
H) Hitching Post Lane: a 5-lot cluster subdivision currently under Special Permit review.

FUTURE DEVELOPMENT IN HAZARD AREAS

Table 28 shows the relationship between potential future development areas and the applicable mapped hazard areas (flood zones, sea level rise and heat). This information is provided so that planners can ensure that development proposals comply with floodplain zoning and that careful attention is paid to drainage and other issues.

Table 28: Relationship of Potential Development to Hazard Areas

Map ID	Potential Future Projects	Flood Zones	Sea Level Rise (3 feet MHW)	High Heat
A	Simon Hill Village	20% in A zone	NA	NA
B	White Barn Village	NA	NA	NA
C	Autumn Woods	15% in X zone	NA	NA
D	Norwell Commons	NA	NA	NA
E	Wildcat Lane	NA	NA	NA
F	Schooner Estates	NA	NA	NA
G	Old Oaken Bucket Estates	NA	NA	NA
H	Hitching Post Lane	NA	NA	NA

CRITICAL FACILITIES & INFRASTRUCTURE IN HAZARD AREAS

Critical facilities and infrastructure includes facilities that are important for disaster response and evacuation (such as emergency operations centers, fire stations, water pump stations, communications, and electricity) and facilities where additional assistance might be needed during an emergency (such as nursing homes, elderly housing, day care centers, etc.). There are 88 facilities identified in Norwell. These are listed in Table 29 and are shown on the maps in Appendix B.

Explanation of Columns in Table 29

- ***Column 1: ID #:*** The first column in Table 29 is an ID number which appears on the maps that are part of this plan. See Appendix B.
- ***Column 2: Name***: The second column is the name of the site.
- ***Column 3: Type*:** The third column indicates what type of site it is.
- ***Column 4: FEMA Flood Zone*:** The fourth column addresses the risk of flooding. A "No" entry in this column means that the site is not within any of the mapped risk zones on the Flood Insurance Rate Maps (FIRM maps). If there is an entry in this column, it indicates the type of flood zone. as follows:
- **Zone A** (1% annual chance) -Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
- **Zone AE** (1% annual chance) **-** Areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. Base Flood Elevations (BFEs) are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
- ***Column 5: Locally-Identified Area of Flooding*:** The fifth column indicates the risk of flooding in local hazard areas. A "No" entry in this column means that the site is not within any of the mapped flood hazard zones. If there is an entry in this column, it indicates the local hazard area.
- ***Column 6: Brush Fire Area:*** The sixth column indicates the risk of brush fire in local hazard areas. A "No" entry in this column means that the site is not within any of the mapped brush fire hazard zones. If there is an entry in this column, it indicates the local hazard area.
- ***Column 7:*** Hot spots indicates areas that are within the 5% of hottest areas in the MAPC region based on satellite data from 2016.
- ***Colum 8:*** Includes infrastructure that is within the projected new MHHW line with 3 feet of sea level rise.

Table 29: Critical Facilities and Relationship to Hazard Areas

ID	NAME	TYPE	FEMA FLOOD ZONE	LOCAL ID FLOOD ZONE	LOCAL ID BRUSH FIRE	HOT SPOT	3 FT SEA LEVEL RISE
1	Rt. 3 North Bound Bridge	Bridge	AE	No	No	No	Yes
2	Rt. 3 South Bound Bridge	Bridge	AE	No	No	No	Yes
3	River Street Over Pass	Bridge	No	No	No	No	No
4	South Street Overpass	Bridge	No	No	No	No	No
5	High Street Overpass North Bound	Bridge	No	Washington Park	No	No	No
6	High Street Overpass South Bound	Bridge	No	Washington Park	No	No	No
7	Bridge Street Bridge	Bridge	AE	No	No	No	Yes
9	Boundary Pond Dam	Dam	No	No	No	No	No
10	Bound Brook Dam	Dam	No	No	No	No	No
11	Norris Pond Dam	Dam	AE	No	Norris Reservation	No	No
12	Talbot Pond Dam	Dam	AE	No	No	No	Yes
13	Torry Pond Dam	Dam	No	No	No	No	No
14	Stoney Brook Dam	Dam	No	No	No	No	No
15	Jacobs Pond Dam	Dam	A	No	No	No	No
16	Turner Pond Dam	Dam	No	No	No	No	No
17	Cranberry Bog Dam	Dam	No	No	No	No	No
18	Copeland Tannery Dam	Dam	AE	No	No	No	No
19	Younger University Day Care	Child Care	No	No	No	No	No
20	Ridge Hill Pre School	Child Care	No	Ridge Hill	No	No	No
21	Kinder Care Day Care	Child Care	No	Brentwood	No	No	No
22	Kinder Care Day Care	Child Care	No	No	No	No	No
23	Bright Horizons Day Care	Child Care	No	No	No	No	No
24	New Nursery School	Child Care	No	No	No	No	No
25	First Parish Nursery School	Child Care	No	No	No	No	No
26	Norwell Highway Surveyor Office	Municipal	No	No	No	No	No

27	Norwell Gardens Elder Housing	Elder Housing	No	No	No	No	No
28	Fire Station #1	Fire Station	No	No	No	No	No
29	Fire Station #2	Fire Station	No	No	No	No	No
30	Fire Station #3	Fire Station	No	No	No	No	No
31	Big Y	Grocery Store	No	No	No	No	No
32	Stop and Shop	Grocery Store	No	No	No	No	No
33	South Shore Medical Center	Medical Facility	No	No	No	No	No
34	School Administration Building	Municipal	No	No	No	No	No
35	Norwell Public Library	Municipal	No	No	No	No	No
36	Southwood at Norwood Nursing Home	Nursing Home	No	No	No	No	No
37	Royal Norwell Nursing and Rehab	Nursing Home	No	Brentwood	No	No	No
38	Saint Helens Church	Church	No	Brentwood	No	No	No
39	UCC Church	Church	No	No	No	No	No
40	First Parish Church	Church	No	No	No	No	No
41	Norwell Police Station	Police Station	No	No	No	No	No
42	State Police Barracks	Police Station	No	No	No	No	No
43	Norwell Middle School	School	No	No	No	Yes	No
44	Norwell High School	School	No	No	No	No	No
45	South Shore Charter K-8	School	No	No	No	No	No
46	Grace Farrar Cole Elementary School	School	No	No	No	No	No
47	William G Vinal Elementary School	School	No	No	No	No	No
48	National Grid Substation	Special Needs	No	No	No	No	No
49	Norwell Town Hall	Municipal	No	No	No	No	No
50	Water Pump Station #6	Water Pump Station	No	No	South St to Tiffany Rd	No	No
51	Water Pump Station #1	Water Pump Station	No	No	South St to Tiffany Rd	No	No
52	Water Pump Station #4	Water Pump Station	No	Washington Park	No	No	No
53	Water Pump Station #7	Water Pump Station	No	No	No	No	No
54	Water Pump Station #8	Water Pump Station	No	No	No	No	No

55	Water Pump Station #9	Water Pump Station	A	No	No	No	No
56	Water Pump Station #3	Water Pump Station	No	No	Grove Street pits	No	No
57	Water Pump Station #5	Water Pump Station	No	No	Grove Street pits	No	No
58	Water Pump Station #10	Water Pump Station	No	No	Grove Street pits	No	No
59	Water Pump Station #2	Water Pump Station	No	No	Grove Street pits	No	No
60	Water Storage Tank Philip Drive	Water Storage Tank	No	No	No	No	No
61	Hingham Water Storage Tank	Water Storage Tank	No	No	No	No	No
62	Water Treatment Plant	Waste Water Treatment	No	No	South St to Tiffany Rd	No	No
63	Verizon Substation	Communications	No	No	No	No	No
64	Water Storage Tank	Water Storage Tank	No	No	No	No	No
65	Water Storage Tank	Water Storage Tank	No	No	No	No	No
66	Cushing Center	Municipal	No	No	No	No	No
67	Rehoboth House	Special Needs	No	No	No	No	No
68	National Grid Substation	Utility	A	Mount Blue Street	No	No	No
69	South Shore Charter High School	School	No	No	No	Yes	No
70	Council on Aging	Municipal	No	No	No	No	No
71	Galen Pond Dam	Dam	No	No	No	No	No
72	Peterson Pond Dam	Dam	A	No	No	No	No

VULNERABILITY ASSESSMENT

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

Introduction to HAZUS-MH

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

> "HAZUS-MH is a nationally applicable standardized methodology and software program that contains models for estimating potential losses from earthquakes, floods, and hurricane winds. HAZUS-MH was developed by the Federal Emergency Management Agency (FEMA) under contract with the National Institute of Building Sciences (NIBS). Loss estimates produced by HAZUS-MH are based on current scientific and engineering knowledge of the effects of hurricane winds, floods and earthquakes. Estimating losses is essential to decision-making at all levels of government, providing a basis for developing and evaluating mitigation plans and policies as well as emergency preparedness, response and recovery planning.
>
> HAZUS-MH uses state-of-the-art geographic information system (GIS) software to map and display hazard data and the results of damage and economic loss estimates for buildings and infrastructure. It also allows users to estimate the impacts of hurricane winds, floods and earthquakes on populations."

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

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

ESTIMATED DAMAGES FROM HURRICANES

The HAZUS software was used to model potential damages to the community from a 100-year and 500-year hurricane event; storms that are 1% and 0.2% likely to happen in a given year, and roughly equivalent to a Category 2 and Category 4 hurricane. The damages caused by these hypothetical storms were modeled as if the storm track passed directly through the town, bringing the strongest winds and greatest damage potential.

Though there are no recorded instances of a hurricane equivalent to a 500-year storm passing through Massachusetts, this model was included in order to present a reasonable "worst case scenario" that would help planners and emergency personnel evaluate the impacts of storms that might be more likely in the future, as we enter into a period of more intense and frequent storms.

Table 30: Estimated Damages from Hurricanes

	Category 2	Category 4
Building Characteristics		
Estimated total number of buildings	3,904	
Estimated total building replacement value (2014 $)	$1,979,000,000	
Building Damages		
# of buildings sustaining minor damage	210	777
# of buildings sustaining moderate damage	12	130
# of buildings sustaining severe damage	0	10
# of buildings destroyed	0	8
Population Needs		
# of households displaced	0	3
# of people seeking public shelter	0	2
Debris		
Building debris generated (tons)	638	2,981
Tree debris generated (tons)	9,349	21,058
# of truckloads to clear building debris	26	119
Value of Damages		
Total property damage (buildings and content)	$17,384,000	$62,261,000
Total losses due to business interruption	$521,320	$4,732,340

ESTIMATED DAMAGES FROM EARTHQUAKES

The HAZUS earthquake module allows users to define an earthquake magnitude and model the potential damages caused by that earthquake as if its epicenter had been at the geographic

center of the study area. For the purposes of this plan, two earthquakes were selected: magnitude 5.0 and a magnitude 7.0. Historically, major earthquakes are rare in New England, though a magnitude 5 event occurred in 1963.

Table 31: Estimated Damages from Earthquakes

	Magnitude 5.0	Magnitude 7.0
Building Characteristics		
Estimated total number of buildings	3,904	
Estimated total building replacement value (2014 $)	$1,979,000,000	
Building Damages		
# of buildings sustaining slight damage	1,144	98
# of buildings sustaining moderate damage	621	738
# of buildings sustaining extensive damage	175	1,107
# of buildings completely damaged	44	1,955
Population Needs		
# of households displaced	46	1,684
# of people seeking public shelter	26	932
Debris		
Building debris generated (tons)	48,000	363,000
# of truckloads to clear debris (@ 25 tons/truck)	1,920	14,520
Value of Damages		
Total property damage	$238,583,600	$1,804,906,500
Total losses due to business interruption	$46,690,800	$256,550,000

ESTIMATED DAMAGES FROM FLOODING

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

Table 32: Estimated Damages from Flooding

	100-Year Flood	500-Year Flood
Building Characteristics		
Estimated total number of buildings	3,904	
Estimated total building replacement value	$1,979,000,000	
Building Damages		
# of buildings sustaining limited damage	8	10

# of buildings sustaining moderate damage	5	6
# of buildings sustaining extensive damage	0	0
# of buildings substantially damaged	0	0
Population Needs		
# of households displaced	1	2
# of people seeking public shelter	138	170
Value of Damages		
Total property damage	$6,560,000	$8,450,000
Total losses due to business interruption	$10,450,000	$38,610,000

SECTION 5: HAZARD MITIGATION GOALS

The Norwell Local Hazard Mitigation Planning Team reviewed and discussed the goals from the 2014 Hazard Mitigation Plan for the Town of Norwell. All of the goals are considered critical for the Town and they are not listed in order of importance. Prior to the Hazard Mitigation Plan update process, the Town of Norwell developed a Climate Change Vulnerability Analysis and Action Plan. The local team chose to incorporate climate considerations as noted in Goal 11.

GOAL 1: Ensure that critical infrastructure sites are protected from natural hazards.

GOAL 2: Protect existing residential and business areas from flooding

GOAL 3: Maintain existing mitigation infrastructure in good condition.

GOAL 4: Continue to enforce existing zoning and building regulations.

GOAL 5: Educate the public about zoning and building regulations.

GOAL 6: Work with surrounding communities to ensure regional cooperation and solutions for hazards affecting multiple communities.

GOAL 7: Encourage future development and redevelopment in areas that are not prone to natural hazards.

GOAL 8: Educate the public about natural hazards and mitigation measures.

GOAL 9: Make efficient use of public funds for hazard mitigation.

GOAL 10: Pursue land acquisition strategies.

GOAL 11: Consider the potential impacts of future climate change. Incorporate climate sustainability and resiliency in hazard mitigation planning.

SECTION 6: EXISTING MITIGATION MEASURES

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

The Town's existing mitigation measures, which were in place prior to the original 2012 Plan, are listed by hazard type here and are summarized in Table 33 below. Many upgrades to existing measures are noted in the following sections.

EXISTING TOWN-WIDE MITIGATION FOR FLOOD-RELATED HAZARDS

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

National Flood Insurance Program (NFIP) – Norwell participates in the NFIP with 35 policies in force as of the June 30, 2019. FEMA maintains a database on flood insurance policies and claims. This database can be found on the FEMA website at https://www.fema.gov/policy-claim-statistics-flood-insurance.

The following information is provided for the Town of Norwell:

Flood insurance policies in force (September 30, 2018)	35
Coverage amount of flood insurance policies	$10,472,700
Premiums paid	$20,612
Closed losses (losses that have been paid)	10
Substantial Damage Claims since 1978	0
Total payments (total amount paid on losses)	$51,230

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

Street sweeping – The Town of Norwell subcontracts street sweeping. It is completed twice a year.

Catch basin cleaning – The Town of Norwell subcontracts catch basin cleaning. It is completed once a year.

Roadway treatments – 100 percent salt used on main and secondary roads. 50% sand/salt mix used dead ends and subdivisions. Liquid deicers are used in conjunction with sand and salt to cut down on salt use. Mix may vary due to weather conditions.

Subdivision Regulations – The town's zoning regulations include a section on Subdivision Rules and Regulations, which contain a number of requirements that address flood hazard mitigation.

Zoning Bylaw - The zoning by-law has protective overlay districts including: Saltmarsh Conservation; Floodplain, Watershed and Wetlands Protection; and Aquifer Protection. The bylaw also has provisions for Open Space Residential Design and a Stormwater bylaw.

Open Space Protection – Norwell has been proactive in preserving open space.

Wetlands Protection - The town has a local Wetlands Protection bylaw.

EXISTING DAM FAILURE MITIGATION MEASURES

The Comprehensive Emergency Management Plan (CEMP) – The CEMP addresses dam safety. The Town is in the process of updating the CEMP.

Permits required for construction – State law requires a permit for the construction of any dam.

DCR dam safety regulations – All dams are subject to the Division of Conservation and Recreation's dam safety regulations.

EXISTING TOWN-WIDE MITIGATION FOR WIND-RELATED HAZARDS

Tree management - The Public Works Department has an effective tree trimming program in public areas and along Rights-of-Ways.

EXISTING TOWN-WIDE MITIGATION FOR WINTER-RELATED HAZARDS

Snow plowing - The Public Works Department using staff and outside contractors provides standard snow plowing operations, including salting and sanding.

Public education – The town provides education on the website and via social media.

Snow disposal - The town has a Snow and Ice Disposal bylaw that states no person shall put any snow or ice in any public place or upon any part of a public street or sidewalk.

Snow storage - The town has sufficient snow storage.

EXISTING TOWN-WIDE MITIGATION FOR FIRE-RELATED HAZARDS

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

Development review - The Fire department reviews all development for compliance with site access, water supply needs, and all other applicable regulations.

Public education - The town provides public education and notices for fire risk.

EXISTING TOWN-WIDE MITIGATION FOR EARTHQUAKE HAZARDS

Shelters - The town does have shelters and backup facilities. The official overnight shelter for Norwell is located in Weymouth.

Massachusetts State Building Code – The State Building Code contains a section on designing for earthquake loads (780 CMR 1612.0). Section 1612.1 states that the purpose of these provisions is "to minimize the hazard to life to occupants of all buildings and non-building structures, to increase the expected performance of higher occupancy structures as compared to ordinary structures, and to improve the capability of essential facilities to function during and after an earthquake". This section goes on to state that due to the complexity of seismic design, the criteria presented are the minimum considered to be "prudent and economically justified" for the protection of life safety. The code also states that absolute safety and prevention of damage, even in an earthquake event with a reasonable probability of occurrence, cannot be achieved economically for most buildings.

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

EXISTING TOWN-WIDE MITIGATION FOR LANDSLIDE HAZARDS

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

EXISTING MULTI-HAZARD MITIGATION MEASURES

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

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

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

Local Emergency Management Planning Committee (LEPC) – The LEPC consists of representatives from Public Works, Water and Sewer, Fire, Police, Health, School Council on Aging, Norwell Housing Authority, Board of Selectmen, Emergency Management, and local businesses.

Public education - Emergency Preparedness public education is available on the town's website.

Reverse 911 - The town has a reverse 911 system and names, phone numbers and email addresses can be added to the database via the town's website.

Generators - The Police and Fire Stations have backup generators.

COMPILATION OF EXISTING MITIGATION

Table 33 summarizes the many existing natural hazard mitigation measures already in place in Norwell when the first Hazard Mitigation Plan was developed in 2014. Because of the number of entities, public and private, involved in natural hazard mitigation, it is likely that this list is a starting point for a more comprehensive inventory of all measures.

Table 33: Existing Natural Hazard Mitigation Measures in Norwell

Type of Existing Mitigation Measures	Effective	Changes Needed
FLOOD HAZARDS		
Participation in the National Flood Insurance Program	Yes	
Street sweeping twice annually	Yes	In-house street sweeper
Catch basin cleaning annually	Yes	
Roadway treatments vary including salt and sand	Yes	
Subdivision Regulations address flooding	Yes	
Zoning Bylaw protective overlay districts	Yes	
Protected open space and proactive land preservation programs	Yes	Finish update to Open Space plan
Wetlands Protection Bylaw	Yes	Update for climate
DAMS		
CEMP addresses dam safety	Yes	
Construction permits required	Yes	
DCR Dam Safety Regulations	Yes	
WIND HAZARDS		
DPW tree management program	Yes	More resources needed
WINTER HAZARDS		
Standard snow operations	Yes	
Public Education on snow operations and winter maintenance is on town website	Yes	
Snow and Ice Disposal Bylaw	Yes	
Sufficient space for municipal snow storage	Yes	
FIRE HAZARDS		
Open Burn Permits required	Yes	
Fire Department reviews all development plans	Yes	
Fire Department provides public education on its website	Yes	

Type of Existing Mitigation Measures	Effective	Changes Needed
EARTHQUAKE HAZARDS		
Shelters and backup facilities available	Yes	More resources needed
State Building code addresses earthquake hazards	Yes	
Evacuation plan	Yes	
LANDSLIDE HAZARDS		
Maximum slopes	Yes	
MULTIPLE HAZARDS		
Multi-department review of developments	Yes	Could be streamlined
Comprehensive Emergency Management Plan (CEMP)	Yes	Share to depts for input
Enforcement of State Building Code	Yes	
Local Emergency Planning Committee (LEPC)	Yes	
Public Education	Yes	Develop local materials
Reverse 911	Yes	
Police and Fire Stations have backup generators	Yes	

MITIGATION CAPABILITIES AND LOCAL CAPACITY FOR IMPLEMENTATION

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

SECTION 7: MITIGATION MEASURES FROM PREVIOUS PLAN

IMPLEMENTATION PROGRESS ON THE PREVIOUS PLAN

At a meeting of the Norwell Hazard Mitigation Planning Committee, Town staff reviewed the mitigation measures identified in the 2014 Norwell Hazard Mitigation Plan and determined whether each measure had been implemented or deferred. Of those measures that had been deferred, the committee evaluated whether the measure should be deleted or carried forward into this Hazard Mitigation Plan 2020 Update. The decision on whether to delete or retain a particular measure was based on the committee's assessment of the continued relevance or effectiveness of the measure and whether the deferral of action on the measure was due to the inability of the Town to take action on the measure. Table 34 summarizes the status of mitigation measures from the 2014 plan.

Table 34: Mitigation Measures from the 2014 Plan

Mitigation Action	Priority in 2014 plan	Current Status	Include in 2020 Plan?
Require freeboard construction of homes in the floodplain	High	Not complete. Requiring freeboard conflicts with the state Building Code. The Town will consider alternatives to promote freeboard.	Yes
Upgrade existing culvert at Mount Blue Street	High	This work was not done.	Yes
Rebuild Mill Street Bridge and breach dam upstream	High	The dam has been breached. A funding source to remove the dam is needed, but the flood risk is abated. The Town unsuccessfully sought funds for the bridge repair.	Yes
Upgrade existing culvert at Route 123	High	Not complete. The Torrey Pond dam has reduced flooding risk here.	Yes
Upgrade existing drainage at Forest Street	Medium	Not complete	Yes
Removal of unnecessary dams along brooks and ponds in town	Medium	The Mill Pond and Tack Factory Dams were removed. The Peterson Dam is permitted for removal, funds have not been identified. The dam is now partially breached and the flood risk is diminished.	No
Update Hazardous Material Response Plan	Medium	Complete	No

Mitigation Action	Priority in 2014 plan	Current Status	Include in 2020 Plan?
Assessment of Historic Structure Natural Hazard Vulnerability	Medium	An assessment was not done, but repairs have been made to town-owned historic properties.	No
Maintenance of Existing Infrastructure	Medium	The Town has invested significant resources in infrastructure projects to address stormwater flooding and comply with the MS4 permit. This is an on-going priority.	Yes
Upgrade drainage pipes to culverts	Medium	Mt. Hope, Pleasant, Bowker: not complete	Yes
Study flooding at Bay Path Lane	Medium	Not complete	Yes
Continuation of Open Space Protection and Land Acquisition	Medium	The town has been proactive with purchase including Carleton property, Simon Hill (3 parcels), Masthead Drive, Grove Street, and Mt. Blue Street properties	Yes
Regulatory Revisions for Stormwater Management	Medium	The town adopted a Stormwater Bylaw that requires incorporation of LID and Green Infrastructure to the maximum extent possible. Additional revisions will be addressed in the 2020 Town Meeting.	Yes
Provide Public Information on NFIP Compliance	Medium	The town posts flood maps and flood information on the Conservation Department website.	Yes
Assessment of Municipal Structures for Susceptibly to Snow Loads	Low	The assessment was not complete, but the Town has a protocol for removing snow from municipal roofs when necessary.	No

As indicated in Table 34, Norwell made significant progress implementing mitigation measures identified in the 2014 Hazard Mitigation Plan. In particular, the Town had rare success with dam removal projects. Three dams were removed or breached, decreasing flood risk and improving the health of Norwell's waterways. The Town adopted a stormwater bylaw that requires incorporation of LID and green infrastructure strategies. The Town purchased and preserved a number of properties for open space. Norwell has utilized its Community Preservation Act funds to support property purchases.

Several projects that were not completed will be continued into this plan update. While the town has addressed stormwater flooding in many locations, it has been challenging to complete expensive culvert replacement projects. The Town will continue to seek resources for the culvert

and drainage projects continued into the next plan. There are a number of measures for which the Town does regular or periodic work, but they remain ongoing priorities. These include drainage infrastructure maintenance, open space purchases, and public information on NFIP compliance

Overall, ten mitigation measures from the 2014 plan will be continued in the plan update. Most retain the same priority in this 2020 Update. Moving forward into the next five-year plan implementation period there will be many more opportunities to incorporate hazard mitigation into the Town's decision-making processes. The challenges the Town faces in implementing these measures are primarily due to limited funding and available staff time. This plan should help the Town prioritize the best use of its limited resources for enhanced mitigation of natural hazards.

SECTION 8: HAZARD MITIGATION STRATEGY

WHAT IS HAZARD MITIGATION?

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

https://www.fema.gov/hazard-mitigation-grant-program
https://www.fema.gov/pre-disaster-mitigation-grant-program
https://www.fema.gov/flood-mitigation-assistance-grant-program

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

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

REGIONAL AND INTER-COMMUNITY CONSIDERATIONS

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

REGIONAL PARTNERS

In developed urban and suburban communities such as the metropolitan Boston area, mitigating natural hazards, particularly flooding, is more than a local issue. The drainage systems that serve these communities are complex systems of storm drains, roadway drainage structures, pump stations and other facilities owned and operated by a wide array of agencies including the Town, the Department of Conservation and Recreation (DCR), the Massachusetts Water Resources Authority (MWRA), Massachusetts Department of Transportation (MassDOT) and the Massachusetts Bay Transportation Authority (MBTA). The planning, construction, operation and maintenance of these structures are integral to the flood hazard mitigation efforts of communities. These agencies must be considered the communities' regional partners in hazard mitigation. These agencies also operate under the same constraints as communities do including budgetary and staffing constraints and they must make decisions about numerous competing priorities.

Following, is a brief overview of regional facilities found in Norwell and a discussion of inter-municipal issues.

OVERVIEW OF REGIONAL FACILITIES WITHIN NORWELL

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

- Wompatuck State Park (Mass DCR)
- State Routes 3, 53, and 228 (MassDOT)
- The Towns of Norwell, Cohasset, Hull, and Hingham, jointly operate emergency communications response at a site located in Hingham.

INTER-COMMUNITY CONSIDERATIONS

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

A) Coordinate and Review Developments on a Regional Basis
As Norwell and the surrounding communities are undergoing development, it is vital that these communities communicate and provide input during the review processes. When addressing housing, transportation, and economic development projects, the impacts to neighbors must be addressed.

B) North and South Rivers Watershed
Stormwater management and flooding are concerns that cross town lines and need attention at the watershed level.

C) Electricity supply. Utility supply crosses town lines. Avoidance of power interruptions often requires regional collaboration.

NEW DEVELOPMENT AND INFRASTRUCTURE

As part of the process of developing recommendations for new mitigation measures for this plan update, the Town considered the issues related to new development, redevelopment, and infrastructure needs in order limit future risks. Taking into consideration Stormwater Bylaw updates, the Wetlands Protection Act and bylaw enforced by the Conservation Commission, the town determined that existing regulatory measures are taking good advantage of local Home Rule land use regulatory authority to minimize natural hazard impacts of development. Priorities for the future include further updates to the Stormwater Bylaw. The Master Plan update that is underway may also inform future regulatory measures.

PROCESS FOR SETTING PRIORITIES FOR MITIGATION MEASURES

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

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

Table 35 below demonstrates the prioritization of the Town's potential hazard mitigation measures. For each mitigation measure, the geographic extent of the potential benefiting area is identified as is an estimate of the overall benefit and cost of the measures. The benefits, costs, and overall priority were evaluated in terms of:

Estimated Benefits	
High	Action will result in a significant reduction of hazard risk to people and/or property from a hazard event
Medium	Action will likely result in a moderate reduction of hazard risk to people and/or property from a hazard event
Low	Action will result in a low reduction of hazard risk to people and/or property from a hazard event

Estimated Costs	
High	Estimated costs greater than $100,000
Medium	Estimated costs between $10,000 to $100,000
Low	Estimated costs less than $10,000 and/or staff time
Priority	
High	Action very likely to have political and public support and necessary maintenance can occur following the project, and the costs seem reasonable considering likely benefits from the measure
Medium	Action may have political and public support and necessary maintenance has potential to occur following the project
Low	Not clear if action has political and public support and not certain that necessary maintenance can occur following the project

INTRODUCTION TO MITIGATION MEASURES TABLE

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

Priority – As described above and summarized in Table 35, the designation of high, medium, or low priority was done considering potential benefits and estimated project costs, as well as other factors in the STAPLEE (Social, Technical, Administrative, Legal, Economic, and Environmental) analysis.

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

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

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

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

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

> Army Corps of Engineers (ACOE) – The website for the North Atlantic district office is http://www.nae.usace.army.mil/. The ACOE provides assistance in a number of types of projects including shoreline/streambank protection, flood damage reduction, flood plain management services and planning services.
>
> Massachusetts Emergency Management Agency (MEMA) – The grants page https://www.mass.gov/hazard-mitigation-assistance-grant-programs describes the various Hazard Mitigation Assistance Program.

Table 35: Mitigation Measures Prioritization

CLIMATE CHANGE	ACTION	GEOGRAPHIC COVERAGE	LEAD	TIME FRAME	EST. BENEFIT	EST. COST	FUNDING SOURCE	PRIORITY
Changes in Precipitation	**Inland Flooding**							
	Stormwater management regulatory revisions	Town-wide	Conservation	2020	High	Low	Dept. funds	High
	Provide NFIP information	Town-wide	Conservation	2020	Medium	Low	Dept. funds	Medium
	Acquire vacant flood prone land	Town-wide	Conservation	2024	Medium	High	CPA	Medium
	Remove Mill Street dam and repair the bridge	Site-specific	Public Works	2023	High	High	Grants	High
	107 Circuit Street Culvert Repair/ Replacement	Site-specific	Public Works	2020	High	High	Town meeting	High
	215 Circuit Street Culvert Replacement	Site-specific	Public Works	2020	High	High	Town meeting	High
	248 Wildcat Lane Culvert Replacement	Site-specific	Public Works	2025	High	High	Town meeting	High
	144 Stetson Road Drainage Headwall Replacement & Drainage Pipe Repairs	Site-specific	Public Works	2021	High	High	MVP grant	High
	20 Meadowbrook Road Culvert Pipe Repair/Replacement	Site-specific	Public Works	2021	High	High	MVP grant	High
	Mt Blue Street Culvert Repairs/Replacements at 13 Locations	Various Locations on Mt Blue St.	Public Works	2022	High	High	Town meeting	High
	Dover & West Street Culvert Replacement	Site-specific	Public Works	2025	High	High	Town meeting	High
	Stoney Brook/1038 Main Street Culvert Repairs/Replacement/Headwalls	Site-specific	Public Works	2025	High	High	Town meeting	Medium
	Upgrade the culvert at Route 123	Site-specific	Public Works	2025	High	Medium	Town meeting	Medium

	ACTION	GEOGRAPHIC COVERAGE	LEAD	TIME FRAME	EST. BENEFIT	EST. COST	FUNDING SOURCE	PRIORITY
	Headwall repairs Main St at Norris	Site-specific	Public Works	2025	High	Medium	Town meeting	Medium
	Headwall repairs Main St Jacob's Pond	Site-specific	Public Works	2025	High	Medium	Town meeting	Medium
	85 Tiffany Road Culvert Pipe Repairs	Site-specific	Public Works	2020	High	Medium	Town meeting	Medium
	Culvert Headwall Repairs Leonard Lane	Site-specific	Public Works	2025	Medium	Medium	Town meeting	Low
	Upgrade drainage at Forest Street (Circuit near crosswalk)	Site-specific	Public Works	2024	Medium	Medium	grant	Medium
	Infrastructure upgrades and MS4 compliance	Town-wide	Public Works	2022	High	High	High	High
	Study flooding at Bay Path Lane	Site-specific	Public Works	2021	High	Medium	Private	High
	Drainage issues: Mount Hope Street at Bound Brook; Pleasant St; Bowker Street.	Site-specific	Public Works	2025	High	High	grant	Medium
	Create a comprehensive assessment of culverts and dams	Site-specific	Consultant Conservation Public Works	2021	High	High	grant	Medium
	Develop a computerized infrastructure tracking system.	Town-wide	Public Works	2022	High	High	Town/ grants	High
	Eliminate all illicit discharges from private and commercial residences.	Town-wide	Public Works Conservation	2021	High	Low	Dept budgets	High
	Retrofit or replace stormwater with systems that filter contaminants and oil.	Town-wide	Public Works	2023	Medium	High	DPW grants	Medium
	Evaluate town storm swales for improved function.	Site-specific	Public Works Conservation	2025	Medium	High	Grants	Low
	Identify and map town areas subject to inundation and flooding during	Town-wide	Conservation Highway	2020	Medium	Low	Depts	High

	extreme storms for reference by all regulatory and public safety departments.		Fire					
	ACTION	GEOGRAPHIC COVERAGE	LEAD	TIME FRAME	EST. BENEFIT	EST. COST	FUNDING SOURCE	PRIORITY
	Drought							
	Adopt protective regulations to identify and protect wetlands during times of drought.	Town-wide	Conservation Planning	2022	High	Low	Grant	High
	Develop a bylaw or design guidelines for drought management.	Town-wide	Conservation Planning	2024	High	Low	Dept	Medium
	Landslide							
	Identify areas of potential landslide risk	Town-wide	Public Works	2025	Low	Low	Dept	Low
Sea Level Rise	**Coastal Flooding (and Tsunamis)**							
	Freeboard outreach and incentives	1% chance flood zones (applies to inland flooding)	Conservation	2021	Medium	Low	Dept	Medium
	Identify properties at risk and develop education and outreach for those residents.	Coastal flood zones North River	Emergency Mgmt.	2021	Medium	Low	Dept	Medium
	Evaluate impacts of future sea level rise on the Bridge St. bridge	Site specific	Emergency Mgmt.	2025	Medium	Low	Dept	Medium
	Coastal Erosion							
	Evaluate town owned coastal North River properties for storm resilience.	North River area	Conservation	2025	Low	Low	Dept	Low
	Extreme Heat and Heat Waves							
	Ensure Norwell's tree cover remains intact and stable as this mitigates the impact from heat waves.	Town-wide	Tree and Grounds/ Conservation	2021	Medium	Low	Town	Medium

	ACTION	GEOGRAPHIC COVERAGE	LEAD	TIME FRAME	EST. BENEFIT	EST. COST	FUNDING SOURCE	PRIORITY
Rising Temperatures	Consider how to manage cooling/heating centers in the current Covid-19 crisis.	Site-specific	Emergency mgmt.	2020	High	Low	Federal reimb. grant	High
	Wildfires							
	Purchase multi-purpose 4x4 forestry firefighting truck.	Forested areas	Fire	2022	High	High	Town Meeting grants	High
	Purchase specialized forestry firefighting equipment	Forested areas	Fire	2022	High	Medium	Town Meeting grants	High
	Address fire risk of brush/downfalls/litter layer.	Forested areas	Fire/ Conservation	2023	High	Medium /High	Town	High
	Invasive species							
	Map invasive infestation levels in Norwell and create a long-term management plan to prioritize and address.	Town-wide	Conservation	2024	Low	Low	Town	Low
Extreme Weather	**Hurricanes and Tropical Storms** (see Multihazards)							
	Severe Winter Storm/Nor'easter							
	Consider alternative to winter salt application.	Town-wide	Water	2021	High	Low	Town	High
	Tornadoes (see Multihazards)							
	Other Severe weather (strong winds, thunderstorms) (see Multihazards)							
Multihazards	**Multihazards**							
	Purchase emergency generators for critical town buildings (Extreme Weather)	Town-wide	Emergency mgmt.	2022	High	High	Grants	High
	Explore possibility of developing a resident discount program for purchasing generators. (Extreme Weather)	Town-wide	Emergency mgmt.	2023	High	High	Town Grants	High

	ACTION	GEOGRAPHIC COVERAGE	LEAD	TIME FRAME	EST. BENEFIT	EST. COST	FUNDING SOURCE	PRIORITY
	Explore grant options for microgrid along Washington St. (north of Rt. 123). (Extreme Weather)	Town-wide	Emergency mgmt.	2025	High	High	grants	Low
	Harden Town operated essential electronic equipment in the event of solar flare or electromagnetic pulse causing grid disruptions (Extreme Weather)	Site-specific	Emergency mgmt.	2023	Medium	High	Grants	High
	Develop and fund a Forestry Management Plan to address the health of trees, dangers to people and infrastructure, as well as fires, pests. (Extreme Weather)	Town-wide	Public Works Emergency mgmt. Conservation	2023	High	Medium	Town grant	High
	Increase funding for removal of dead and damaged street trees and replacement with appropriate trees.	Town-wide	Public works	2023	High	High	Town, grant	High
	Evaluate radio transmission problems	Fire District 3	Fire	2020	High	High	Grant town	High
	Create committee to implement climate and natural hazards priorities and provide public education.	Town-wide	Emergency mgmt./CERT	2021	High	Low	Depts	High
Non-Climate Hazard	**Earthquake**							
	Determine which critical buildings may be most vulnerable to earthquake damage and conduct a structural assessment if needed.	Site-specific	Facilities	2025	Medium	Low	Depts	Low

DESCRIPTION OF MITIGATION MEASURES

Changes in Precipitation

Inland Flooding

Stormwater management regulatory revisions: The town adopted a Stormwater Bylaw that requires incorporation of LID and Green Infrastructure to the maximum extent possible. Additional revisions will be addressed in the 2020 Town Meeting.

Provide NFIP information: The town posts flood maps and flood information on the Conservation Department website.

Acquire Vacant Flood Prone Land: Continue pro-active efforts to preserve land that can provide flood protection. Utilize this land to create new flood storage and infiltrate stormwater to increase the Town's capacity to withstand extreme rainfall events.

Remove Mill Street dam and repair the bridge: Located near the Hanover town line, the dam has been breached but still needs to be removed. A funding source has not yet been identified, but the flood risk is abated. The Town was been working to find funding for the bridge repair. Meet or exceed stream crossing standards, enhance the new fish passage along Third Herring Brook, and create flood storage capacity if feasible.

107 Circuit Street: The existing 48" Steel Corrugated Pipe has serious corrosion along the invert and is at risk of collapse or complete failure. This culvert is expected to be lined or replaced during the Summer of 2020 in order to complete the repaving of Circuit Street in August of 2020.

215 Circuit Street: The existing 24" Steel Corrugated Pipe shows severe corrosion around the inlet and outlet and has partially collapsed along the top of the pipe and the road has begun to sink. This pipe is at risk of collapse or complete failure. This culvert is to be replaced with 24" Concrete or Ductile Iron Pipe during the Summer of 2020 in order complete the repaving of Circuit Street in August of 2020.

248 Wildcat Lane: The original culvert located near 248 Wildcat Lane is a 72" x 44" Elliptical Steel Corrugated Pipe with a concrete headwall. Around 2006-2007 the center 72" x 44" pipe collapsed and the road began to wash out. The existing (3) 72" x 44" Elliptical Steel Corrugated Pipe Culverts was removed and a 24" Concrete Pipe was sleeved through the (3) existing concrete headwall 72" x 44" Elliptical Steel Corrugated Pipe openings. The annular space between the newly installed 24" Reinforced Concrete Pipe and the existing concrete headwall was never sealed which has led to erosion underneath the road causing asphalt settling. Due to the much smaller 24" Concrete Pipes that replaced the existing 72" x 44" Elliptical Steel Corrugated Pipe, it has significantly reduced the calculated designed flow which causes a backup of water on the East side of Wildcat Lane during periods of heavy rains and has almost breached the road on several occasions. This culvert needs to be inspected, engineered, and replaced to avoid flooding of homes on Pleasant Street, Wildcat Lane, and Centennial Way along with damage to the town infrastructure on Wildcat Lane.

144 Stetson Road: This Culvert/Drainage Pipe Outlets drain Stormwater from Masthead Drive, Bowspirt Lane, Till Rock Lane, Barque Hill Drive & Stetson Road. The existing 18" Reinforced Concrete Pipe appears to be undersized for the stormwater that drains Masthead Drive & Bowspirt Lane which is connected to a concrete headwall which has moved, become undermined and in jeopardy of complete failure. The existing 36" Reinforced Concrete Pipe appears to be

adequately sized for the Stormwater that drains Till Rock Lane, Barque Hill Drive, and Stetson Road looks structurally intact but needs the pipe joints need to be repaired. There is also no transition manhole at 144 Stetson Road in which the casting is setting directly on the pipe which compromises the structural integrity of the pipe. The 36" Reinforced Concrete Pipe headwall which was placed at a different time but was connected to the existing headwall for Masthead Drive has moved, is undermined, and is jeopardy of complete failure. The Town is currently preparing a grant application to the Municipal Vulnerability Preparedness program.

20 Meadow Brook Road: This Culvert/Drainage Pipe Outlet allows Copeland Tannery Brook to drain under Meadowbrook Road through a 36" Reinforced Concrete Pipe and eventually out to the North River. The 36" Reinforced Concrete Pipe joints have been compromised and is subject to failure during peak rain and snow melting events. The drainage pipes that run upgradient Meadowbrook Road appear to be undersized that connect to the 36" culvert pipe and are connected without any diversion manholes. Also, the (2) catch basin castings at the lowest point of Meadow Brook Road are sitting directly on the pipe which compromises the structural integrity of the pipe. Although the headwall appears to be in decent condition it is recommended that the headwall should be further inspected. Meadowbrook Road is a dead-end road so if this 36" culvert pipe was to fail the road would be washed out and it would strand access to 18 residences. The Town is currently preparing a grant application to the Municipal Vulnerability Preparedness program.

Mt. Blue Street various locations: There are approximately 13 drainage culverts or drainage pipe outlets along Mount Blue Street. There are several steel corrugated pipes of various sizes that should be investigated and replaced before repaving this street. Several of these pipes show signs of corrosion and a few pipes have begun to collapse due to minimal pipe cover which has led to pothole asphalt patches.

Dover & West Street culvert replacement: The existing 12" Steel Corrugated Pipe shows severe corrosion around the inlet and outlet. Due to minimal pipe cover, this pipe is starting to show signs of collapse along the top of the pipe and the road has begun to sink. This pipe should be replaced before the sidewalk along Dover Street is constructed and the drainage from West & River Street should be studied and possibly integrated into this culvert replacement.

Stoney Brook Culvert/1038 Main Street: This culvert/drainage pipe outlet allows Stoney Brook to drain under Main Street through a 36" reinforced concrete pipe and eventually out to the North River. The drainage pipes that run upgradient on Main Street appear to be undersized that connect to the 36" culvert pipe and are connected without diversion manholes. It is recommended that the structural integrity of the upgradient pipe connections to the 36" reinforced concrete pipe be inspected and evaluated. The stone headwall to the north on the upgradient side of Stoney Brook has partially collapsed and in jeopardy of complete failure. Complete failure of this headwall could impact traffic along Main Street and could lead to culvert pipe failure.

Upgrade the culvert at Route 123: Flooding at this location is somewhat less frequent than at other sites in town and work at Torrey Pond has reduce the risk. But flooding impacts a major thoroughfare in town. Town officials have determined that the culvert beneath Route 123 needs to be replaced with a larger culvert, at an estimated cost of about $250,000.

Main Street Headwall @ Norris: The existing headwall for these (2) 60" reinforced concrete pipe culverts are constructed of +/- 2' granite blocks. The mortar joints between these granite blocks are in various stages of deterioration of the headwall with signs of increase wear of the mortar the lower the elevation towards Second Herring Brook. Some areas the mortar has deteriorated 6"-8" back from the face of the block especially the granite blocks closer to the brook. Although the (2) reinforced concrete pipes look to be stable, further inspection is recommended for the pipe joints and of the headwall's for structural stability.

Main Street Headwall @ Jacobs Pond: The existing headwall for the 48" reinforced concrete pipes are constructed of +/- 2' granite blocks. The mortar joints between these granite blocks are in various stages of deterioration of the headwall with signs of increase wear of the mortar the lower the elevations of the headwall. Some areas the mortar has deteriorated 6"-8" back from the face of the block especially the granite blocks closer to the brook. Although the 48" reinforced concrete pipe appears to be stable, further inspection is recommended of the pipe joints, gate, and on the headwall's for structural stability.

Culvert @ 85 Tiffany Road: There are (2) 42" reinforced concrete pipes with a cast in place concrete headwall on each side of Tiffany Road. The road has been settling and has been patched with asphalt several times over the culvert pipes throughout the years. It is believed that the (2) 42" Reinforced Concrete Pipe joints have been compromised and are subject to failure during peak rain and snow melting events. Although the reinforced concrete pipes and cast in place concrete headwall appear to be in decent structural condition it is recommended that the pipe joints and concrete headwall should be further inspected. This work should be completed before Tiffany Road is paved from Common Street to the Norwell/Hanover Town Line.

Leonard Lane: The existing headwall for a 36" reinforced concrete pipe culvert is constructed of stone. The mortar joints between these stones are in various stages of deterioration of the headwall with signs of increase wear of the mortar the lower the elevations. Some areas the mortar has deteriorated 6"-8" back from the face of the stone especially the stones closer to the brook. Although the 36" reinforced concrete pipes look to be stable, further inspection is recommended for the pipe joints and of the headwall's for structural stability.

Upgrade drainage at Forest Street: Flooding at this site was caused by heavy rains in March 2010 and was further impacted by insufficient drainage in the area. The flooding in March 2010 impacted eight homes, but it was the first flooding in that area that most town officials could recall. This issue doesn't seem to be a major flooding concern, it took nearly two weeks of heavy rains to cause the flooding here, but the amount of damage caused to personal property and the potential for threats to human safety make it important for the town to look for a solution to this flooding problem. The area needs better drainage and a study of the surrounding system. There is no estimate for what the study of potential drainage improvements could cost until the issue can be investigated further.

Infrastructure upgrades and MS4 compliance: The Town has invested significant resources in infrastructure projects to address stormwater flooding and comply with the MS4 permit. This is an on-going priority.

Study flooding at Bay Path Lane: Town officials feel it is important to conduct a study of the Bay Path Lane drainage system and determine if there is some mechanical or maintenance solution for what caused flooding following the March 2010 rain storms. The town has not as yet undertaken

to determine how much it would cost to study Bay path Lane, so there is no firm estimate on how much this project would cost or how long it would take.

Drainage issues: Mount Hope Street at Bound Brook; Pleasant St at poles 15 and 32; Bowker Street between poles 17 and 18: There is a need to increase stormwater detention here. Sedimentation has accumulated in the pond. An ecological restoration project could restore the pond and increase stormwater detentions.

Comprehensive assessment of culverts and dams: The culvert assessment should include prioritization and proposed plans to replace with appropriately sized culverts meeting stream crossing standards, enhancing and improving wildlife passage and where feasible including additional stormwater storage capacity and infiltration to reduce storm damage impacts from significant rainfall events. The DPW has begun the process of identifying all culvert locations and assessing their condition.

Develop a computerized infrastructure tracking system. The system would track infrastructure type, condition, and maintenance schedules. The town has started this work on GIS as part of MS4 compliance. Other departments have also begun to input this data in GIS.

Eliminate all illicit discharges from private and commercial residences: This will reduce flood danger and damage during storms and reduce the risk of hazardous material impacts to wetlands downgradient of the erosion control structures and conveyances.

Retrofit or replace stormwater with systems that filter contaminants and oil: This will be an ongoing project that will reduce stormwater pollution.

Evaluate town storm swales for improved function: Evaluate and repair or used LID strategies to create naturalized stream channels where feasible.

Identify and map town areas subject to inundation and flooding during worst storms for reference by all regulatory and public safety departments: Study the contributing water sources, areas of restriction and blockage and develop plans to alleviate artificial sources of flooding and increase floodplain for natural sources of flooding

Drought

Adopt protective regulations to identify and protect wetlands during times of drought: Seek a grant to assist in developing model language to assure that evaluation of development proposals during times of drought takes into account non-drought conditions.

Develop a bylaw or design guidelines for drought management: Use this to guide policy and regulate development. Prioritize drainage upgrades with the goal of engineering and funding these drainage/stormwater system upgrades on a continuing rolling basis. Include drought tolerant landscaping, onsite infiltration in problem areas and increased stormwater storage capacity to infiltrate stormwater to decrease the impacts of drought. Evaluate and propose a water banking policy.

Landslide

Identify areas of potential landslide risk: Do a survey of town identify landslide risk.

Sea Level Rise

Coastal Flooding (and Tsunamis)

Freeboard Outreach and Incentives: Develop outreach materials and incentives for residents to incorporate freeboard in new construction and upgrades. This measure also applies to inland flooding.

Identify properties at risk and develop education and outreach for those residents. Utilize CZM StormSmart materials.

Evaluate impacts of future sea level rise on the Bridge St. bridge: Flood waters already reach close to the bridge, evaluate risk associated with sea level rise.

Coastal Erosion

Evaluate Town owned coastal North River Properties for storm resilience: Create a plan including prioritization to address erosion weaknesses for each.

Rising Temperatures

Extreme Heat and Heatwaves

Ensure Norwell's tree cover remains intact and stable as this mitigates the impact from heat waves: Work to replace tree loss due to storms and drought/flood with a more diverse mix of tree species resilient to climate change.

Consider how to manage cooling/heating centers in the current Covid-19 crisis: Develop strategies to keep residents safe from contracting Covid-19 in the event shelters need to be opened.

Wildfires

Purchase multi-purpose 4x4 forestry firefighting truck: The current truck is 24 years old. This purchase would give the department greater capacity and flexibility to reach fires with smaller equipment. The vehicle could address multiple hazards and potentially be shared across departments.

Purchase specialized forestry firefighting equipment: This would equip the 4x4 vehicle with appropriate equipment (saws, pumps).

Address fire risk of brush/downfalls/litter layer: Extensive fuel has accumulated in Norwell's forested areas. Analyze risk and develop a controlled burn or mulching program to address woodlands adjacent to residences. Perform a sample burn to assess feasibility. This will require training of personnel.

Invasive species

Map invasive infestation levels in Norwell and create a long-term management plan to prioritize and address. Phragmites, garlic mustard, and purple loosestrife are invasive species common to Norwell. Provide public education about controlling invasive species.

Extreme Weather

Hurricanes and Tropical storms See Multihazards

Severe Winter Storms/Nor'easter

Consider alternative to salt use on roads: Although this issue has been studied in the past, the Town is concerned about sodium levels in drinking water and ecological impacts. DOT use of salt is a particular concern. Develop a committee to seek alternative management strategies.

Tornadoes See Multihazards

Other Severe weather (strong winds, thunderstorms) See Multihazards

Multihazards

Purchase emergency generators for critical town buildings: The EOC generator is over 20 years old, has needed repeated service calls, and lost power during a recent emergency necessitating relocating of emergency management staff. The Sparrow Middle School which serves as a shelter is in need of a replacement generator.

Explore possibility of developing a resident discount program for purchasing generators: Power outages are a critical issue in Norwell. Research existing programs and funding sources to assist residents in installing generators.

Explore grant options for microgrid along Washington St. (north of Rt. 123: The microgrid would support a nursing home and other facilities and homes that support vulnerable residents.

Harden Town operated essential electronic equipment: Protect town equipment in the event of solar flare or electromagnetic pulse causing grid disruptions.

Develop and fund a Forestry Management Plan: Address the health of trees, dangers to people and infrastructure, as well as fires, pests. Develop a computerized system that would track tree type, condition, and maintenance schedules for street trees to prevent tree falls and damage during severe storms and wind. Create a coordinated program between the Town and utility companies to provide community outreach regarding privately owned trees. Removing tree cover is not the goal, creating resilient tree cover and woodland areas. Considering developing a town tree nursery.

Increase funding for removal of dead and damaged street trees and replacement with appropriate trees. Expand and fund the hazard tree program along streets, sidewalks, pathway, and woodland trails to prioritize, remove and then replace hazard trees with climate change resilient species.

Increase outreach to seniors and low-income populations: Conduct a study, assessing needs and vulnerabilities and, ensuring that residents are/will be connected to emergency communications as well as pro-active education.

Develop a policy for public communication during storm events: Utilize through user-friendly web mapping programs that help communicate and coordinate challenges such as downed trees, power outages, road closures, and flooding to residents and responding staff.

Evaluate and correct radio transmission problems: Fire District 3 is experiencing transmission problems. The issue may be a repeater; evaluate and repair or replace.

Create committee to implement climate and natural hazards priorities and provide public education: Through the process of developing this plan and completing an analysis of future climate vulnerabilities the town has developed a robust set of goals and plans. The appointment of an-ongoing committee can oversee projects and develop outreach and support programs all residents with a focus on seniors and low-income residents.

Non-Climate Hazard

Earthquake

Determine which critical buildings may be most vulnerable to earthquake damage and conduct a structural assessment if needed.

SECTION 9: PLAN ADOPTION & MAINTENANCE

PLAN ADOPTION

The Norwell Hazard Mitigation Plan 2020 Update was adopted by the Board of Selectmen on *[ADD DATE]*. See Appendix D for documentation. The plan was approved by FEMA on [*ADD DATE*] for a five-year period that will expire on [*ADD DATE*].

PLAN MAINTENANCE

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

IMPLEMENTATION AND EVALUATION SCHEDULE

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

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

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

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

Prepare and Adopt an Updated Local Hazard Mitigation Plan – Once the resources have been secured to update the plan, the Hazard Mitigation Team may decide to undertake the update

themselves, contract with the Metropolitan Area Planning Council to update the plan or to hire another consultant. However, the Hazard Mitigation Implementation Team decides to update the plan, the Town will need to review the current FEMA hazard mitigation plan guidelines at that time for any changes in requirements for hazard mitigation plans since the previous plan. Once the next plan update is prepared, the Town will submit it to MEMA and FEMA for review and approval and adopt the plan update in order to obtain formal FEMA approval of the plan.

INTEGRATION OF THE PLANS WITH OTHER PLANNING INITIATIVES

Upon approval of the Norwell Hazard Mitigation Plan 2020 Update by FEMA, the Local Hazard Mitigation Team will provide all interested parties and implementing departments with a copy of the plan and will initiate a discussion regarding how the plan can be integrated into that department's ongoing work. At a minimum, the plan will be reviewed and discussed with the following departments:

- Fire/Emergency Management
- Police
- Public Works
- Planning
- Conservation
- Water
- Facilities

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

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

SECTION 10: LIST OF REFERENCES

General Bylaws for the Town of Norwell

Town of Norwell Community Resilience Building Workshop Summary of Findings January 2020

Town of Norwell Open Space and Recreation Plan 2005-10 and 2012-2019

Norwell 2018 Economic Growth Plan

Blue Hill Observatory

FEMA, Flood Insurance Rate Maps for Norfolk County, MA, 2012

FEMA, Hazards U.S. Multi-Hazard

FEMA, Local Mitigation Plan Review Guide, October 2011

Fourth National Climate Assessment, 2018

Massachusetts Flood Hazard Management Program

Massachusetts Office of Coastal Zone Management Shoreline Change Data

Massachusetts Office of Dam Safety, Inventory of Massachusetts Dams 2018

Massachusetts State Hazard Mitigation Plan, 2013

Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 2018

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

National Weather Service

Nevada Seismological Library

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

NOAA National Climatic Data Center, http://www.ncdc.noaa.gov/

Northeast Climate Adaptation Science Center

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

Tornado History Project

US Census, 2010 and American Community Survey 2017 5-Year Estimates

USGS, National Water Information System, http://nwis.waterdata.usgs.gov/usa/nwis

APPENDIX A: MEETING AGENDAS

Norwell Municipal Vulnerability Preparedness (MVP) Hazard Mitigation Plan (HMP) Team Meeting

September 12, 2019

Norwell Town Hall

1. Welcome and Introductions
2. Overview and Purpose MVP and HMP projects
3. The role of this committee
4. MVP: a little more detail on the workshop
5. Set Date and Location of MVP Workshop
6. Discussion of Workshop Invitees
7. HMP: Update hazard areas, critical infrastructure, new development sites
8. Next steps

Norwell Municipal Vulnerability Preparedness/ Hazard Mitigation Plan

Team Meeting
October 31, 2019
10:00-12:00
Osborne Room

MVP: Workshop – Thursday, November 7, 9:30 to 3:30

1. Check in on invitations, logistics
2. Review the workshop agenda
3. Review the workshop posters
4. Identify the top four hazards
5. Check in on the Critical Infrastructure

Norwell Municipal Vulnerability Preparedness Meeting #3
Hazard Mitigation Plan Meeting #1

January 16, 2020
10:00-12:00
Osborne Room, Town Hall

MVP

1. Debrief the workshop
2. Workshop Report
3. Listening Session February 13 – agenda and logistics

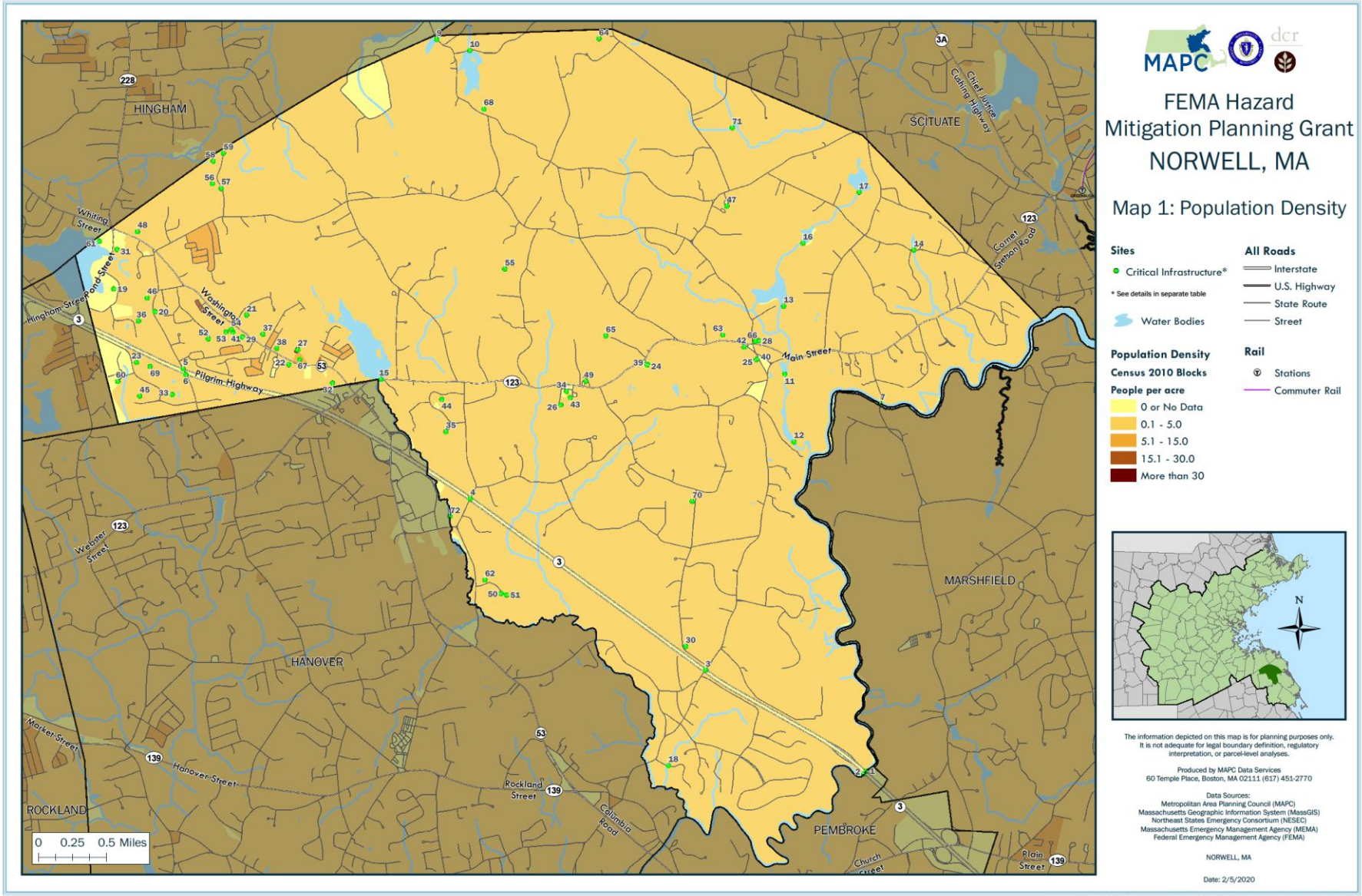
HMP

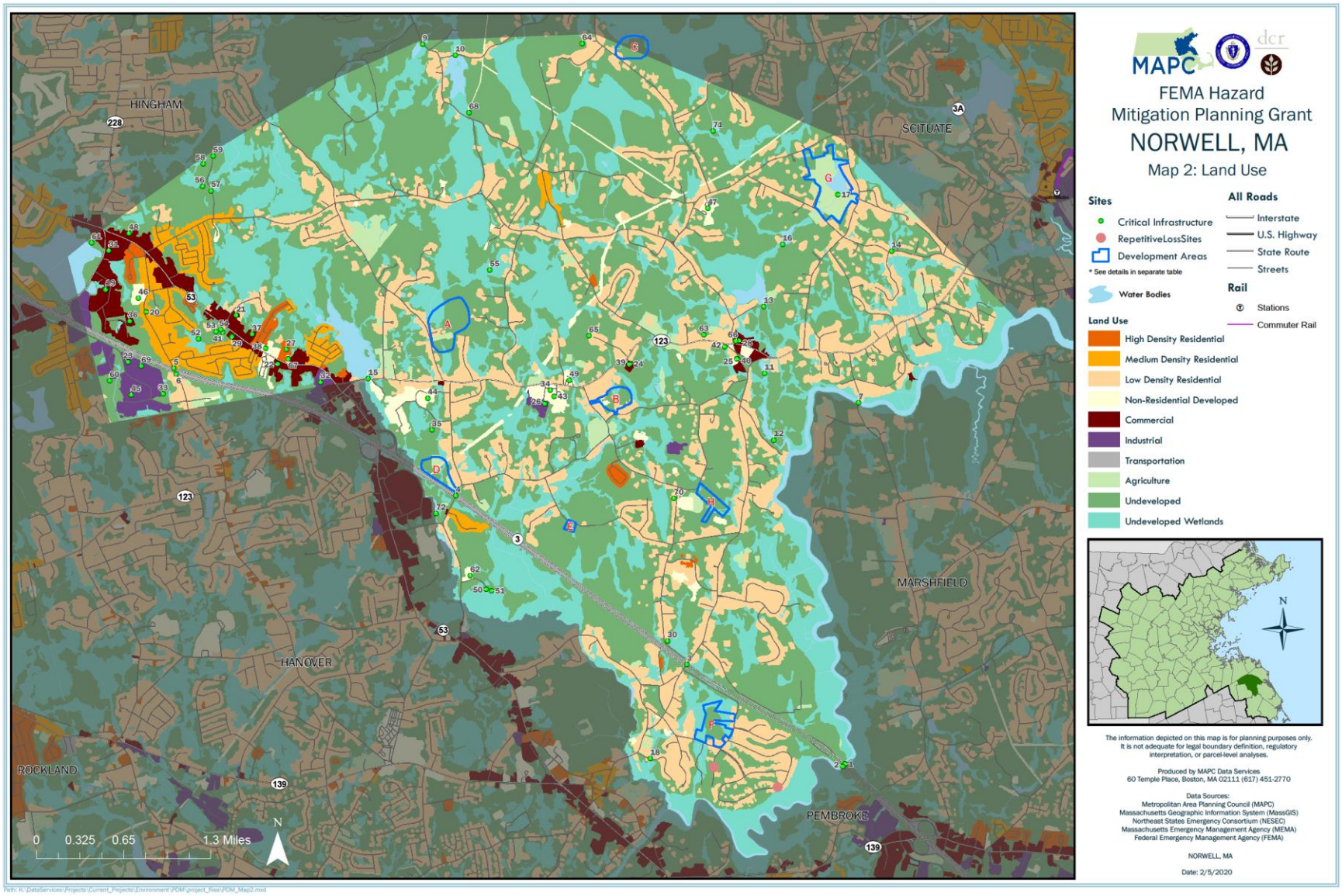
4. Update Critical Infrastructure, Development Areas, Hazard Areas
5. Review pre-existing mitigation measures from the 2014 plan
6. Review mitigation measures from the 2014 plan
7. Review and update Hazard Mitigation Goals

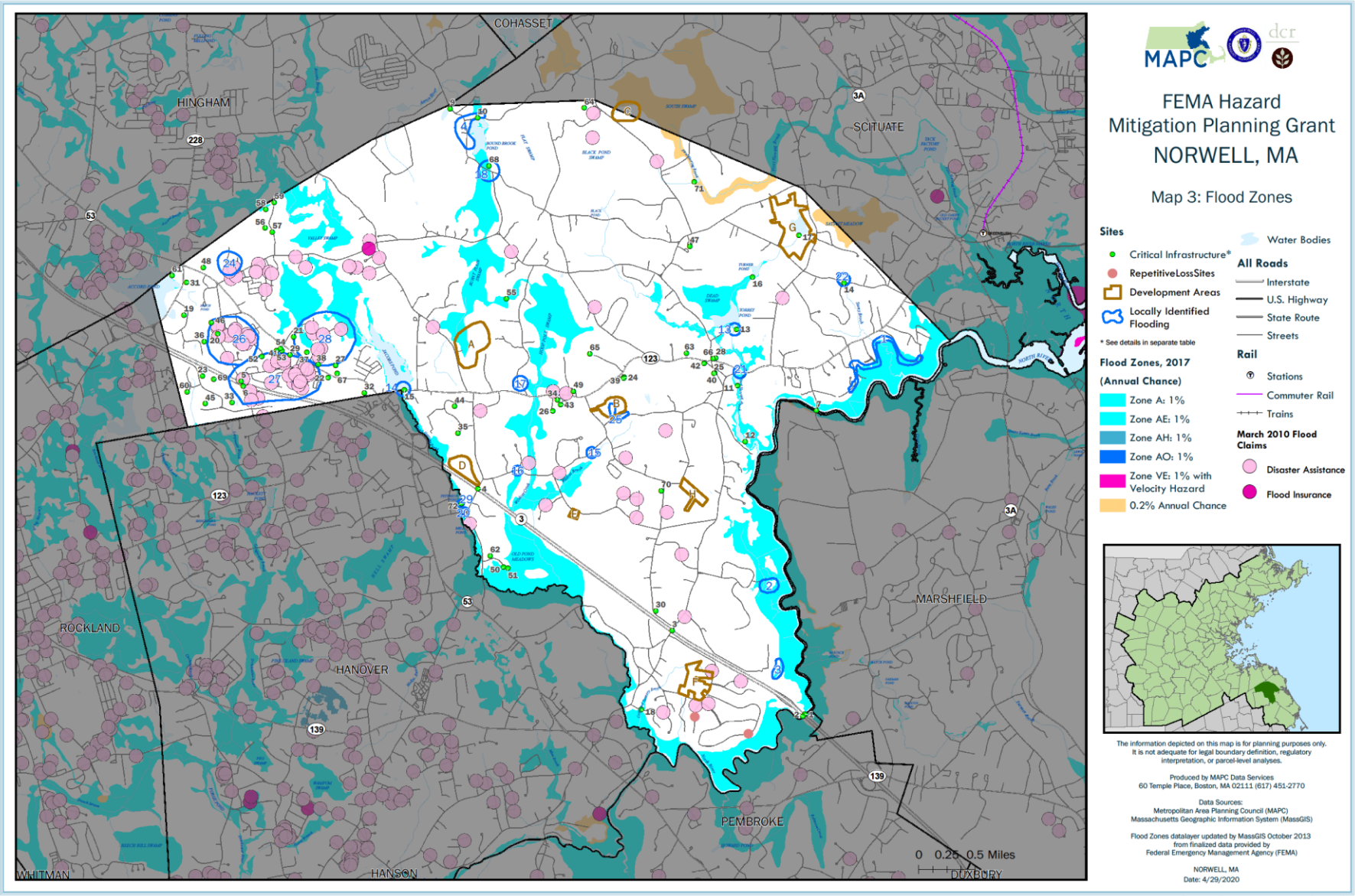
Norwell Hazard Mitigation Plan Team Meeting
Thursday May 14
10- 12:30
Via Zoom

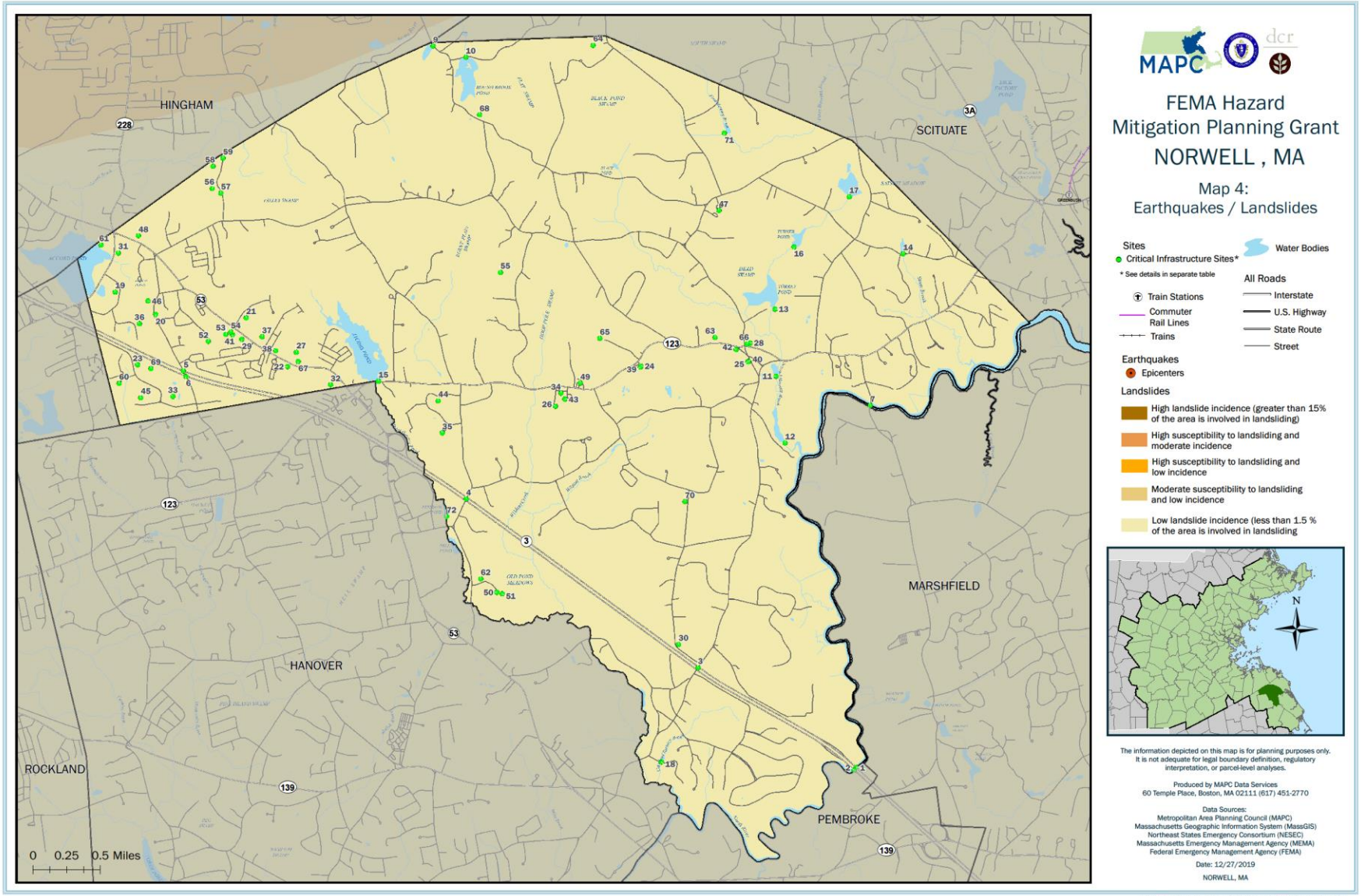
1. Review progress to date
2. Develop mitigation measures for the plan update

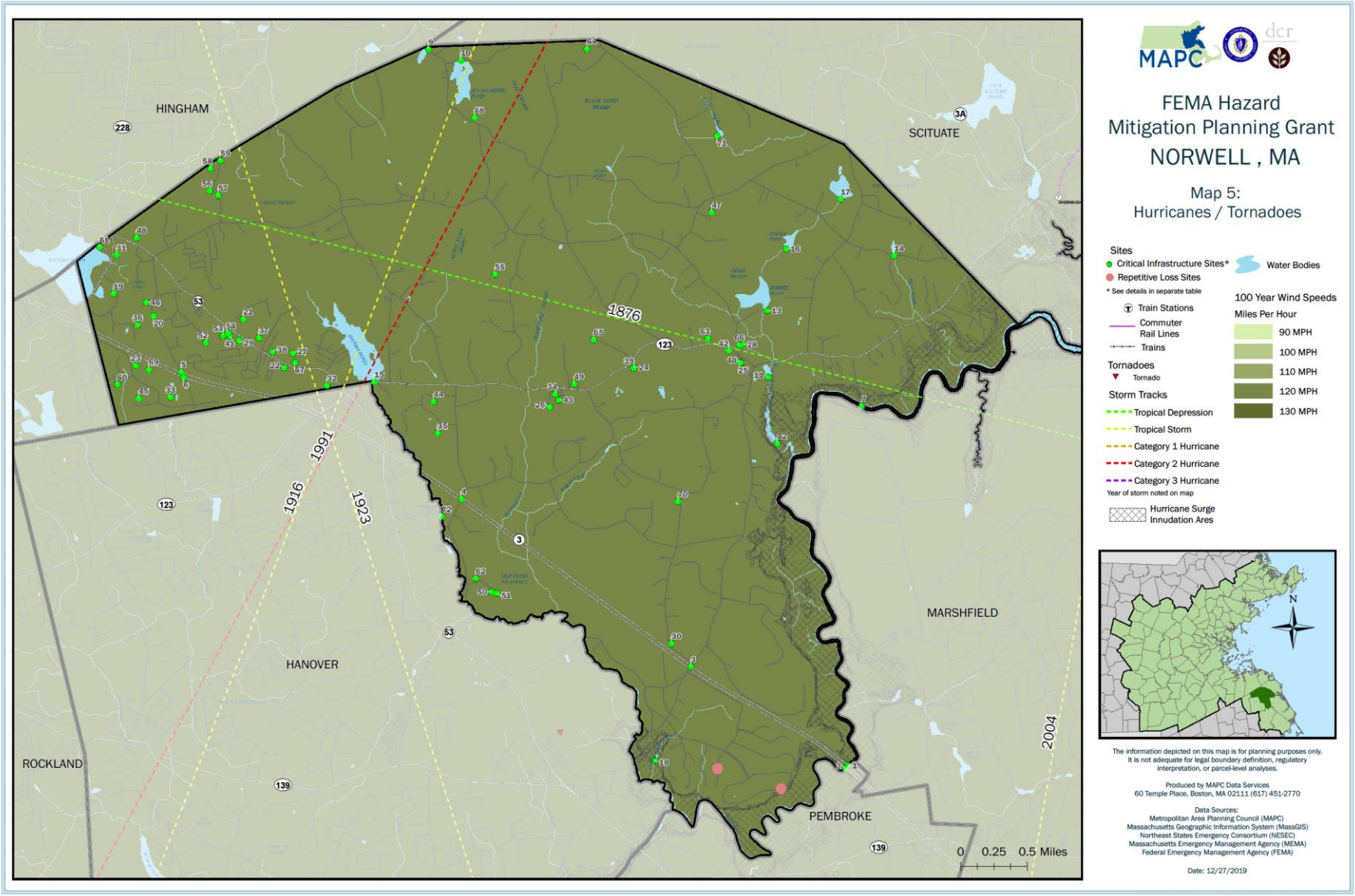
APPENDIX B: HAZARD MAPPING

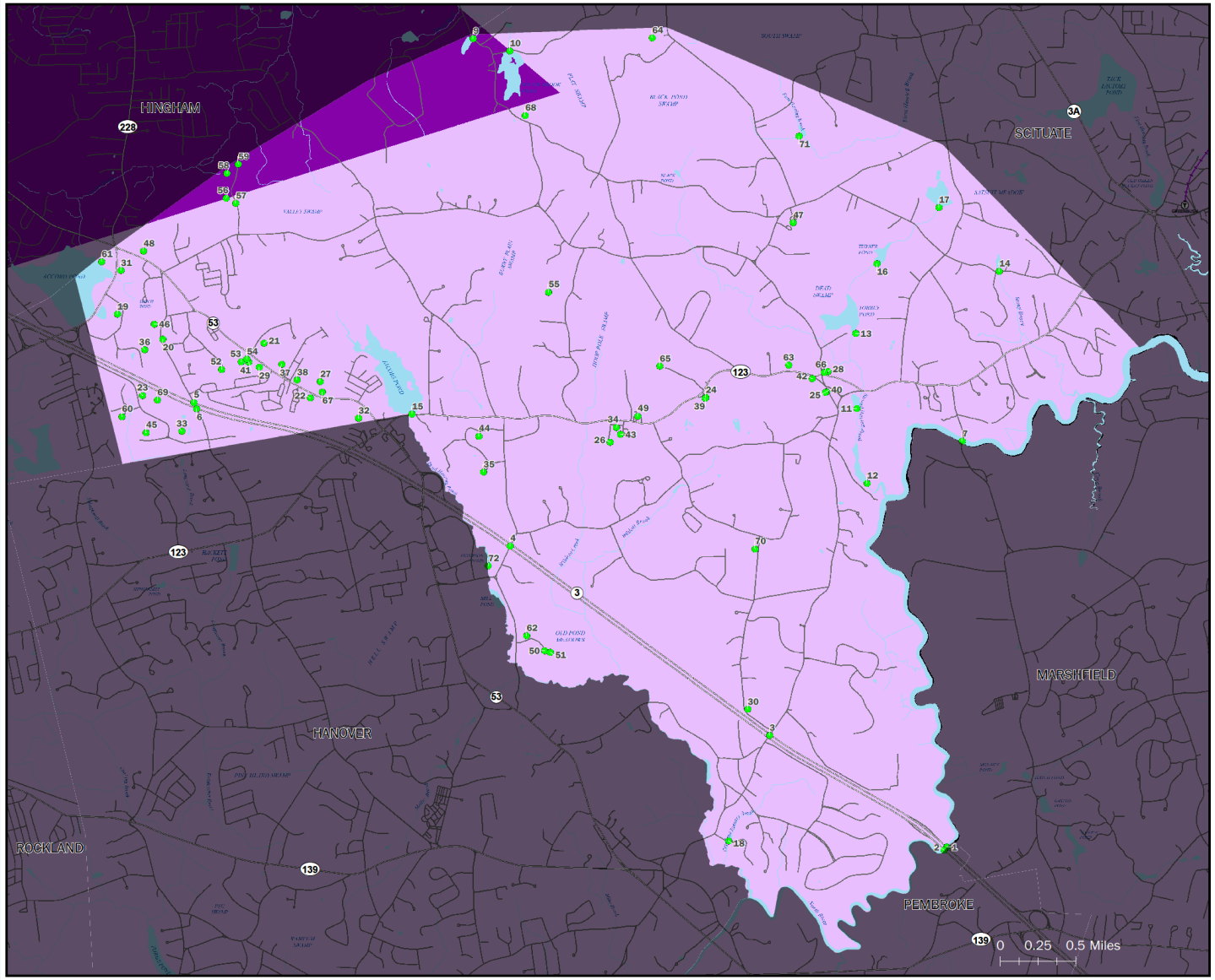

FEMA Hazard
Mitigation Planning Grant
NORWELL, MA
Map 1: Population Density
Sites
Critical Infrastructure*
* See details in separate table
Water Bodies
Population Density
Census 2010 Blocks
People per acre
0 or No Data
0.1 - 5.0
5.1 - 15.0
15.1 - 30.0
More than 30
All Roads
Interstate
U.S. Highway
State Route
Street
Rail
Stations
Commuter Rail
HINGHAM
SCITUATE
HANOVER
MARSHFIELD
ROCKLAND
PEMBROKE
Whiting Street
Hingham Street
Pond Street
Washington Street
Pilgrim Highway
Main Street
Webster Street
Market Street
Hanover Street
Rockland Street
Columbia Road
Church Street
Plain Street
Chief Justice Cushing Highway
Comet Siebon Road
0 0.25 0.5 Miles
N
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
NORWELL, MA
Date: 2/5/2020
Path: K:\DataServices\Projects\Current_Projects\Environment\PDM\project_files\PDM_Map1.mxd


FEMA Hazard
Mitigation Planning Grant
NORWELL, MA
Map 2: Land Use
Sites
Critical Infrastructure
RepetitiveLossSites
Development Areas
* See details in separate table
Water Bodies
Land Use
High Density Residential
Medium Density Residential
Low Density Residential
Non-Residential Developed
Commercial
Industrial
Transportation
Agriculture
Undeveloped
Undeveloped Wetlands
All Roads
Interstate
U.S. Highway
State Route
Streets
Rail
Stations
Commuter Rail
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
NORWELL, MA
Date: 2/5/2020
HINGHAM
SCITUATE
MARSHFIELD
HANOVER
ROCKLAND
PEMBROKE
0 0.325 0.65 1.3 Miles
N


FEMA Hazard
Mitigation Planning Grant
NORWELL, MA
Map 3: Flood Zones
Sites
Critical Infrastructure*
RepetitiveLossSites
Development Areas
Locally Identified Flooding
* See details in separate table
Flood Zones, 2017
(Annual Chance)
Zone A: 1%
Zone AE: 1%
Zone AH: 1%
Zone AO: 1%
Zone VE: 1% with Velocity Hazard
0.2% Annual Chance
Water Bodies
All Roads
Interstate
U.S. Highway
State Route
Streets
Rail
Stations
Commuter Rail
Trains
March 2010 Flood Claims
Disaster Assistance
Flood Insurance
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Flood Zones datalayer updated by MassGIS October 2013
from finalized data provided by
Federal Emergency Management Agency (FEMA)
NORWELL, MA
Date: 4/29/2020
COHASSET
HINGHAM
SCITUATE
ROCKLAND
HANOVER
MARSHFIELD
PEMBROKE
WHITMAN
HANSON
DUXBURY
0 0.25 0.5 Miles


HINGHAM
SCITUATE
HANOVER
ROCKLAND
MARSHFIELD
PEMBROKE
0 0.25 0.5 Miles
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
NORWELL , MA
Map 4:
Earthquakes / Landslides
Sites
Critical Infrastructure Sites*
* See details in separate table
Train Stations
Commuter Rail Lines
Trains
Water Bodies
All Roads
Interstate
U.S. Highway
State Route
Street
Earthquakes
Epicenters
Landslides
High landslide incidence (greater than 15% of the area is involved in landsliding)
High susceptibility to landsliding and moderate incidence
High susceptibility to landsliding and low incidence
Moderate susceptibility to landsliding and low incidence
Low landslide incidence (less than 1.5 % of the area is involved in landsliding
N
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Date: 12/27/2019
NORWELL, MA


FEMA Hazard
Mitigation Planning Grant
NORWELL , MA
Map 5:
Hurricanes / Tornadoes
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Train Stations
Commuter Rail Lines
Trains
Tornadoes
Tornado
Storm Tracks
Tropical Depression
Tropical Storm
Category 1 Hurricane
Category 2 Hurricane
Category 3 Hurricane
Year of storm noted on map
Hurricane Surge Innudation Ares
Water Bodies
100 Year Wind Speeds
Miles Per Hour
90 MPH
100 MPH
110 MPH
120 MPH
130 MPH
HINGHAM
SCITUATE
MARSHFIELD
HANOVER
ROCKLAND
PEMBROKE
1876
1991
1916
1923
2004
0 0.25 0.5 Miles
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Date: 12/27/2019



MAPC

dcr

FEMA Hazard Mitigation Planning Grant
NORWELL, MA

Map 6: Average Snowfall

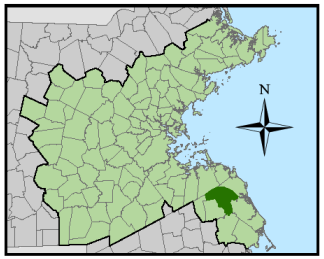
Sites
- Critical Infrastructure Sites*

* See details in separate table

Average Annual Snowfall
- 36.1 to 48.0 inches
- 48.1 to 72.0 inches

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

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



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

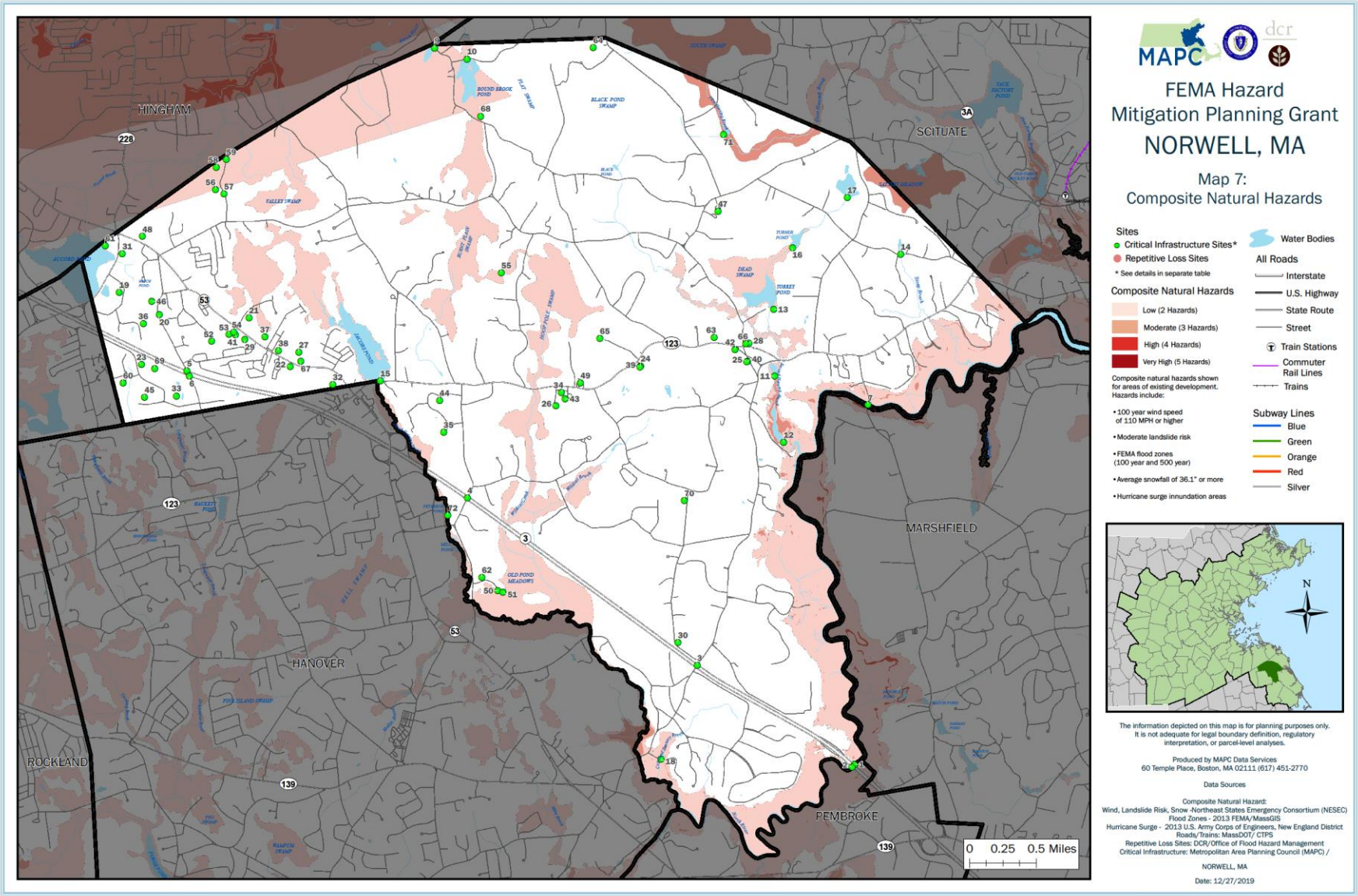
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770

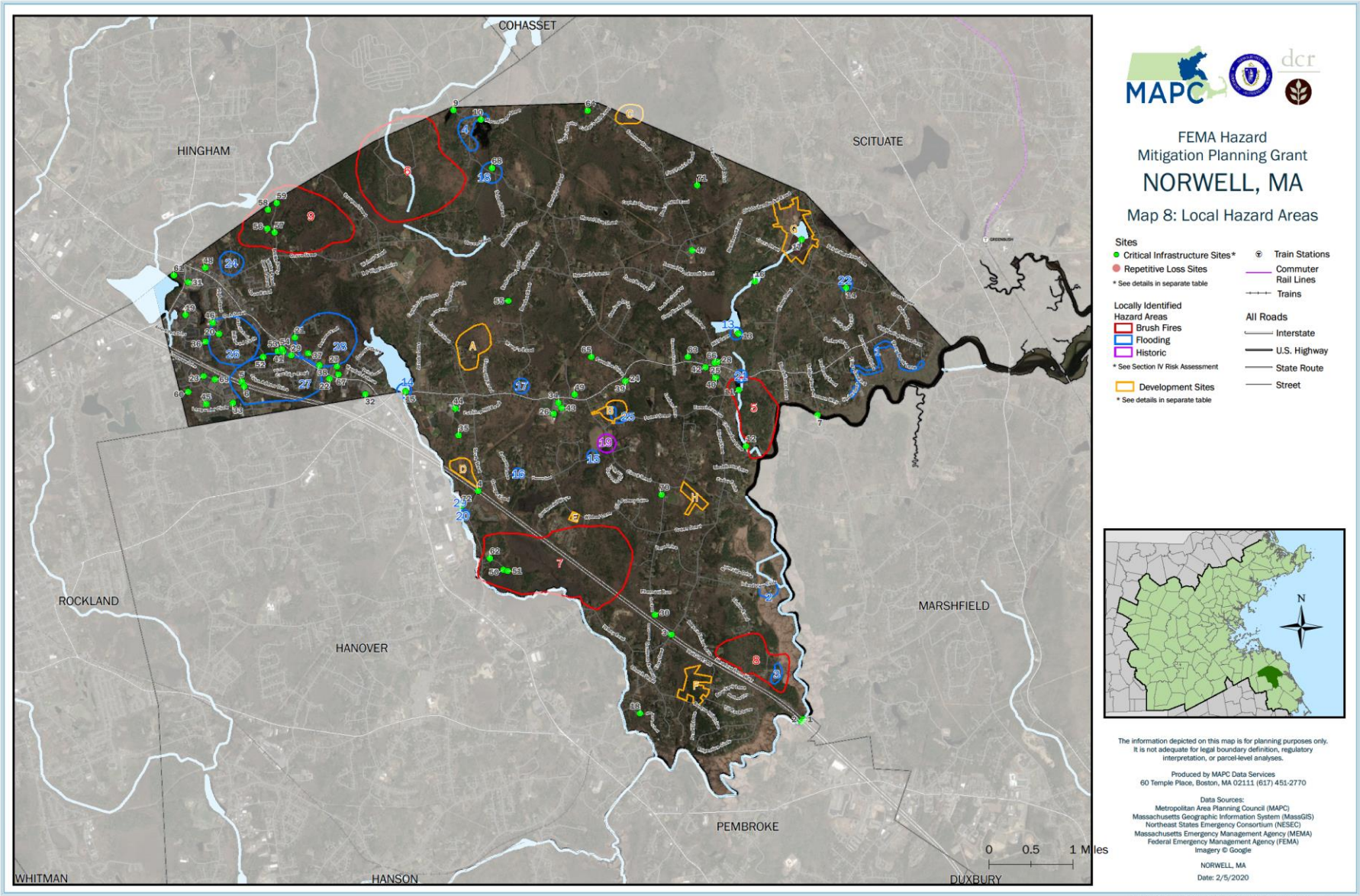
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)

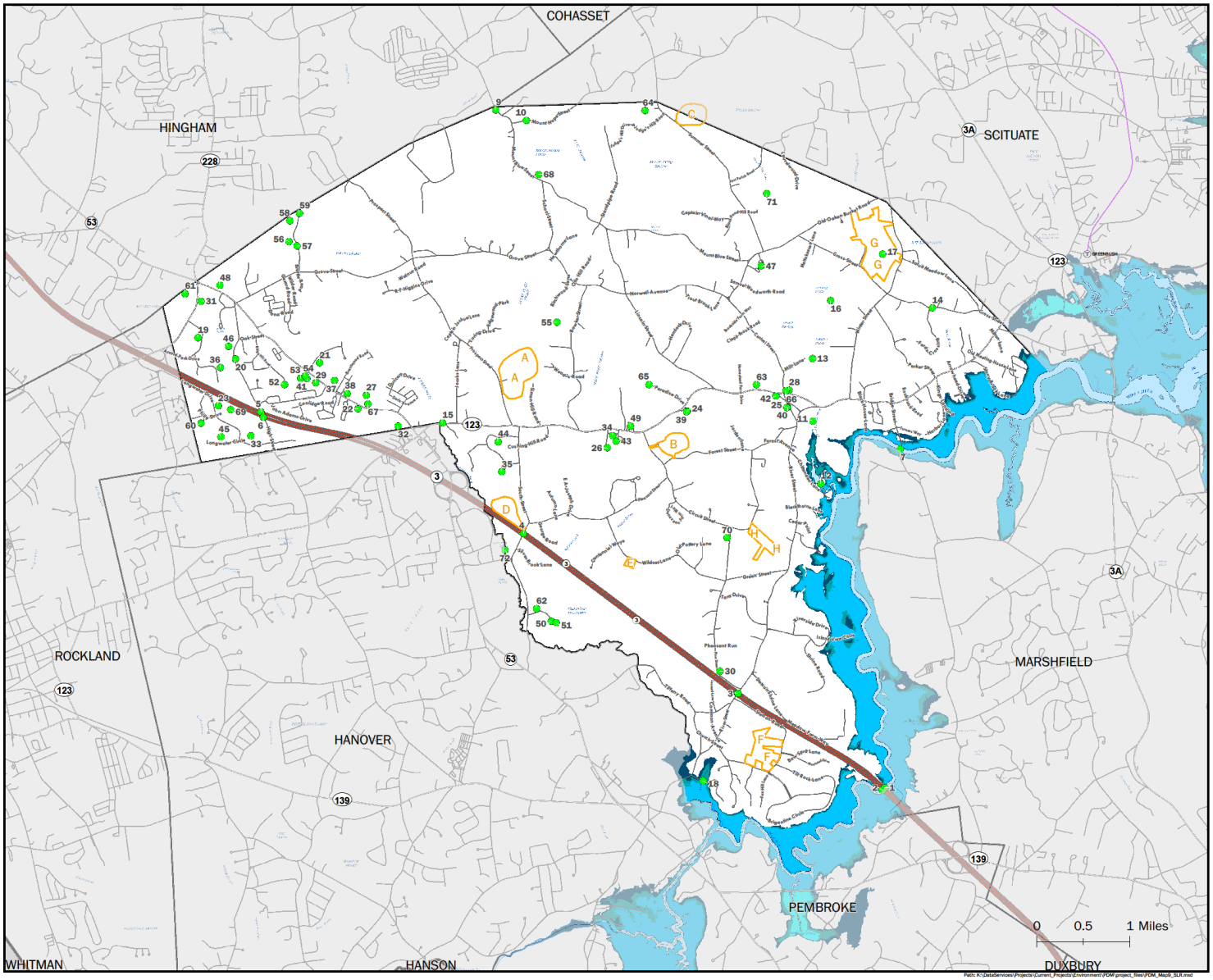
NORWELL, MA

Date: 12/27/2019

Path: K:\DataServices\Projects\Current_Projects\Environment\FDM\project_files\FDM_Map6.mxd


FEMA Hazard
Mitigation Planning Grant
NORWELL, MA
Map 7:
Composite Natural Hazards
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Composite Natural Hazards
Low (2 Hazards)
Moderate (3 Hazards)
High (4 Hazards)
Very High (5 Hazards)
Composite natural hazards shown for areas of existing development. Hazards include:
• 100 year wind speed of 110 MPH or higher
• Moderate landslide risk
• FEMA flood zones (100 year and 500 year)
• Average snowfall of 36.1" or more
• Hurricane surge innundation areas
Water Bodies
All Roads
Interstate
U.S. Highway
State Route
Street
Train Stations
Commuter Rail Lines
Trains
Subway Lines
Blue
Green
Orange
Red
Silver
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources
Composite Natural Hazard:
Wind, Landslide Risk, Snow -Northeast States Emergency Consortium (NESEC)
Flood Zones - 2013 FEMA/MassGIS
Hurricane Surge - 2013 U.S. Army Corps of Engineers, New England District
Roads/Trains: MassDOT/ CTPS
Repetitive Loss Sites: DCR/Office of Flood Hazard Management
Critical Infrastructure: Metropolitan Area Planning Council (MAPC) /
NORWELL, MA
Date: 12/27/2019
HINGHAM
SCITUATE
MARSHFIELD
HANOVER
ROCKLAND
PEMBROKE
0 0.25 0.5 Miles
N


COHASSET
HINGHAM
SCITUATE
ROCKLAND
HANOVER
MARSHFIELD
PEMBROKE
WHITMAN
HANSON
DUXBURY
0 0.5 1 Miles
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
NORWELL, MA
Map 8: Local Hazard Areas
Sites
Critical Infrastructure Sites*
Repetitive Loss Sites
* See details in separate table
Train Stations
Commuter Rail Lines
Trains
Locally Identified Hazard Areas
Brush Fires
Flooding
Historic
* See Section IV Risk Assessment
Development Sites
* See details in separate table
All Roads
Interstate
U.S. Highway
State Route
Street
N
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.
Produced by MAPC Data Services
60 Temple Place, Boston, MA 02111 (617) 451-2770
Data Sources:
Metropolitan Area Planning Council (MAPC)
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Imagery © Google
NORWELL, MA
Date: 2/5/2020



MAPC dcr

FEMA Hazard Mitigation Planning Grant

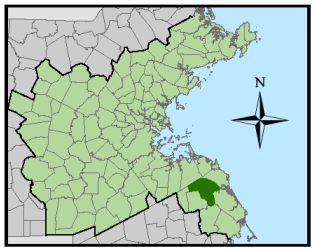
NORWELL, MA

Map 9: Sea Level Rise

Sites
- Critical Infrastructure Sites*
- Repetitive Loss Sites
- Development Sites
- Train Stations
- Commuter Rail Lines
- Trains

Future Coastline
- Sea Level Rise (1 ft.)
- Sea Level Rise (3 ft.)
- Sea Level Rise (6 ft.)
- Sea Level Rise (10 ft.)

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



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60 Temple Place, Boston, MA 02111 (617) 451-2770

Data Sources:
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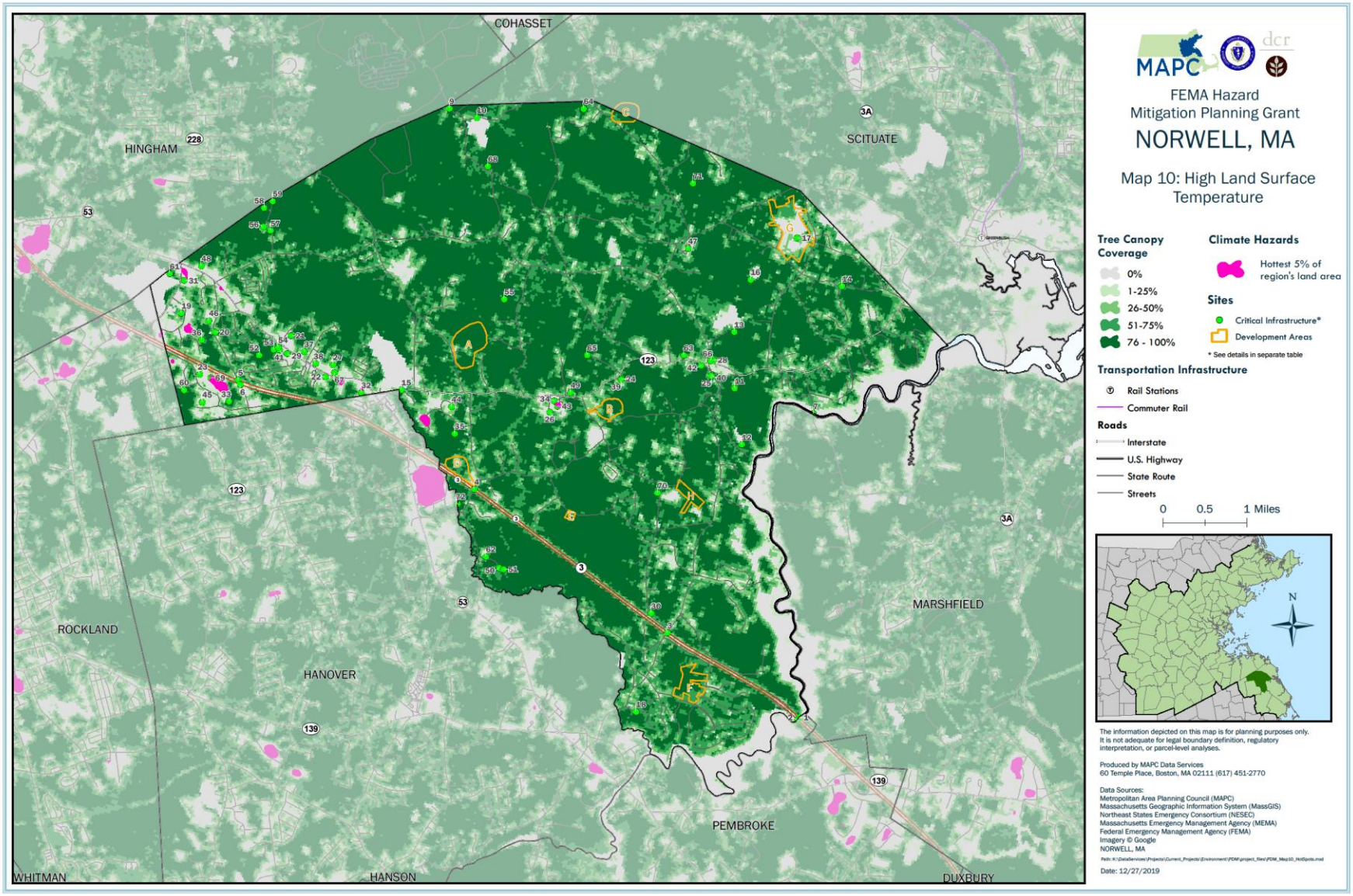
Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Imagery © Google

NORWELL, MA

Date: 12/27/2019


COHASSET
HINGHAM
SCITUATE
ROCKLAND
HANOVER
MARSHFIELD
PEMBROKE
WHITMAN
HANSON
DUXBURY
MAPC
dcr
FEMA Hazard
Mitigation Planning Grant
NORWELL, MA
Map 10: High Land Surface Temperature
Tree Canopy Coverage
0%
1-25%
26-50%
51-75%
76 - 100%
Climate Hazards
Hottest 5% of region's land area
Sites
Critical Infrastructure*
Development Areas
* See details in separate table
Transportation Infrastructure
Rail Stations
Commuter Rail
Roads
Interstate
U.S. Highway
State Route
Streets
0 0.5 1 Miles
N
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Data Sources:
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Massachusetts Geographic Information System (MassGIS)
Northeast States Emergency Consortium (NESEC)
Massachusetts Emergency Management Agency (MEMA)
Federal Emergency Management Agency (FEMA)
Imagery © Google
NORWELL, MA
Date: 12/27/2019

APPENDIX C: PUBLIC MEETINGS

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

CALENDAR LISTING / MEDIA ADVISORY

NORWELL DRAFT HAZARD MITIGATION AND CLIMATE PLANS TO BE PRESENTED AT FEBRUARY 6TH PUBLIC MEETING

Meeting to present Norwell's Hazard Mitigation and Climate Plans and solicit public comments

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

What: At the Norwell Public Safety Building on Thursday, February 6 at 7:00 PM, a presentation will be made by the Metropolitan Area Planning Council (MAPC), which is assisting the Town with its Climate and Hazard Mitigation Plans.

The Hazard Mitigation plan identifies natural hazards affecting Norwell such as floods, hurricanes, winter storms, and earthquakes. The climate plan focuses on hazards associated with our warming climate. The plans include actions that the Town can take to reduce future vulnerability to these hazards. The public is invited to offer feedback on priorities the town has identified to prepare for future extreme weather.

When: Thursday, February 6 at 7:00 PM

Where: Norwell Public Safety Building
300 Washington Street
Norwell, MA

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

##

CLIMATE CHANGE AND NATURAL HAZARDS PUBLIC MEETING

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

The Town of Norwell is developing Hazard Mitigation and Climate Plans to prepare for future extreme weather events. The plans will make the Town eligible to apply for funding of town priorities.

Please join us for a presentation on natural hazards and climate impacts. We are seeking your feedback on the priorities we have identified to date.

Date:	**Thursday, February 6, 2020**
Time:	**7:00 PM**
Location:	**Norwell Public Safety Building**
	300 Washington Street

Natural Hazards and Climate Impacts
Public Meeting
Town of Norwell

TIME	ACTIVITIES
7:00	Introductions and Welcome
7:15	Review FEMA Hazard Mitigation Plan Process MVP Grant and Workshop Process
7:20	Climate Presentation
7:30	Examine Climate Posters and Workshop Results Participants add suggestions
8:00	Reconvene for questions or comments Participants identify top 5 priorities for Hazard Mitigation Planning
8:20	Report back results Next Steps
8:30	Adjourn

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

CALENDAR LISTING / MEDIA ADVISORY

NORWELL'S HAZARD MITIGATION PLAN TO BE DISCUSSED AT JUNE 10 PUBLIC MEETING

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

What: At a public meeting on Wednesday, June 10 at 7:00 PM, a presentation on the *Norwell Draft Hazard Mitigation Plan, 2020 Update* will be hosted by the Board of Selectmen. The presentation will be made by the Metropolitan Area Planning Council (MAPC), which is assisting the Town with the preparation of the updated Hazard Mitigation Plan. There will be an opportunity for questions and discussion following the presentation.

The Town of Norwell has prepared the draft Hazard Mitigation plan to document natural hazards that affect the Town, such as floods, hurricanes, and severe winter storms, and to recommend actions that the Town can take to reduce its vulnerability to these hazards. Once completed and approved by the Federal Emergency Management Agency (FEMA), the Town will be eligible for federal Hazard Mitigation Grants from FEMA.

When: Wednesday, June 10, 2020 at 7:00 PM

Where: Virtual meeting via Zoom
Link to meeting available at: https://www.townofnorwell.net/board-selectmen/events/137803

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

##

HAZARD MITIGATION PLAN PUBLIC MEETING

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



The Town of Norwell has prepared a draft Hazard Mitigation Plan, as well as a Climate Plan, to help the town reduce its vulnerability to natural hazards such as flooding, hurricanes, and winter storms. Please join the Board of Selectmen for a public presentation of the Hazard Mitigation Plan. Your questions and suggestions for the draft plan are welcome, please join us!

Date: **Wednesday June 10, 2020**
Time: **7:00 PM**
Location: **The meeting will be held virtually. Link available at: https://www.townofnorwell.net/board-selectmen/events/137803**

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

Board of Selectmen's Meeting
June 10, 2020
Amended Agenda

Remote Participation
(conducted pursuant to the Executive Order dated March 12, 2020 suspending certain provisions of the Open Meeting Law, Gen. L. c. 30A §20 et seq. and 940 CMR 29.01 et seq.)

Instructions to Zoom Access Remote Participation Meeting:

Phone: +1 929 205 6099 Plus Meeting ID: 590 544 2324 then #

7:00pm Call to Order

NOTE: All votes taken at this meeting, Open and Executive Sessions, will be roll call votes

Approval of Agenda

1. **Reports**
   a) Selectmen's Reports and Announcements
   b) Town Administrator's Report

Discussion/Action Items

a) **Hazard Mitigation draft plan and climate planning update - – Anne Herbst, MAPC**
b) BOS approval – outdoor seating and service at The Fours Restaurant
outdoor seating and service at Trattoria San Pietro
c) FY2021 Budget - review and discussion
d) Vote to freeze Town Administrator's salary
e) Authorization for Town Administrator to submit COVID reimbursement requests to Plymouth County

Approval of Meeting Minutes – 6/3/20

Future Meeting Agendas

Adjourn to Executive Session to discussion Personnel Matter
Fire Chief Position – Succession

APPENDIX D: PLAN ADOPTION

<TOWN LETTERHEAD>

CERTIFICATE OF ADOPTION
BOARD OF SELECTMEN

TOWN OF NORWELL, MASSACHUSETTS

A RESOLUTION ADOPTING THE
TOWN OF NORWELL HAZARD MITIGATION PLAN 2020 UPDATE

WHEREAS, the Town of Norwell established a Committee to prepare the *Town of Norwell Hazard Mitigation Plan 2020 Update*; and

WHEREAS, the *Town of Norwell Hazard Mitigation Plan 2020 Update* contains several potential future projects to mitigate potential impacts from natural hazards in the Town of Norwell, and

WHEREAS, duly noticed public meetings were held by the LOCAL HAZARD MITIGATION PLANNING TEAM on February 6, 2020 and JUNE 10, 2020 and

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

NOW, THEREFORE BE IT RESOLVED that the Town of Norwell Board of Selectmen adopts the *Town of Norwell Hazard Mitigation Plan 2020 Update*, in accordance with M.G.L. 40 §4 or the charter and bylaws of the Town of Norwell.

ADOPTED AND SIGNED this Date. _____

Name(s)

Title(s)

Signature(s)

APPENDIX E: MVP WORKSHOP RESULTS

HIGHEST PRIORITIES

Forest and Tree Management: All five groups highlighted concerns regarding town forests and trees. Concerns range from the health of forested lands to power outages from falling trees. Developing and funding a Forestry Management Plan was suggested to address the health of trees, dangers to people and infrastructure, as well as fires, pests, and resources for staffing. The need to ensure Fire Department access and equipment to reach forested land and the need to remove brush were proposed to address fire risks. Other suggestions included expanding the hazard tree program, increasing coordination between the town and utilities, working regionally, community outreach regarding privately owned trees, and widening sidewalks to create more of a buffer. Also suggested was greater National Grid staffing for storm response and pro-active tree management. (39)

Generators: Four of the groups highlighted the need to identify and prioritize municipal facilities that need improved generator capacity. Police and Fire, as well as Town Hall, the Middle School and the DPW campus were identified as locations with need. As part of this priority a Task Force to identify potential shelter sites and address deficiencies in the availability of generators was proposed. (33)

Outreach to older adults, vulnerable populations, and the public at large: Several groups proposed increased outreach to seniors and low-income populations. A focus of suggestions was assessing needs and vulnerabilities and, ensuring that residents are connected to emergency communications as well as pro-active education. It was suggested that the Board of Selectmen work with the Emergency Management Team to develop a policy for public communication during storm events. Another suggestion was a user-friendly web mapping program that could help communicate and coordinate challenges such as downed trees, power outages, road closures, and flooding. (21)

Stormwater Management: Proposals included creating a Low Impact Development/Green Infrastructure plan as well as policies and regulations to support the plan. Also suggested was a prioritization plan for drainage upgrades. (12)

Improved Water Supply Management: Suggestions included water conservation, drought tolerant landscaping, onsite infiltration, developing a water banking policy and, education to reduce the use of automatic irrigation systems and to explain water tier restrictions. (8)

Power Resilience: Consider a bylaw that would require larger developments to build in resilience and secondary power supplies. (8)

Infrastructure Management: Several groups offered related suggestions regarding town asset management. One suggesting funding for a comprehensive assessment of aging infrastructure including culverts, dams and power utilities. Similarly, a computerized system that would track infrastructure type, condition and maintenance schedules for infrastructure and, for trees, was proposed. (7)

Outreach to Children: Continue the Risk Awareness for Children in Elementary Schools (RACES) program. Develop emergency plans and work with educators to develop age-specific programs. (3)