TOWN OF NORFOLK
DRAFT HAZARD MITIGATION PLAN
2023 UPDATE

Photo from the Norfolk Town website

Town of Norfolk
Metropolitan Area Planning Council

Draft Plan for Review
May 8, 2023

ACKNOWLEDGEMENTS & CREDITS

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

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF 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. Other common concerns are the impacts of extreme heat, drought, and nor'easters. This plan also considers how our changing climate will affect natural hazards. Warming temperatures will fuel changing precipitation patterns and an increasing frequency and intensity of severe storms. The Federal Disaster Mitigation Act of 2000 requires all municipalities that wish to be eligible to receive FEMA hazard mitigation grants to adopt a local multi-hazard mitigation plan and update the plan in five-year intervals.

PLANNING PROCESS

The Hazard Mitigation Plan update was led by the Norfolk Local Hazard Mitigation Planning Team (or "Local Team"), composed of staff from Town Departments including Public Works, Land Use, Town Administration, Council on Aging, Police, Facilities, Fire, and the Building Department. The Local Team met on the following dates:

- September 14, 2022
- November 3, 2022
- December 7, 2022
- January 9, 2023

The Local Team discussed updates to local hazard areas, critical facilities, hazard mitigation goals, the Town's existing mitigation measures, and new or revised hazard mitigation measures that would benefit the Town. Public participation in the planning process is important for improving awareness of the impacts of natural hazards and to build support for the actions the Town takes to mitigate them. The Local Team hosted two public meetings via Zoom, including on:

- December 15, 2022
- May TBD, 2023

Key stakeholders and neighboring communities were notified and invited to participate. The first public meeting was also used to launch a public survey that helped gather additional information related to hazard mitigation concerns, impacts, and preferred strategies. The second public meeting was used to launch a public comment period for the draft plan update. Please see Appendix E for more information about the public comments received, and "Section 3: Planning Process & Public Participation" for more information about the outreach and engagement efforts that informed this plan update.

RISK ASSESSMENT

The Norfolk Hazard Mitigation Plan update assesses the potential impacts to the Town from flooding, drought, geologic hazards, extreme temperatures, wildfire, wind events and severe storms, and severe winter weather. The Town of Norfolk was particularly concerned about the

potential risks posed by flooding and brushfires. The Town is well prepared to deal with the impacts of many natural hazards, including severe winter weather. For each risk, the assessment identifies the projected impacts of a warming climate. See "Section 4: Risk Assessment" for more information.

Potential natural hazard risks are also visualized in the map series in Appendix A. The Local Team identified 60 critical facilities throughout Norfolk. These are also shown on the map series in Appendix A and listed in the table in the "Critical Infrastructure in Hazard Areas" section, which identifies which facilities are located within the mapped hazard zones.

HAZUS (Hazards US) is a standardized risk modeling methodology developed by FEMA that utilizes Geographic Information Systems (GIS) to estimate physical, economic, and social impacts of disasters (FEMA, 2022). A HAZUS analysis provided estimates of damages in Norfolk from 100-year and 500-year hurricanes, earthquakes of magnitudes 5 and 7, and flooding from 100-year and 500-year storms. Please see Appendix B for tables showing the results of the HAZUS analyses for these hazards in Norfolk.

HAZARD MITIGATION GOALS

The Local Team identified the following hazard mitigation goals for the Town. Compared to the 2010 plan, the team added two new goals focused on incorporating climate change and environmental justice.

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

2. Identify and seek funding for measures to mitigate or eliminate natural hazards.

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 impacts of climate change and incorporate climate sustainability and resiliency into the Town's planning, policies, and projects.

10. Incorporate environmental justice considerations throughout natural hazard mitigation – including in supporting climate vulnerable populations, the outreach and engagement process, analysis of hazard impacts, and development and implementation of mitigation measures.

HAZARD MITIGATION STRATEGY

The Local Team identified a number of mitigation measures that would help reduce the Town's vulnerability to natural hazards. Overall, the hazard mitigation strategy recognizes that mitigating hazards for Norfolk 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 will impact the Town's vulnerability in the future, and local officials will need to work together across departments and municipalities, and collaborate with state and federal agencies in order to understand and address these changes. The hazard mitigation strategy outlined in this report will be incorporated into the Town's other related plans and policies, including the currently ongoing Master Plan update. See "Section 8: Hazard Mitigation Strategy" for more information.

PLAN REVIEW & UPDATE PROCESS

The process for developing Norfolk's Hazard Mitigation Plan 2023 Update is summarized in Table 1 below. Please see each corresponding report section for more information.

Table 1: Plan Review & Update Process

Report Section	Reviews and Updates
3: Planning Process & Public Participation	The Local Team placed an emphasis on public participation for the Hazard Mitigation Plan update, and discussed strategies to enhance outreach and engagement efforts during Local Team meetings. During the project process, the plan was discussed at two public meetings, a public survey was shared, and the plan was made available on the Town's website for public comment. Outreach efforts to publicize these engagement opportunities included webpage content, social media posts, e-blasts, and flyers.
4: Risk Assessment	MAPC gathered the most recently available hazard, climate, 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. This information was incorporated into an updated hazard map set, available in Appendix A. MAPC also used the most recently available version of HAZUS to assess the impacts of flooding,

Report Section	Reviews and Updates
	hurricanes, and earthquakes.
5: Hazard Mitigation Goals	The Hazard Mitigation Goals were reviewed, updated, and endorsed by the Local Team.
6: Existing Mitigation Measures	The list of existing mitigation measures was updated by the Local Team to reflect current mitigation activities in the Town.
7 & 8: Hazard Mitigation Strategy	Mitigation measures from the 2010 plan were reviewed and assessed as to whether they were completed, partially completed, or not completed. The Local Team determined whether to carry forward mitigation measures into the 2023 Plan, revise them, or delete them. The hazard mitigation strategy reflects both new measures and measures carried forward from the 2010 plan. The Local Team prioritized mitigation measures based on current conditions.
9: Plan Adoption & Maintenance	This section of the plan was updated with recommendations for an ongoing plan implementation review and five-year update process that will assist the Town in incorporating hazard mitigation into other Town planning and regulatory review processes, and better prepare the Town for the next comprehensive HMP update.

As indicated in Section 7, Norfolk has made progress in implementing mitigation measures identified in the 2010 Hazard Mitigation Plan, which is summarized below.

- **2** projects were fully completed, including efforts related to firefighting and emergency response equipment, and culvert upgrades.
- **11** of the mitigation measures from the 2010 plan were carried over to this 2023 plan update. Some of these strategies are partially complete, and some are considered complete but ongoing action items. The description of each of these mitigation measures has been updated to reflect the most recent information.
- **4** mitigation measures from the 2010 plan were not completed and were not carried over to this plan update, as they are no longer relevant.
- **20** new mitigation measures that were not in the previous plan were identified and added to this plan update.

Of the **32** total recommendations included in Section 8 of this 2023 plan update, **13** are high priority, **10** are medium priority, and **9** are low priority.

Moving forward into the next five-year plan implementation period, there will be more opportunities to incorporate hazard mitigation into the Town's decision-making processes. 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 Local Team, as described in "Section 9: Plan Adoption and Maintenance."

Snow in Norfolk in 2013. Image from the Town of Norfolk Facebook page.

SECTION 2 INTRODUCTION

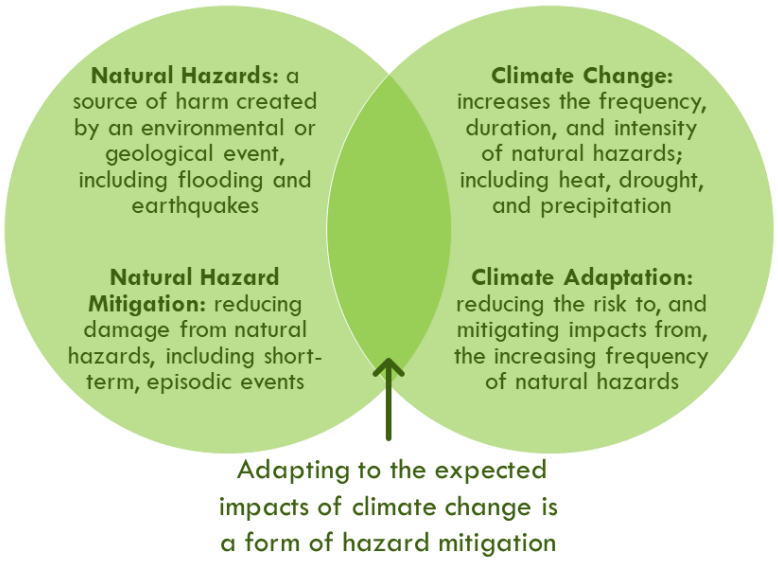
PLANNING REQUIREMENTS UNDER THE FEDERAL DISASTER MITIGATION ACT

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 Norfolk contracted with the Metropolitan Area Planning Council (MAPC), to assist the Town in updating its original local Hazard Mitigation Plan, which was first adopted in 2010. MAPC is the Regional Planning Agency (RPA) serving the 101 communities in the greater Boston area, and provided facilitation and technical support for this project.

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 permanently reducing or alleviating 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. FEMA's 2022 Local Mitigation Planning Policy Guide recognized that adapting to the expected impacts of climate change is a form of hazard mitigation (FEMA, 2022). Therefore, this plan incorporates consideration of future risks due to projections for the increased frequency and severity of extreme weather fueled by a warming planet.

Figure 1: Natural Hazards and Climate Change Overlap



PREVIOUS FEDERAL/STATE DISASTERS

Since 1991, there have been 36 natural hazard events that triggered disaster declarations that included Norfolk County. These are listed in Table 2 below. The majority of these events involved flooding and winter weather, while others were due to hurricanes or the COVID-19 pandemic (Commonwealth of Massachusetts, 2018), (FEMA, 2023), and (FEMA, n.d.).

Table 2: Federal Disaster Declarations 1991-2023

Disaster Name	Date of Event	Declared Areas
Hurricane Bob	August 1991	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
Severe Coastal Storm No Name Storm	October 1991	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
Blizzard	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	March 2001	Berkshire, Essex, Franklin, Hampshire, Middlesex, Norfolk, Worcester
Snowstorm	February 2003	Statewide
Snowstorm	December 2003	Barnstable, Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, Worcester
Flooding	April 2004	Essex, Middlesex, Norfolk, Suffolk, Worcester
Snowstorm	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 Winter Storm	December 2008	Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Suffolk, Worcester
Severe Storms, Flooding	December 2008	Statewide

Disaster Name	Date of Event	Declared Areas
Severe Storms, Flooding	March/April 2010	Bristol, Essex, Middlesex, Suffolk, Norfolk, Plymouth, Worcester
Hurricane (Hurricane Earl)	September 2010	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester
Severe Winter Storm, Snowstorm	January 2011	Berkshire, Essex, Hampden, Hampshire, Middlesex, Norfolk, Suffolk
Hurricane (Hurricane/Tropical Storm Irene)	August 2011	Barnstable, Berkshire, Bristol, Dukes, Franklin, Hampden, Hampshire, Norfolk, Plymouth
Severe Storm, Snowstorm	October 2011	Berkshire, Franklin, Hampden, Hampshire, Middlesex, Worcester
Severe Winter Storm, Snowstorm, Flooding	February 2013	Statewide
Severe winter storm, snowstorm, flooding	January 2015	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester
Severe winter storm and Snowstorm	March 2018	Essex, Middlesex, Norfolk, Suffolk, Worcester
Severe winter storm and flooding	March 2018	Barnstable, Bristol, Essex, Nantucket, Norfolk, Plymouth
COVID-19 Pandemic	January 2020	Statewide
COVID-19	January 2020	Statewide
Severe winter storm and snowstorm	January 2022	Bristol, Norfolk, Plymouth, Suffolk

Sources: Massachusetts State Hazard Mitigation and Climate Adaptation Plan, Appendix B, 2018; OpenFEMA Dataset: Disaster Declarations; and FEMA Declared Disasters. See "Section 10: Reference List" for more information.

FEMA FUNDED MITIGATION PROJECTS

MEMA has no record of the Town of Norfolk receiving funding from FEMA for mitigation projects under the Hazard Mitigation Grant Program (Talbot, 2023).

COMMUNITY PROFILE

The Town of Norfolk is a rural suburban community located in eastern Massachusetts in the Charles River watershed. The town is bordered by Millis and Medfield on the north, Walpole on the east, Foxborough and Wrentham on the south, and Franklin and Medway on the west. Norfolk is about 20 miles southwest of Boston and about 28 miles north of Providence, Rhode Island.

Norfolk belongs to the Southwest Advisory Planning Committee (SWAP) Subregion of the Metropolitan Area Planning Council (MAPC). The town is governed by a Select Board with a Town Administrator, and operates under the open town meeting format. Norfolk maintains a website at: https://norfolk.ma.us/.

The land where the Town is located was originally home to the Wampanoag, Massachusetts, and Pokanoket tribes (Native Land Digital, 2023). Europeans arrived in the area that is now Norfolk as early as 1632. Some permanent homes were built by 1667 while others settled in the Lake Pearl area of Wrentham or in Dedham. In 1673, the General Court designed a new town under the name of Wrentham, which was declared separate from Dedham. Many residents abandoned the Town during King Philip's War, which lasted from 1675-1677. Post-war rebuilding resulted in a number of operational or planned mills by 1694, which led to a population increase.

Around 1795, a large group moved from Wrentham to North Wrentham and a meetinghouse was constructed on the top of the town hill, which became the town hall in 1870 but later burned down in 1922. The 1800s saw an increase in factories, jobs, and population. The first railroad line into town, operated by the Norfolk County Railroad, opened in 1848. In October 1869, residents petitioned the General Court for independence and in February 1870, North Wrentham and sections of Franklin, Walpole and Medway were organized into present-day Norfolk. The Town's population at the time was 1,124 residents across 9,000 acres of land (Town of Norfolk, 2022). The Town's current population is included in the Table below.

Table 3: Town of Norfolk Demographics

Population	
Total population	11,662 residents
Residents under 18 years old	24.1%
Residents 65 years old and over	11.3%
Race & Ethnicity	
American Indian and Alaska Native	17 residents
Asian	306 residents
Black or African American	614 residents
Native Hawaiian and Pacific Islander	0 residents
White	9,949 residents
Other Race	126 residents
Two or More Races	650 residents
Hispanic or Latino	602 residents
Not Hispanic or Latino	9,809 residents
Households	
Total Households	2,967 units
Total Housing Units	3,601 units
Occupied Housing Units	3,512 units
Median Household Income	$168,281
Median Gross Rent	$1,439
Homeownership Rate	95.6%
Language other than English spoken at home	10.6%
Employment	
Employment Rate	52.7%

Industry for Employed Populations	Most residents (24.5%) work in educational services and health care and social assistance
Class of Worker	Most residents (67.4%) are employed by private companies
Average commute to work	38.7 minutes
Additional Information	
Residents with a Disability	6.1%
Residents in Poverty	1.5%
Residents with a Bachelor's Degree or Higher	50.4%
Residents without Health Care Coverage	0.5%

Sources: 2020 Decennial Census and American Community Survey (ACS) 5-Year Estimates (US Census Bureau, 2021)

The Town is also home to Environmental Justice (EJ) populations that include minority residents. Please refer to Map 1a in Appendix A for more information. Norfolk has several unique characteristics to consider when planning for natural hazards; including those related to transportation infrastructure, water and wastewater, natural resources, and other town features.

TRANSPORTATION

Norfolk has an MBTA Commuter Rail station in Town, which is part of the Franklin/Foxboro Line. State highways in Town include:

- Route 115, which runs roughly north-south
- Route 1A, which runs northeast-southwest

WATER & WASTEWATER

The Norfolk Department of Public Works Water Division supplies the Town of Norfolk with drinking water from ten (10) gravel-packed groundwater wells and treats at three (3) water treatment plants for its public water supply. Water is treated for pH adjustment, disinfection, and sequestration and corrosion control. The Town serves a population of approximately 7,912 through 75 miles of pipe varying in size from less than 6 inches to 12 inches in diameter. The water system is comprised of one main service zone with a hydraulic grade line of approximately 365 feet. The Warren Drive booster pump station serves a small residential area off of Maple Street and has a hydraulic grade line of 415 feet.

The average daily water demand for the system is approximately 0.41 million gallons per day (MGD). The peak daily demand is approximate 0.93 million gallons (MG) and typically occurs during June. The Division maintains a contract with WhiteWater to oversee the operation of the water system (Town of Norfolk, Environmental Partners, 2021). More information on municipal water infrastructure is included in the "Critical Infrastructure in Hazard Areas" section.

The Public Works Department provides wastewater services through its Wastewater Division. The Town of Norfolk relies on individual on-site wastewater disposal systems (septic systems) for the majority of the Town's developed parcels. The one exception is the municipally owned Amphidrome Wastewater Treatment Facility (WWTF) located on Meetinghouse Road, which provides sewer service to a limited geographic area of the Town Center. The facility is a two train Amphidrome treatment system with a shared Amphidrome Plus reactor. The site includes residential townhomes and retail and commercial spaces. The Title 5 flow for this mixed-use site is 30,000 gallons per day (gpd). The treatment facility and effluent disposal system are located at the top of Meeting House Road off of Liberty Lane, with the treatment facility building being

located at 51 Meeting House Road. The treatment facility was approved by MassDEP in October of 2002, based on using a dual train Amphidrome® treatment technology, and came online in 2006 which the Town then acquired in 2015.

The existing sewer system in Norfolk consists of approximately 2,500 feet of gravity sewer, 800 feet of force main, one pump station and the existing Meetinghouse Road WWTF. The facility receives sewage by gravity from the Town Center Condominiums where the facility is located and from a remote sewage pump station at the retail complex in the Town center (Town of Norfolk and Woodard & Curran, 2021).

NATURAL RESOURCES

Norfolk is home to significant natural resources, and more than half of the Town's land use is forested land (MA Dept of Public Health, 2022). More information about key natural features in Norfolk is summarized below:

- Every road is a "Scenic Roadway", which means that trees are close to the roadway and power lines and tree maintenance requirements also consider Norfolk's rural character.
- Norfolk is home to several rivers and streams including the Stop River, Mill River, Stony Brook and the Cress Brook.
- Mass Audubon's Stony Brook Wildlife Sanctuary and Bristol Blake State Reservation are located in Norfolk (BETA, 2020).
- Additional scenic and unique sites include Campbell Forest, City Mills and Comey Pond, Cranberry Bogs, Kunde Conservation Land, Maple St. Forest, Mirror Lake, and Populatic Pond (PGC Associates, Inc., 2017)
- The Town is home to rare and endangered species, including those considered by the State to be threatened, endangered, or of "special concern" (PGC Associates, Inc., 2017).

HISTORIC RESOURCES

Norfolk's Town Center is home to irreplaceable historic sites (Town of Norfolk, n.d.), including:

- Town Hill
- The Ware Crypt
- Library Schoolhouse
- The Tramp House
- The Old Parsonage
- Federated Church
- Blake-Campbell House and Blacksmith Shop
- Ware/Dupee/Thayer Gross House
- Norfolk Grange
- Salmon Mann House

REGIONAL FACILITIES

Norfolk is home to regional facilities that serve neighboring communities, including:

- Metacomet Emergency Communication Center (MECC) Public Safety Regional Dispatch
- King Philip Regional Middle School
- Correctional facilities including MCI Norfolk, Pondville Correctional Center, and Bay State Correctional Center. Additionally, MCI-Cedar Junction in Walpole borders Norfolk.

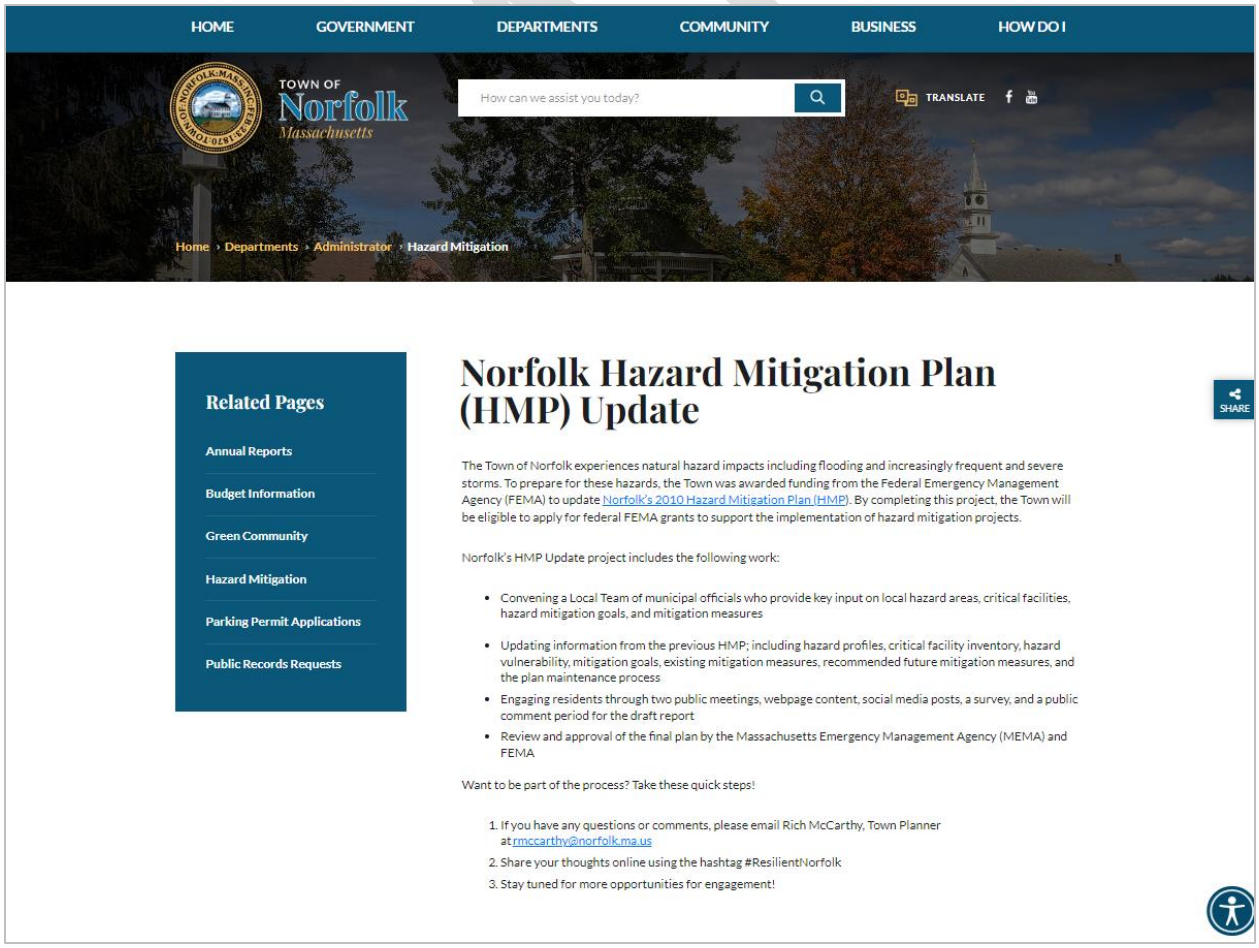
See the "Critical Infrastructure in Hazard Areas" section for more information on regional and critical facilities in Norfolk.

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:

- Meetings and work with the Local Teams
- Two public meetings, shared on Local Access TV and advertised through e-blasts, webpage content, a flyer, and social media posts
- A public survey and advertising the survey through e-blasts, webpage content, a flyer, social media posts, and invitations sent to community stakeholders, Town boards and commissions, neighboring communities, and other local or regional entities.
- A project website, available at tinyurl.com/NorfolkHMP
- Launching a public comment period at the second public meeting, and posting the draft plan to the project website to facilitate public comment

Figure 2: A Screenshot of the Norfolk HMP Update Project Website



PLANNING PROCESS SUMMARY

The six-step planning process summarized in the diagram below is based on FEMA's Local Mitigation Planning Policy Guide, focusing on local needs and priorities but maintaining a regional perspective matched to the scale and nature of natural hazard events and regional climate change. Public participation is a central element of this process, which attempts to focus on local problem areas and identify needed mitigation measures based on where gaps occur in the existing mitigation efforts of the municipality. In plan updates, the process described below allows staff to bring the most recent hazard information into the plan, including new hazard occurrence data, changes to a municipality's existing mitigation measures, and progress made on actions identified in previous plans.

Figure 3: Six-Step Planning Process

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

2. **Assess the Risks & Potential Damages** – Working with the Local Team, 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 many resources to complete this plan update, including the sample of key documents listed below. Refer to "Section 10: Reference List" for a full list of sources and more detailed information.

- Town of Norfolk, Bylaws
- Town of Norfolk and Woodard & Curran, Norfolk Town Center Wastewater Study, 2021
- Town of Norfolk and BETA, MVP Community Resilience Program: Resilience Building Report Summary of Findings, 2020
- Town of Norfolk and PGC Associates, Inc., Open Space and Recreation Plan, 2017
- Commonwealth of Massachusetts, Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP), 2018
- Commonwealth of Massachusetts, Massachusetts Climate Change Assessment, 2022
- DCR, Community Information System, Community Overview, 2022
- FEMA, Local Mitigation Planning Policy Guide, 2022
- FEMA, Disaster Declarations for States and Counties, 2023
- FEMA, Flood Insurance Rate Maps for Norfolk County, Massachusetts, 2012
- FEMA, HAZUS, 2022
- MA Dept of Public Health, Massachusetts Environmental Public Health Tracking: Community Profile for Norfolk, 2022
- Massachusetts Office of Dam Safety, Inventory of Massachusetts Dams 2018
- MA Department of Early Education and Care, Licensed Child Care Programs, 2022
- US Census Bureau, 2021
- MA Climate Change Adaptation Report, 2011
- Blue Hill Observatory
- Mass. Emergency Management Agency, *State Hazard Mitigation Plan,* 2013
- NOAA, National Centers for Environmental Information, Storm Events Database
- Tornado History Project
- USDA Forest Service, Wildfire Risk to Communities
- U.S. Global Change Research Program, *Fourth National Climate Assessment*, 2018
- USACE Ice Jam Database

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 have been 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 8.

5. **Plan Approval & Adoption** – Once a final draft of the plan is complete, it is sent to MEMA for the state level review and subsequently 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 by the Town can be found in Appendix F.

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 ongoing activity. Section 9 includes more detailed information on plan maintenance.

2010 PLAN IMPLEMENTATION & MAINTENANCE

The 2010 Town of Norfolk Hazard Mitigation Plan contained a risk assessment of identified hazards for the Town and mitigation measures to address the risks and vulnerability from these hazards. Since approval of the plan by FEMA, the Town advanced several hazard mitigation measures and completed a Municipal Vulnerability Preparedness (MVP) planning process in 2020. Norfolk was subsequently designated an MVP Community by the Executive Office of Energy and Environmental Affairs. See Section 7 for more information on the status of mitigation measures from the 2010 HMP.

THE LOCAL HAZARD MITIGATION PLANNING TEAM

MAPC worked with the local community representatives to organize a Local Hazard Mitigation Planning Team (the "Local Team") for Norfolk. The Local Team is central to the planning process, and was tasked with working with MAPC to update local hazard areas, critical facilities, hazard mitigation goals, the Town's existing mitigation measures, and develop new or revised hazard mitigation measures. The Local Team members are listed below.

Barry Lariviere	Assistant Director of Public Works
Richard McCarthy	Director of Planning & Development
Justin Casanova-Davis	Town Administrator
Matt Tanis	Environmental Health Agent
Karen Edwards	Council on Aging Director
Timothy Heinz	Chief of Police
Matt Haffner	Facilities Director
Caitlin Nover	Conservation Agent
Erron Q. Kinney	Fire Chief
Robert J. Bullock Jr.	Building Commissioner

The Town Administrator, Planning & Development department, and Public Works department are responsible for managing and regulating development in Town. MAPC, the State-designated Regional Planning Agency (RPA) for Norfolk, works with all agencies that regulate development in the region, including state agencies such as the Department of Transportation and the Department of Conservation and Recreation.

The Local Team met on the dates listed below. The agendas for these meetings are included in Appendix C.

- **September 14, 2022:** to discuss the project overview and update local hazard areas and critical facilities inventory
- **November 3, 2022:** to update hazard mitigation goals and existing mitigation measures, and prepare for Public Meeting #1
- **December 7, 2022:** to update recommended mitigation strategies from the 2010 HMP
- **January 9, 2023:** to develop new recommended mitigation measures and prepare for Public Meeting #2

Additional meetings conducted to inform this plan update included:

- July 26, 2022: Kickoff meeting
- September 26, 2022: Discussion of development updates
- February 2, 2023: Discussion to update and finalize the hazard map series
- February 7, 2023: Meeting with the Charles River Watershed Association

PUBLIC MEETINGS, SURVEY & PUBLIC COMMENT

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 on December 15, 2022; and one after a complete draft plan is available for review on May TBD, 2023.

For both of these public meetings, key stakeholders and neighboring communities were notified and invited to participate. Both meetings were publicized as part of regular meetings of the Planning Board according to the Massachusetts Public Meeting Law and shared via Local Access TV. The Town advertised the public meetings through a flyer, e-blast, social media posts, and webpage content. The project webpage was kept updated during the process and is available at: tinyurl.com/NorfolkHMP. See public meeting materials and outreach materials in Appendix D.

The first public meeting included a presentation of information, interactive polling and information gathering, and Q&A discussion. Questions used to prompt discussion included those listed below.

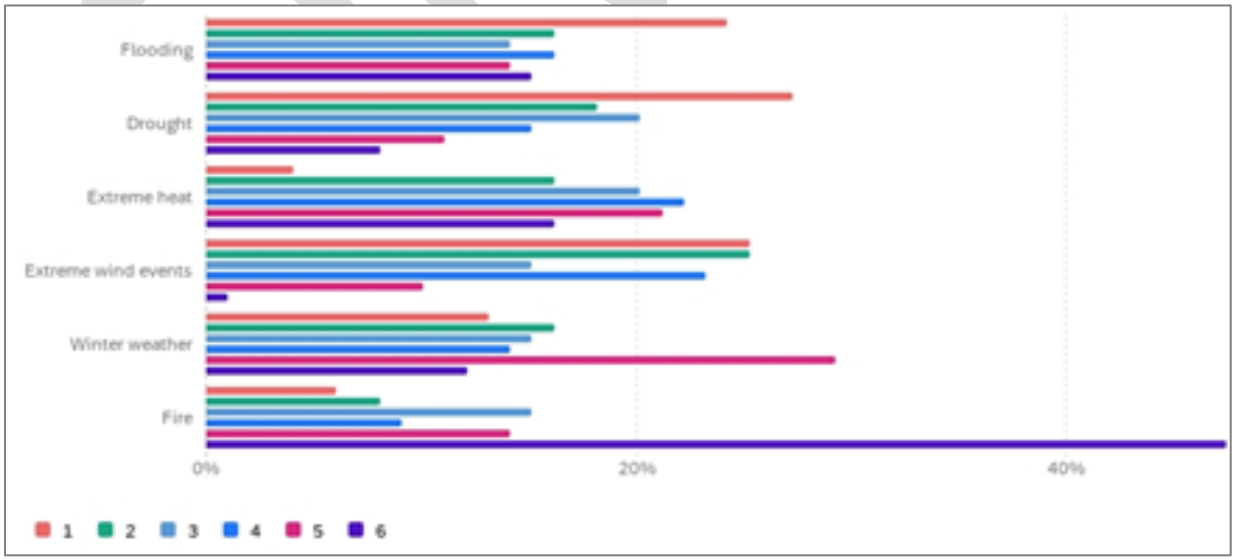
- What is your connection to the Town?
- What brought you to tonight's meeting?
- What natural hazards are you most concerned about?
- What's your top priority for this project?

There were 11 participants at the first public meeting. The polling responses suggested that most attendees lived or worked in Norfolk; were most concerned with flooding, winter weather, and extreme wind events; and wanted to prioritize strategies related to open space and protecting vulnerable residents. During the Q&A, the project team received one question related to how the plan could help protect seniors. The team mentioned that the Local Team included a Council on Aging representative, and discussed potential strategies that could protect Norfolk's climate vulnerable residents.

Figure 4: A Word Cloud Visualizing Top Priorities for Public Meeting #1 Attendees

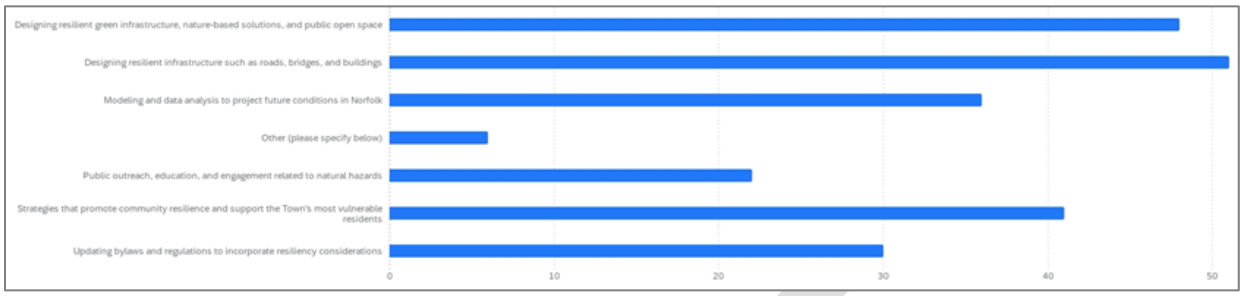
This first public meeting was also used to launch a public survey that helped gather additional information related to hazard mitigation concerns, impacts, and preferred strategies. The Town advertised the survey through a flyer, e-blast, social media posts, and webpage content. The survey was made available through an online link, and hard copy prints distributed at the Senior Center. 149 survey responses were received, and key findings are summarized below. Most survey respondents owned a home in Norfolk, heard about the survey on Facebook, were over the age of 50, identified as white, and had an annual income of more than $100,000.

Figure 5: Public Survey Results: Natural Hazards of Concern



Respondents were asked to rank the natural hazards that they were most concerned about. The top #1 selections were drought, extreme wind events, and flooding.

Figure 6: Public Survey Results: Preferred Strategies



Respondents were asked to rank the hazard mitigation strategies that were most important to them. The top selections were designing resilient infrastructure such as roads and bridges, nature-based solutions, and supporting the Town's most vulnerable residents.

The second public meeting was used to launch a public comment period for the draft plan update. There were 12 attendees at the second public meeting. The draft plan was posted on the Town's website to facilitate a 2-week public review and comment period. During this time, feedback was received from 10 number of stakeholders, and the report was updated to reflect and incorporate these comments. Please see Appendix E for more information about the public comments received.

LOCAL STAKEHOLDER INVOLVEMENT

The Local Team was encouraged to reach out to local stakeholders that might have an interest in the Hazard Mitigation Plan update, including neighboring communities, agencies, businesses, nonprofits, and other interested parties. Notice was sent to the following Town boards, committees, departments; regional and state organizations; and neighboring municipalities inviting them to participate in the public meetings, take the public survey, review the draft HMP, and submit comments to the Town.

- Norfolk Housing Authority
- Norfolk Recreation Dept
- Norfolk Cultural Council
- Norfolk Historical Commission
- Norfolk Affordable Housing Trust
- Norfolk Board of Health
- Norfolk Community Preservation Committee
- Norfolk Energy Committee
- Norfolk Fire Station Building Comm.
- Norfolk Public School Committee
- Norfolk Planning Board
- Norfolk Recreation Commission
- Norfolk Select Board
- Norfolk Veterans Services
- Norfolk Public Library
- King Philip Regional School District
- Regional Health & Social Services Consortium (HESSCO) Elder Services
- Charles River Watershed Association
- Mass Audubon Stony Brook Wildlife Sanctuary
- Central Norfolk Regional Emergency Planning Committee (REPC)
- MEMA
- Municipal Vulnerability Preparedness (MVP) Regional Coordinator at EEA
- Town of Foxborough
- Town of Wrentham
- Town of Franklin
- Town of Medway
- Town of Millis
- Town of Medfield
- Town of Walpole

CONTINUING PUBLIC PARTICIPATION

Following the adoption of the plan update, the Local 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 Local Team, these will be placed on the project website and any future public meetings related to natural hazard mitigation will be publicly noticed in accordance with municipal and state open meeting laws. See Section 9 for more information on plan adoption and maintenance.

PLANNING TIMELINE

Table 4: Planning Timeline for the 2023 HMP Update

July 26, 2022	Project Kick off Meeting
September 14, 2022	Local Team Meeting #1
September 26, 2022	Meeting to discuss development updates
November 3, 2022	Local Team Meeting #2
December 7, 2022	Local Team Meeting #3
December 15, 2022	Public Meeting #1
January 9, 2023	Local Team Meeting #4
February 2, 2023	Meeting to update and finalize the hazard map series
February 7, 2023	Meeting with the Charles River Watershed Association
May TBD, 2023	Public Meeting #2
TBD	Draft Plan Update submitted to MEMA
TBD	Draft Plan Update submitted to FEMA
TBD	Notice of Approvable Pending Adoption sent by FEMA
TBD	Plan Adopted by the Town of Norfolk
TBD	FEMA Formal Approval of the plan for 5 years

Table 5: Post-Plan Approval Implementation & Plan Update Timeline

2025	Conduct Mid-Term Plan Survey on Progress
2026	Seek FEMA grant to prepare next plan update
2027	Begin process to update the plan
2028	Submit Draft 2028 Plan Update to MEMA and FEMA
2028	FEMA approval of 2028 Plan Update

SECTION 4 RISK ASSESSMENT

The risk assessment analyzes the potential natural hazards that could occur within the Town 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 Norfolk's risk assessment, MAPC gathered the most recently available hazard and land use data and met with the Local Team to identify changes in local hazard areas and development trends. MAPC also used FEMA's damage estimation software, HAZUS.

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

> *"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)

Massachusetts' 2022 Climate Change Assessment.

CLIMATE CHANGE OBSERVATIONS AND PROJECTIONS

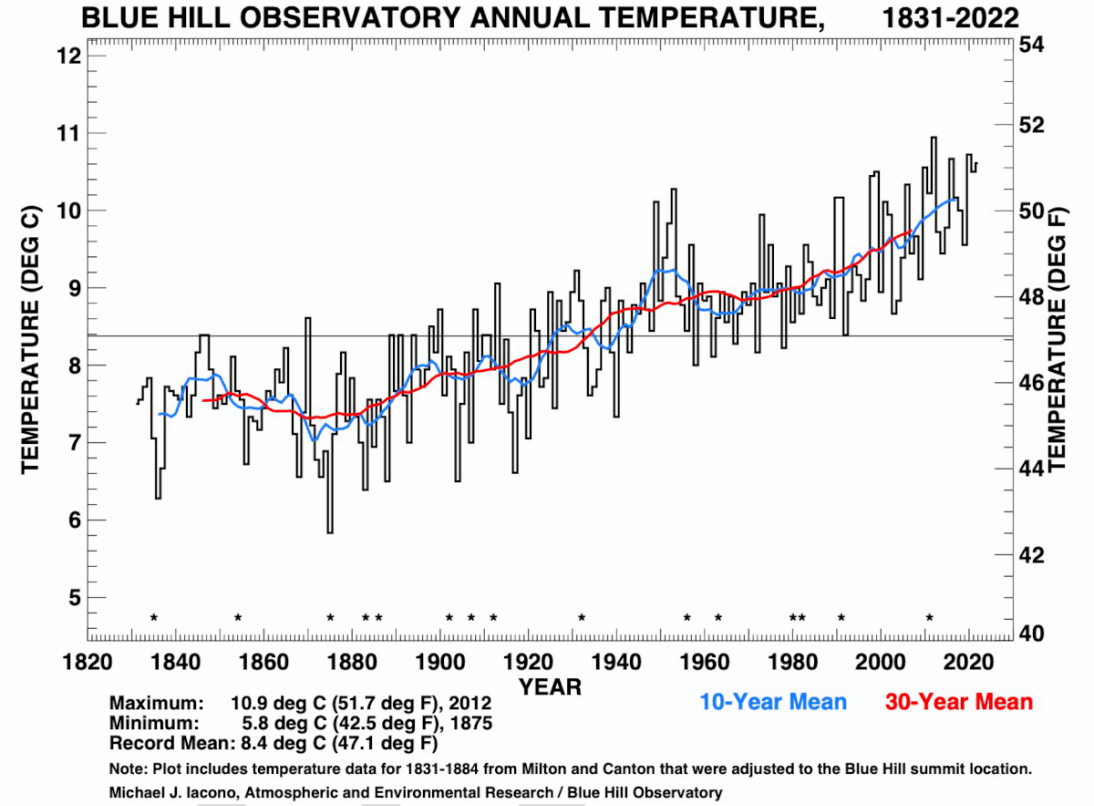
Climate change observations come from a variety of data sources that have measured and recorded changes in recent decades and centuries. Climate change projections, however, predict future climate impacts and, by their nature, cannot be observed or measured. As a result of the inherent uncertainty in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

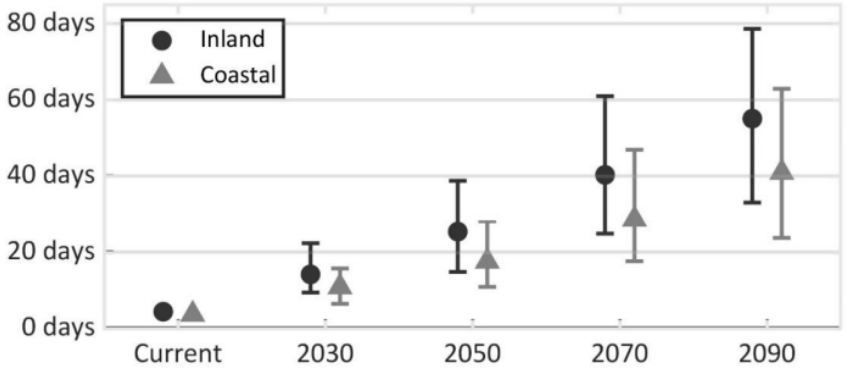
Records from the Blue Hill Observatory in Milton, MA show that average temperatures (30-year mean) have risen approximately 3 degrees (F) in the almost 200 years since record keeping began in 1831. See the figure below for more information.

Figure 7: Observed Increase in Temperature



Climate projections include an increase in average temperature and in the number of extreme heat days. Extreme cold days are projected to decrease in number. By 2030, the summer mean temperature could increase by 3.6°F from the historical period (1950-2013). By 2070, there could be 58 fewer days below freezing, which could lead to an increase in ticks. By mid-century, the State anticipates about 25 more days per year where the temperature exceeds 90°F for inland areas, and about 19 more days above 90°F for coastal areas (Commonwealth of Massachusetts, 2022).

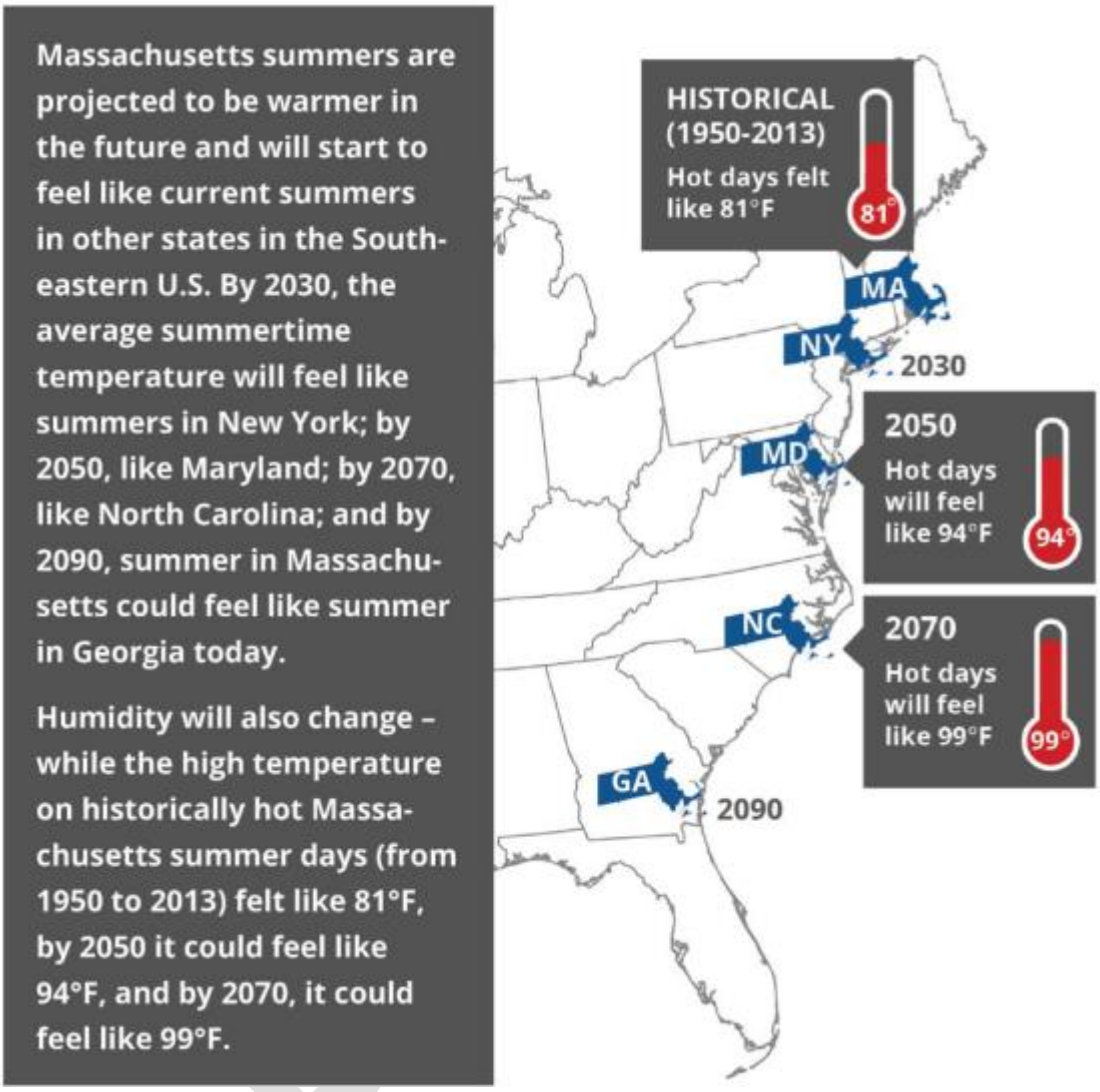
Figure 8: Change in the Annual Number of Days Over 90°F Compared to Today



Sources: 2022 MA Climate Change Assessment and Stochastic Weather Generator

These changes could result in Massachusetts summers feeling like a more southern state, as described in the infographic below from the State's 2022 Climate Change Assessment.

Figure 9: Change in Average Summertime Temperatures for Massachusetts

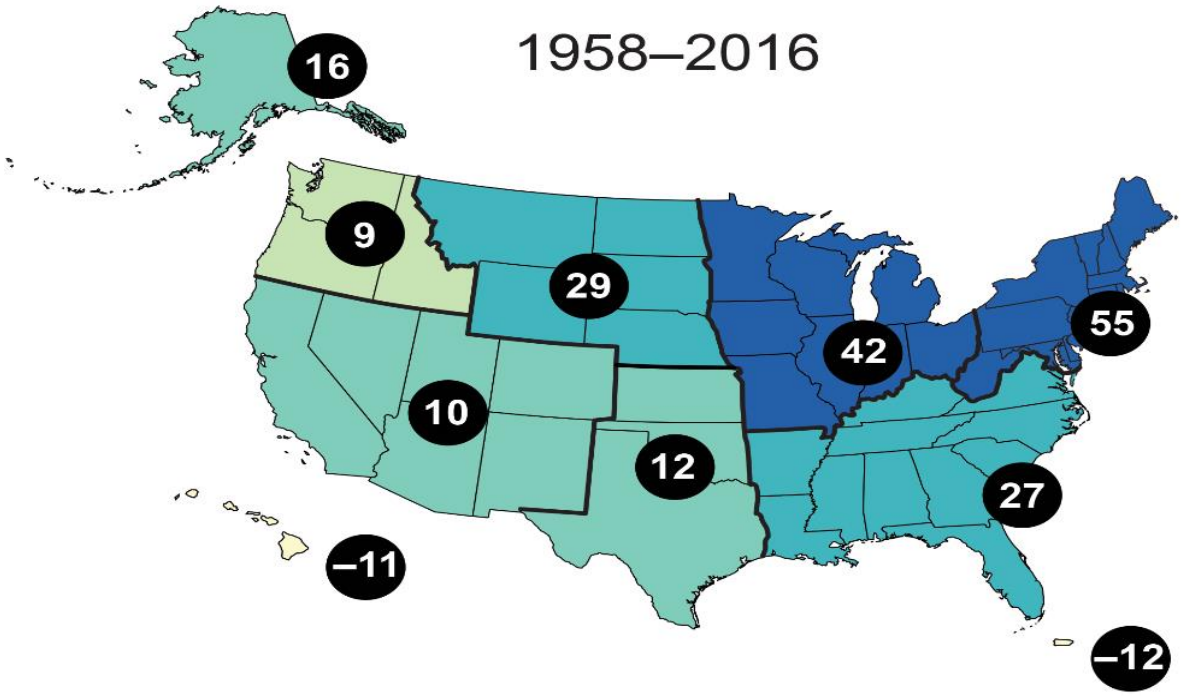


Source: 2022 MA Climate Change Assessment

PRECIPITATION PATTERNS

Annual precipitation in Massachusetts has increased by approximately 10% in the fifty-year period from 1960 to 2010 (MA EEA, 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 (US Global Change Research Program, 2018). Changes in precipitation are fueled by warming temperatures which increase evaporation and, therefore, the amount of water vapor in the air. See the figure below for more information.

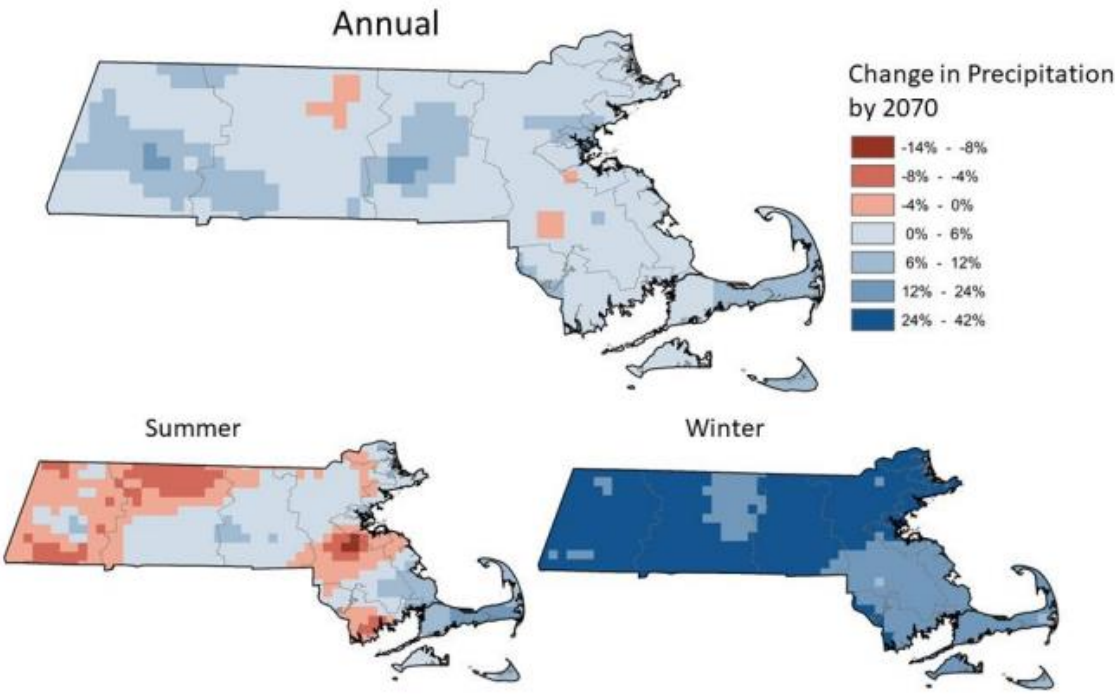
Figure 10: Observed Change in Total Annual Precipitation in the Heaviest 1% Events



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

Massachusetts' 2022 Climate Change Assessment anticipates that most parts of the State will see a future increase in annual total precipitation of less than 8% per year. Most of these increases are anticipated during the winter months. Additionally, the historic 10% annual chance daily
rainfall event (2.8-4.0" of rain) could occur four times more frequently by 2090 (Commonwealth of Massachusetts, 2022).

Figure 11: Change in Annual and Seasonal Precipitation in 2070 Compared to Today



Source: 2022 MA Climate Change Assessment. Current climate is the 1986-2005 era, the projection for 2070 is for a 20-year era centered on 2070. Maps show LOCA downscaled GCM projections at the 50th percentile across 20 LOCA GCMs that overlap with the GCMs used in the Stochastic Weather Generator.

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, a result of earlier snow melt, and higher temperatures that will reduce soil moisture. Massachusetts' 2022 Climate Change Assessment anticipates that these changes will vary by region. The Eastern Inland region where Norfolk is located may experience slightly more consecutive dry days, and significantly more days without rain per year, by 2090 (Commonwealth of Massachusetts, 2022). See the Figure below for more information.

Figure 12: Consecutive dry day events (number of multiple-dry-day events per year)

Panel A: Consecutive dry day events (number of multiple-dry-day events per year)

Region	Baseline	2030	2050	2070	2090
Berkshires & Hilltowns	29	29	30	30	31
Greater Connecticut River Valley	31	31	32	32	33
Central	32	32	32	33	33
Eastern Inland	32	32	32	33	33
Boston Harbor	31	31	32	32	33
North & South Shores	31	31	32	32	33
Cape, Islands, & South Coast	31	31	32	32	33
Statewide	**31**	**31**	**31**	**32**	**33**
Statewide Percent Change	**0%**	**1%**	**2%**	**4%**	**6%**

Source: Stochastic Weather Generator

Panel B: Annual number of days without rain (days per year)

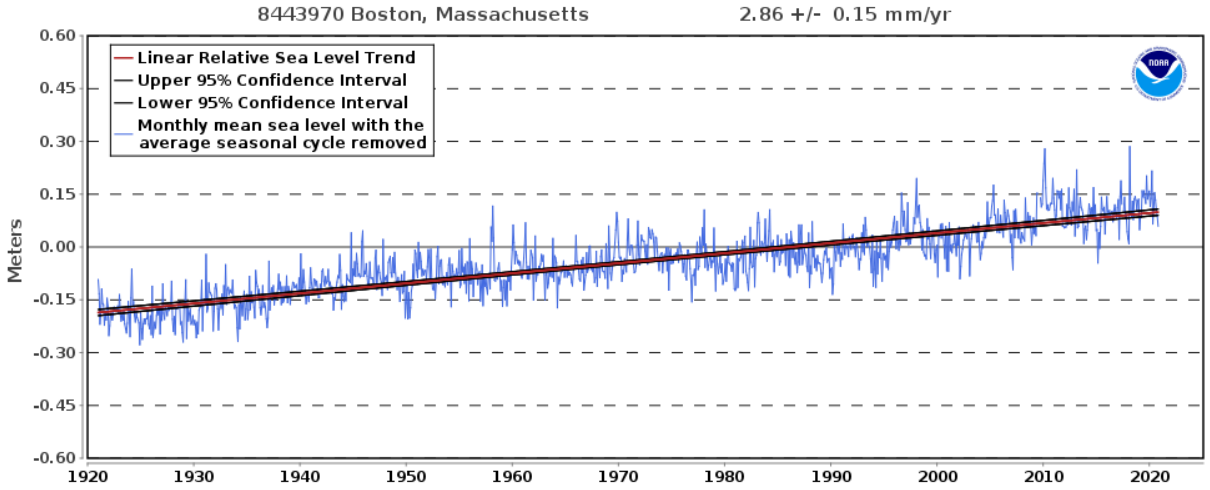
Region	Baseline	2030	2050	2070	2090
Berkshires & Hilltowns	159	161	165	167	170
Greater Connecticut River Valley	171	172	175	178	181
Central	180	182	185	188	192
Eastern Inland	186	181	185	188	193
Boston Harbor	192	185	192	194	198
North & South Shores	184	182	187	190	195
Cape, Islands, & South Coast	186	182	187	191	194
Statewide	**176**	**175**	**179**	**182**	**187**
Statewide Percent Change	**0%**	**-1%**	**2%**	**3%**	**6%**

Source: 2022 MA Climate Change Assessment. The Town of Norfolk is located in the Eastern Inland Region, outlined by the blue box above.

SEA LEVEL RISE

While Norfolk is not a coastal community, high-level information on sea level rise is discussed here as the regional economy of the Boston Metro area may be impacted by sea level rise in the future. Warming temperatures contribute to sea level rise in three ways. First, warm water expands to take up more space. Second, rising temperatures are melting land-based ice which enters the oceans as melt water. A third, quite minor, contributor to sea level rise in New England is not related to climate change. New England is still experiencing a small amount of land subsidence (drop in elevation) in response to the last glacial period. NOAA's records from the Boston Tide Station show nearly one foot of sea level rise over the past century. See the figure below for more information.

Figure 13: Observed Increase in Sea Level Rise



Source: NOAA

The sea level rise information in Massachusetts' 2022 Climate Change Assessment considers sea-level changes, land-level changes, and other regional facts that can impact the rate of change. The report includes the following approximate sea level rise projections for the State:

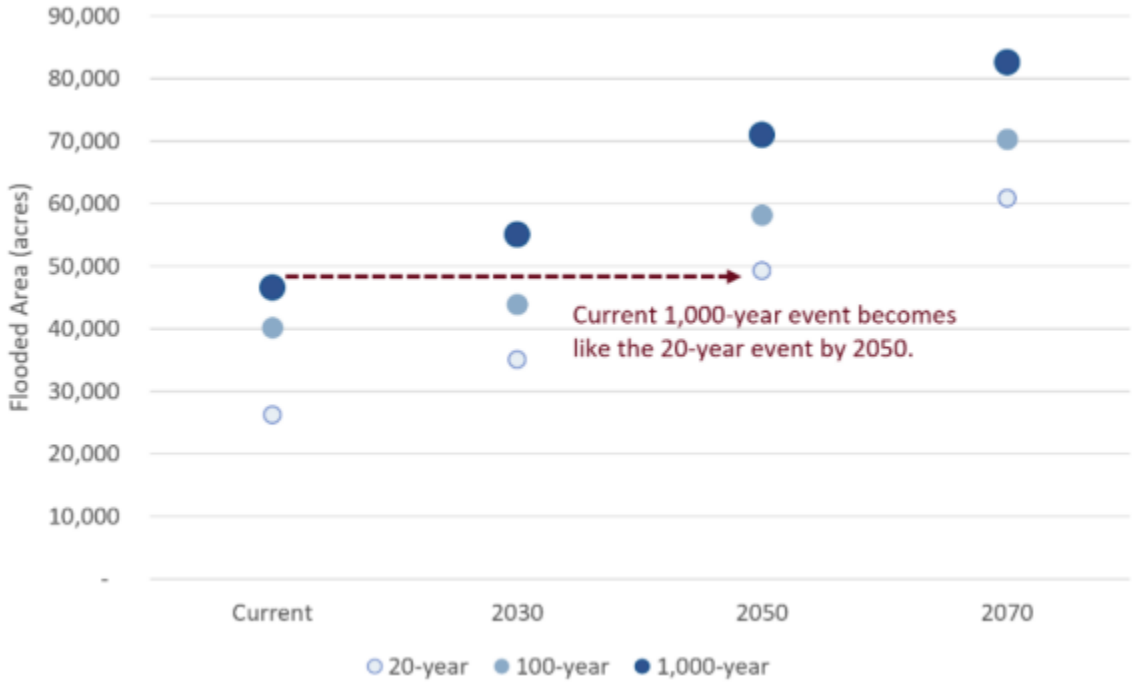
- **Northern Massachusetts:** 21 inches by 2050, and 43 inches by 2070
- **Southern Massachusetts:** 23 inches by 2050 and 45 inches by 2070

The 2022 Climate Change Assessment also quantified the developed land area flooded for events including:

- the 20-year (5% annual probability)
- 100-year (1% probability)
- 1000-year (0.1% probability) events

This approach found that the area flooded by the current 1000-year event is comparable to the area of a 20-year event by 2050. Even more area could be impacted by the annual probability event by 2070. See the figure below for more information.

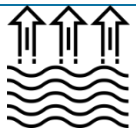
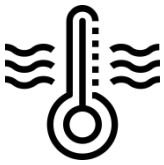
Figure 14: Total Flooded Area of the Commonwealth for Selected Events



Source: 2022 MA Climate Change Assessment

Following the outline of the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP), this local hazard mitigation plan organizes consideration of natural hazards based on their relationship to projected climate changes. The table below, which is originally from the SHMCAP, summarizes the natural hazards reviewed in this plan, climate interactions, and expected impacts.

Table 6: Climate Change & 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, increased potential for loss of life, 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 of wetlands
	Coastal Erosion	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, increase in vector-borne illnesses (West Nile, Zika, EEE), ecosystem stress, energy brownouts from higher energy demands, more intense heat waves, public health impacts from high heat exposure and poor outdoor air quality, increased potential for loss of life, 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		
	Tornadoes		
	Other Severe Weather (Strong Wind & Thunderstorms)		

OVERVIEW OF HAZARDS AND IMPACTS

The 2018 SHMCAP and the 2013 Massachusetts State Hazard Mitigation Plan are two key planning documents that examine natural hazards that have the potential to impact the Commonwealth. The 2013 State HMP set the stage by defining considerations such as frequency and severity and summarizing the frequency and severity of hazards of greatest concern. The 2018 SHMCAP used similar definitions for hazard considerations and expanded on this research by including additional climate projections. Because the 2013 State HMP includes definitions that were not specified in the 2018 SHMCAP, both resources are referred to in this report.

Frequency: The frequency designations used for Norfolk were based on research, Town and stakeholder input, and the 2013 State HMP definitions; which define frequency categories as:

- **Very low:** Events that occur less frequently than once in 100 years (less than 1% per year).
- **Low:** Events that occur from once in 50 years to once in 100 years (1%-2% per year).
- **Medium:** Events that occur from once in five years, to once in 50 years (2%-20% per year).
- **High:** Events that occur more frequently than once in five years (Greater than 20% per year)

Severity: The 2018 SHMCAP defines severity as, "the extent or magnitude of a hazard, as measured against an established indicator (e.g., Richter Scale, Saffir-Simpson Hurricane Scale, or Regional Snowfall Index)." The severity designations used for Norfolk were based on research, Town and stakeholder input, and the 2013 State HMP definitions, which define severity categories as:

- **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

The table below summarizes the frequency and severity of hazard risks for Massachusetts and Norfolk, based on available data, including:

- **State-level data** including the 2022 Climate Change Assessment, 2018 SHMCAP, and 2013 State HMP)
- **County-level data** from NOAA's National Climatic Data Center and Storm Events Database for Norfolk County (where Norfolk is located)
- **Local-level information** including input from the Local Team, the hazard mapping included in Appendix A, and the Hazus results included in Appendix B.

Table 7: Hazards Risk Summary

Natural Hazard	Frequency		Severity	
	MA	Norfolk	MA	Norfolk
Inland Flooding	High	High	Serious to Catastrophic	Serious
Drought	Medium	Medium	Minor to Serious	Minor to Serious
Landslide	High	Very Low	Minor to Extensive	Minor
Coastal Flooding	High	N/A	Serious to Extensive	N/A
Coastal Erosion	Variable	N/A	Serious to Extensive	N/A
Tsunami	Very Low	N/A	Extensive to Catastrophic	N/A
Extreme Temperatures	High	High	Minor to Serious	Minor
Wildfires/Brushfire	High	High	Minor to Extensive	Minor to Serious
Invasive Species	High	High	Minor	Minor
Hurricanes/Tropical Storms	Medium	Medium	Serious to Catastrophic	Minor to Serious
Severe Winter Storm / Nor'easter	High	High	Minor to Extensive	Minor
Tornadoes	High	Very Low	Serious to Extensive	Serious
Other Severe Weather (Strong Wind & Thunderstorms)	High	High	Minor to Extensive	Minor
Earthquakes	Very Low	Very Low	Serious to Catastrophic	Serious to Catastrophic

Sources: Frequency information for MA comes from the 2018 SHMCAP. Severity information for MA comes from the 2013 State HMP. Frequency and severity information for Norfolk come from NOAA's county-level data, local information from the Local Team, hazard mapping and Hazus results.

Not all hazards included in the 2022 Climate Change Assessment, 2018 SHMCAP, or 2013 State HMP apply to the Town. Given Norfolk's inland location, coastal hazards and tsunamis are unlikely to affect the Town and are therefore listed as Not Applicable ("N/A") in the table above. Ice jams are also not a hazard in Norfolk. The US Army Corps Ice Jam Database shows no record of ice jams in Norfolk, and the Town did not identify ice jams as an issue of concern.

CHANGES IN PRECIPITATION

FLOODING

Flooding is generally caused by severe rainstorms, thunderstorms, hurricanes, and nor'easters. Large rainstorms can occur year-round. Hurricanes are most common in the summer and early fall. Nor'easters are most common in winter. Spring snowmelt may exacerbate flooding during storm events. Large rainstorms can occur year-round. Climate change has the potential 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 caused by high seasonal groundwater levels.

Flooding is one of the most prevalent natural hazards in Norfolk. Flooding can be associated with overflowing rivers and streams, as well as stormwater associated with impervious surfaces which overwhelms the capacity of natural or structured drainage systems and stormwater infrastructure.

Norfolk is located in the Charles River Watershed. The Charles River divides the towns of Norfolk, Millis, and Medfield. Norfolk is home to several streams that flow into the Charles River, including Stop River, Mill River, Stony Brook and Cress Brook (PGC Associates, Inc., 2017).

Regionally Significant Floods

There have been a number of major floods that have affected the Metro Boston region over the last fifty years. Significant historic flood events have included those listed below (Commonwealth of Massachusetts, 2018) and (NOAA, 2022).

- The Blizzard of 1978
- January 1979
- April 1987
- October 1991 ("The Perfect Storm")
- October 1996
- June 1998
- March 2001
- April 2004
- May 2006
- April 2007
- March 2010
- February 2013
- January 2018
- March 2018
- June 2020

The best available data on previous occurrences of flooding is available through NOAA's National Centers for Environmental Information Storm Events Database. Norfolk County,

which includes the Town of Norfolk, experienced 33 flood events from December 2012 to December 2022. No deaths or injuries were reported and the total reported property damage in the county was $68,200. See the table below for more information.

Table 8: Norfolk County Flood Events, 2012-2022

DATE	DEATHS	INJURIES	PROPERTY DAMAGE ($)
6/7/2013	0	0	0
7/29/2013	0	0	0
8/9/2013	0	0	15000
10/22/2014	0	0	0
10/23/2014	0	0	0
8/15/2015	0	0	0
8/18/2015	0	0	0
6/7/2016	0	0	5000
8/14/2016	0	0	5000
4/1/2017	0	0	5000
7/12/2017	0	0	0
7/18/2017	0	0	1000
8/2/2017	0	0	0
9/30/2017	0	0	10000
10/25/2017	0	0	0
10/29/2017	0	0	0
1/12/2018	0	0	0
1/13/2018	0	0	0
4/16/2018	0	0	0
7/6/2018	0	0	10000
10/29/2018	0	0	0
11/3/2018	0	0	500
4/15/2019	0	0	0
7/6/2019	0	0	0
7/17/2019	0	0	0
6/21/2020	0	0	0
6/28/2020	0	0	14700
8/23/2020	0	0	2000
12/25/2020	0	0	0
7/7/2021	0	0	0
7/18/2021	0	0	0
9/5/2022	0	0	0
10/14/2022	0	0	0
TOTAL	**0**	**0**	**68200**

Source: NOAA, National Centers for Environmental Information, Storm Events Database

Additionally, Norfolk County experienced 3 flash flood events from December 2012 to December 2022. No deaths or injuries were reported and the total reported property damage in the county exceeded $30 million. Most of the reported property damage occurred during the flash flood event on June 28, 2020. See the table below for more information.

Table 9: Norfolk County Flash Flood Events, 2012-2022

DATE	DEATHS	INJURIES	PROPERTY DAMAGE ($)
9/1/2013	0	0	85000
9/18/2018	0	0	0
6/28/2020	0	0	30000000
TOTAL	**0**	**0**	**30085000**

Although not included in the tables above showing flood events over the last ten years, the March 2010 flood event also had a significant impact in Norfolk. See Appendix A for a map showing flood insurance claims in Norfolk resulting from the March 2010 flood. See Appendix B for Hazus estimates for damages resulting from a 100-year and 500-year flood.

Locally Identified Flood Hazard Areas

Information on potential flood hazard areas was taken from two sources. The first was the National Flood Insurance Rate Maps (FIRM). The FIRM flood zones are shown on maps in Appendix A and their definitions are listed below. The FIRM maps currently in effect for Norfolk were adopted in 2012.

It should also be noted that the Town will be impacted by the Charles Watershed RiskMAP mapping update for Norfolk, Plymouth and Suffolk Counties. This process is expected to result in a Letter of Final Determination (LFD) from FEMA by late December 2023 or January 2024. The Town will need to adopt an updated floodplain bylaw to reflect the new mapping before the updated Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS) will become effective in June or July 2024. The State model floodplain ordinance is available to assist municipalities with making these updates. Municipalities can also go above and beyond the State's minimum requirements by including additional language. This additional language can be related to strengthening floodplain overlay district requirements, stormwater regulations, site plan review, and more.

Flood Insurance Rate Map Zone Definitions

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

Zone AE (1% annual chance) **-** Zone AE is the flood insurance rate zones that correspond to the 100-year floodplains that are determined in the FIS by detailed methods. In most

instances, BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.

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

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

Table 10: Locally Identified Areas of Flooding in Norfolk

Map ID	Name	Description
3	City Mills Pond Dam	There are two culvert structures along with bridge at this location that are in poor condition and are currently being looked at for replacement. PARE engineering is working with the Town on a redesign of the bridge and realignment of the culverts. A State Earmark grant for $200,000 is being used and the work is in the 25% design phase.
8	River Road	Residential homes on the northern side of River Road, near the Charles River, are of most concern. These homes do experience flooding. The roadway is elevated through this area so it does not flood.
12	Seekonk Street	Seekonk Street is a main throughway with a wetland to the east and west. During a storm, water goes across the road and can become dangerous if a car is moving quickly through. There have also been issues with beavers damming up wetland upstream. The Town acquired funding to complete engineering and design work to replace the culverts and update the water main. The Town is now seeking funding for the construction phase of work. This area is considered a high concern for the Town and the project is a high priority for the Charles River Watershed Association, based on the results of their recent regional flood modeling work.
15	Bridge and culvert on Walpole Town Line	The bridge and box culvert at this location are old and in poor condition, as described in a recent MassDOT report. This is a high concern for the Town. Flooding has overtopped the roadway in the past.
20	Priscilla Avenue	Stormwater flooding occurs in this location. There is a steep grade and the two catch basins are not functional. Additionally, after Priscilla Avenue was

Map ID	Name	Description
		repaved, some valleys in roadway remained where water now ponds. DPW is considering this location for a drainage roadway improvement project in the near future.

Additionally, the Local Team identified one hazard area related to wind. See the subsequent "Extreme Weather" report section for more information.

Repetitive Loss Structures

As defined by the National Flood Insurance Program (NFIP), a repetitive loss property is any property which the NFIP has paid two or more flood claims of $1,000 or more in any given 10-year period since 1978 (FEMA, 2020). There are 5 repetitive flood loss properties in Norfolk and all were single family homes. More information is included in the table below (Zukowski, 2022).

Repetitive Loss Properties	*5*
Total Losses	14
Total Building Payments	$68,681.79
Total Contents Payments	$3,402.95
Single Family	*5*

There was also a severe repetitive loss in Norfolk, although no additional detail was available from MEMA.

Flooding and Climate Change

Data from the 2022 MA Climate Change Assessment related to changes in precipitation patterns is included in an earlier section of this chapter. Those projections suggest that future rain events will be increasingly intense and lengthy, which could lead to increased inland and stormwater flooding.

Precipitation frequency estimates, which are used to derive stormwater design standards, were published in 1961 by the U.S. Commerce Department in a document known as TP-40 (Technical Paper 40). The 10-year, 24-hour storm for eastern Massachusetts was calculated as a 4.5-inch event. Recently the National Oceanic and Atmospheric Administration published updated estimates (NOAA Atlas 14), which increased this design storm by 0.6 inches to 5.14 inches for eastern Massachusetts. Communities should consider future rainfall rates when designing infrastructure. For example, Norfolk could consider using NOAA Atlas 14 rainfall rates with an additional allowance to account for projected rainfall during the life of projects permitted today when sizing stormwater infrastructure. DEP takes a similar approach to describe current (not future) rainfall rates, called "NOAA14+". Mystic River Watershed Association (MyRWA) communities propose "NOAA14++", which they say reflects 2070 projections. The NOAA 14+ number is calculated by multiplying the NOAA 14 precipitation frequency estimate upper confidence interval by 0.9 (i.e., current but extreme precipitation events reflect 90% of upper confidence intervals). The NOAA 14++ number is the upper confidence interval. A

comparison of these numbers for the Town of Norfolk is summarized in the table below (NOAA, 2023).

Table 11: Rainfall rates for the 10-year 24-hour storm for the Town of Norfolk

NOAA 14	NOAA 14+	NOAA 14++
5.27 inches	5.90 inches	6.56 inches

The 2022 MA Climate Change Assessment also highlights the following climate impacts for the Eastern Inland Region (where Norfolk is located), related to flooding:

- By 2050, the 1 percent annual chance river flood could be two times more likely to occur
- By 2090, the historical 10 percent annual chance daily rainfall event (2.8 to 4 inches) could occur four times more frequently
- Damage could occur to inland buildings from heavy rainfall and overwhelmed drainage systems
- Damage could occur to transit service due to flooding
- There could be a reduction in the availability of affordably priced housing from direct damage including from flooding (Commonwealth of Massachusetts, 2022)

DROUGHT

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

In Massachusetts, droughts are caused by the prevalence of dry northern continental air and a decrease in coastal- and tropical-cyclone activity. Average annual precipitation in Massachusetts is 44 inches per year, with approximately 3 to 4 inch average amounts for each month of the year. In the driest calendar year (1965), the statewide precipitation total of 30 inches was 68 percent of the average.

Although Massachusetts is relatively small, it has a number of distinct regions that experience significantly different weather patterns and react differently to the amounts of precipitation they receive. The 2019 Massachusetts Drought Management Plan divides the state into seven regions: Western, Central, Connecticut River Valley, Northeast, Southeast, Cape Cod, and Islands. Norfolk is located in the Southeast Region, and drought is considered a potential town-wide hazard.

The 2019 Massachusetts Drought Management Plan establishes one normal condition and four drought severity levels, including:

- Level 0-Normal (i.e., No Drought)
- Level 1-Mild Drought (formerly Advisory)
- Level 2-Significant Drought (formerly Watch)
- Level 3-Critical Drought (formerly Warning)

- Level 4-Emergency Drought (formerly Emergency)

These levels are based on conditions of natural resources and provide information on the current status of water resources. The levels provide a framework from which to take actions to assess, communicate, and respond to drought conditions. Drought levels are also used to coordinate both state agency and local response to drought situations. Water restrictions might be appropriate at the significant drought stage, depending on the capacity of each individual water supply system. A critical drought level indicates a severe situation and the possibility that a drought emergency may be necessary. A drought emergency is one in which mandatory water restrictions or use of emergency supplies is necessary.

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

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

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

Previous Occurrences

Because drought is considered a regional natural hazard, the best available date on previous drought occurrences is county-level and state-wide, including NOAA's National Centers for Environmental Information Storm Events Database. Norfolk County, which includes the Town of Norfolk, experienced 9 drought events from 2012 –2022. No deaths, injuries, or property damage were reported (NOAA, 2022). The drought dates included:

- 7/26/2016
- 8/1/2016
- 8/2/2016

- 8/23/2016
- 9/1/2016
- 10/1/2016
- 11/1/2016
- 12/1/2016
- 1/1/2017

EEA's Drought Management Task Force also provides information on historic drought status for the Southeast region in Massachusetts, where Norfolk is located. That information is summarized in the table below.

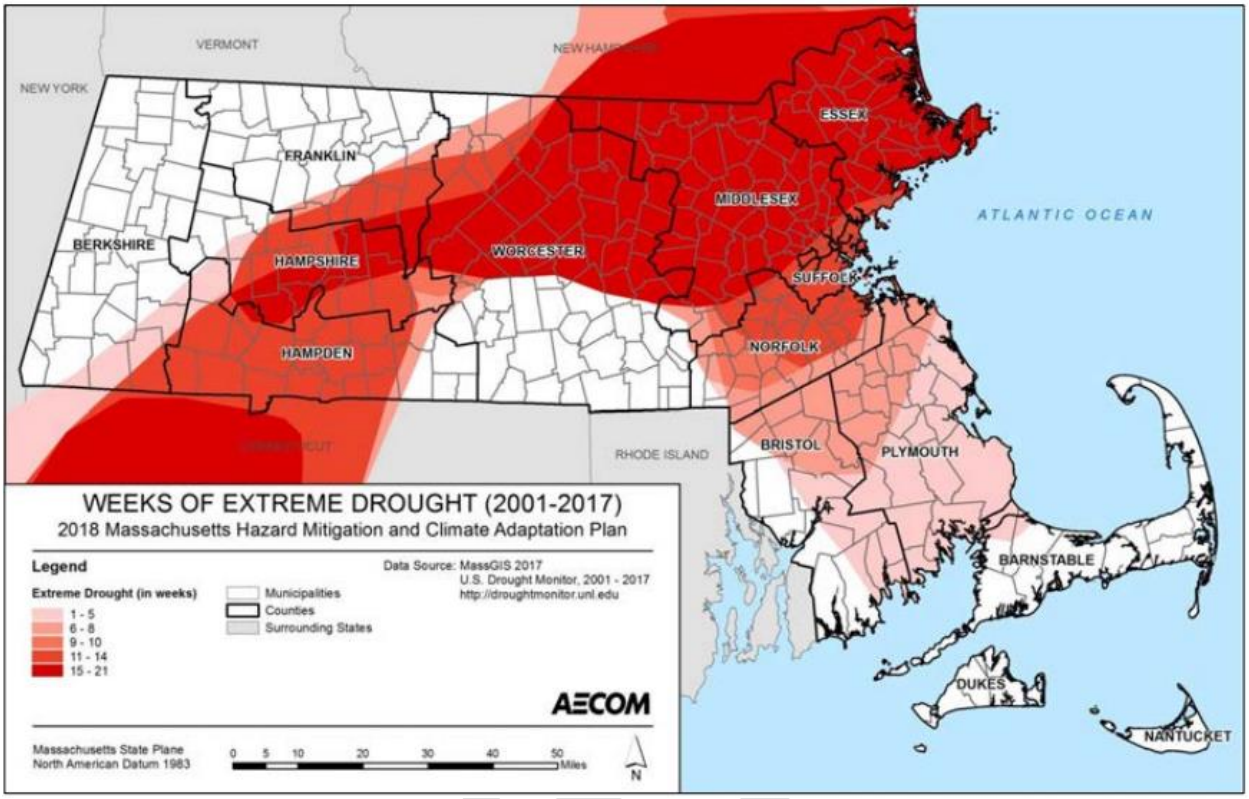
Table 12: Drought Status History for the Southeast Region, 2001-2023

Mild Drought/Advisory	2001, 2002, 2007, 2014, 2016, 2017, 2020, 2021, 2022
Significant Drought/Watch	2002, 2016, 2017, 2020, 2021, 2022
Critical Drought/Warning	2016, 2017, 2020, 2022
Emergency Drought/Emergency	None

(Drought Management Task Force, 2023)

Another measure of drought is the U.S. Drought Monitor, which characterizes droughts as abnormally dry, moderate, severe, extreme, and exceptional. Extreme drought is characterized by likely crop and pasture losses, water shortages, and water restrictions (US Drought Monitor, 2023). As shown in the map below, Norfolk county experienced severe drought between 2001 and 2017.

Figure 15: Weeks of Extreme Drought, 2001-2017



Source: 2018 SHMCAP, 2017 US Drought Monitor data

In just the last five years there have been three droughts in Massachusetts. The drought of 2016 was the worst one since 1985, with more than half of the state reaching the Extreme Drought stage for several months (Figure 13). This was followed by another drought four years later in 2020, which was most severe in Southeastern Massachusetts, including Norfolk County. Finally, in the early spring of 2021 a third, milder, drought was declared. By the summer of 2021 conditions in the northeast region improved.

Potential Drought Vulnerability

The town's vulnerability to drought could include impacts on public and private water supplies, agriculture, aquatic ecology, wildlife, and fire hazard. Norfolk shares major aquifers with Franklin, Medway, Millis and Wrentham. The Town's Water Division serves 7,600 residents of Norfolk via 2,605 service connections using its two active well sites and two water storage tanks. The peak daily demand typically occurs during June (Town of Norfolk, Environmental Partners, 2021). Many residents rely on individual private wells (PGC Associates, Inc., 2017). More information on municipal water infrastructure is included in the "Critical Infrastructure in Hazard Areas" section.

Prolonged drought could lower water tables and reduce the amount of water available from pumping wells. Lowering the water table could also result in reductions in water quality. A severe drought could also increase the risk of wildfire on forested lands and other vegetated areas, which are a dominant feature of Norfolk.

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. See the table below for more information.

Table 13: 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: 2018 SHMCAP

Droughts And Climate Change

Droughts are projected to increase in frequency and intensity in the summer and fall as weather patterns change. Factors contributing to this include increasing evaporation as a result of warmer weather, earlier snow melt, and more extreme weather patterns. Information from the 2022 Massachusetts Climate Change Assessment related to drought is included in the "Climate Change Observations and Projections" section of this report. Additionally, the 2022 Assessment highlights the following drought-related impacts to the Eastern Inland region where Norfolk is located:

- Freshwater ecosystem degradation due to drought and other impacts
- Increased contaminant concentrations in freshwater during drought conditions
- Loss of tree cover due to drought and other impacts

LANDSLIDES

According to the US Geological Survey (USGS), "The term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors" (USGS, 2023). Among the contributing factors are erosion by rivers or ocean waves over steepened slopes; rock and soil slopes weakened through saturation by snowmelt or heavy rains; earthquakes create stresses that make weak slopes fail; and excess weight from accumulation of rain or snow, and stockpiling of rock or ore, from waste piles, or from man-made structures.

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

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.

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

Table 14: Landslide Volume and Velocity

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

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

The SHMCAP utilized data from the MA Department of Transportation from 1986 to 2006 to estimates that, on average, roughly one to three known landslides have occurred each year in the state. 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.

Norfolk is classified as having a low risk for landslides (See Map 4 in Appendix A). Although potentially a town-wide hazard, there are no documented previous occurrences of landslides in Norfolk. 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 Norfolk.

Climate Change and Landslides

Changes in precipitation may increase the chance of landslides, as extreme rain events could result in more frequent saturated soils which are conducive to landslides. Drought may also increase the likelihood of landslides if loss of vegetation decreases soil stability.

DAMS AND DAM FAILURE

Dam failure can occur as a result of structural failure, independent of a hazard event, or as the result of the impacts of a hazard event such as flooding associated with storms or

an earthquake. In the event of a dam failure, the energy of the water stored behind even a small dam can cause loss of life and property damage if there are people or buildings downstream. The number of fatalities from a dam failure depends on the amount of warning provided to the population and the number of people in the area in the path of the dam's floodwaters.

Dam failure is a highly infrequent occurrence. According to the Office of Dam Safety, three dams have failed in Massachusetts since 1984, one of which resulted in a death. There have been no recorded dam breaches in Norfolk.

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 2018 SHMCAP indicates that changing precipitation patterns may increase the likelihood of overflow event.

According to data provided by the Massachusetts Department of Conservation and Recreation (DCR) Office of Dam Safety and the Town, there are 8 dams in Norfolk with various hazard classifications. More information is summarized in the table below.

Table 15: DCR Inventory of Dams in Norfolk

Dam Name	River	Impoundment	Owner	Hazard Potential Classification
Bristol Blake State Reservoir Dam	Stony Brook	Stony Brook Pond	DCR - Dept. of Conservation & Recreation	Significant
Highland Lake Dam	Stop River	Highland Lake	Kevin Roche, private owner	Low
City Mills Pond Dam	Mill River	City Mills Pond	Town of Norfolk, Department of Public Works	Significant
Bush Pond #2 Dam	Eagle Brook	Bush Pond	Unknown private owner.	Low
Mirror Lake Dam	Tributary of Stony Brook	Mirror Lake	Town of Norfolk, Select Board	Significant
Sharp's Pond Dam		Sharp's Pond	Private owner. Information not available for unregulated small dams	N/A
Mirror Lake Dike	Tributary of Stony Brook	Mirror Lake	Town of Norfolk, Select Board	Significant
Industries Drive Dam	Stony Brook		Private owner. Information not available for unregulated small dams	N/A

(Office of Dam Safety, 2018)

DCR defines dam hazard classifications as follows:

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

The Town frequently inspects its dams and dikes, and submits reports to the DCR Office of Dam Safety as required.

RISING TEMPERATURES

EXTREME TEMPERATURES

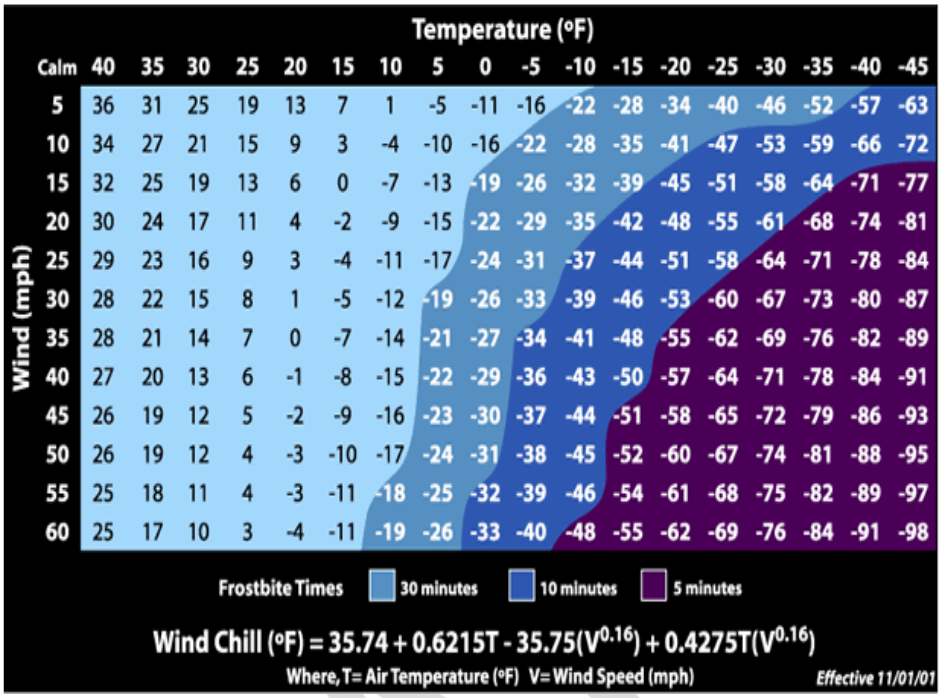
Extreme temperatures occur when either high temperature or low temperatures relative to average local temperatures occur. These can occur for brief periods of time and be acute, or they can occur over long periods of time where there is prolonged period of excessively hot or cold weather.

Like the rest of New England, Norfolk has four well-defined seasons. The seasons have several defining factors, with temperature one of the most significant. Extreme temperatures can be defined as those, which are far outside of the normal seasonal ranges for Massachusetts.

Extreme Cold

Extreme cold is relative to the normal climatic lows in a region. Temperatures that drop decidedly below normal and wind speeds that increase can cause harmful wind-chill factors. The severity of extreme cold temperature is typically measured using 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 the figure below. A Wind Chill warning is issued when the Wind Chill Index is forecast to fall below -25 degrees F for at least 3 hours.

Figure 16: Wind Chill Temperature Index and Frostbite Risk



Source: National Weather Service

Extreme cold is a dangerous situation that can result in health emergencies for susceptible people, such as those without shelter or who are stranded or who live in homes that are poorly insulated or without heat. The greatest vulnerability to the town would be a power outage during a winter storm, which could temporarily leave many residents without heat. In Norfolk, 11.3% of residents are 65 years old and over, and 1.5% are living in poverty (US Census Bureau, 2021).

The Town does not collect data for previous occurrences of extreme cold. The best available data on extreme cold is recorded for Norfolk County, where Norfolk is located, by NOAA's National Centers for Environmental Information (NCEI) Storm Events Database. There are four extreme cold and wind chill events on record from December 2012 to December 2022, which caused zero deaths, injuries or property damage. See the table below for more information. Extreme cold is considered a town-wide hazard for Norfolk.

Table 16: Norfolk County Extreme Cold and Wind Chill, 2012-2022

Date	Deaths	Injuries	Damages
2/16/2015	0	0	0
2/13/2016	0	0	0
2/14/2016	0	0	0
1/6/2018	0	0	0

Source: NOAA, Centers For Environmental Information, Storm Events Database

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 18) 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 17: Heat Index Chart

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

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

Source: National Weather Service

The Town does not collect data for previous occurrences of extreme heat. The best available data on extreme heat is recorded for Norfolk County, where Norfolk is located, by NOAA's National Centers for Environmental Information (NCEI) Storm Events Database. There have been three days of excessive heat recorded from December 2012-December 2022, which caused zero deaths, injuries or property damage. See the table below for more information. Extreme heat is considered a town-wide hazard for Norfolk.

Table 17: Norfolk County Excessive Heat, 2012-2022

Date	Deaths	Injuries	Damages
7/1/2018	0	0	0
7/3/2018	0	0	0
8/28/2018	0	0	0

Source: NOAA, Centers for Environmental Information, Storm Events Database

Heat waves and lower air quality can threaten the health of vulnerable populations, including the very young, the elderly, and people with certain medical conditions. In Norfolk, about 11% of residents are 65 years old and over, and about 24% are under

age 18. The Massachusetts Department of Public Health Bureau of Environmental Health does not have any records of heat stress emergency department visits in Norfolk (MA Dept of Public Health, 2022). However, even healthy individuals can succumb to heat if they participate in strenuous physical activities during hot weather. People who work outdoors, such as construction, farming, and landscaping can be at higher risk of exposure to extreme heat combined with physical activity. 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.

Extreme Temperatures and Climate Change

Data from the 2022 MA Climate Change Assessment related to changes in temperature is included in an earlier section of this chapter. Those projections predict an increase in average temperature and in the number of extreme heat days. The 2022 Assessment also highlights the following climate impacts for the Eastern Inland Region (where Norfolk is located), related to temperatures:

- Warmer temperatures and more frequent heat waves are connected to impaired human health, increased droughts, reduced agriculture yields, species range shifts, and damaged infrastructure.
- By 2030, the summer mean temperature could increase by 3.6°F from the historical period (1950-2013), worsening stress on electric transmission and utility distribution infrastructure.
- By 2070, there could be 58 fewer days below freezing, increasing the chance of ticks overwintering and reducing winter recreation opportunities.
- Increase in vector borne diseases incidence and bacterial infections, including West Nile Virus and Lyme disease due to more favorable conditions for ticks and mosquitoes.
- Damage to electric transmission and utility distribution infrastructure associated with heat stress
- Damage to rails and loss of rail/ transit service, including flooding and track buckling during high heat events.
- Reduced ability to work, particularly for outdoor workers during extreme heat, as well as commute delays due to damaged infrastructure
- Freshwater ecosystem degradation due to warming waters
- Forest health degradation from warming temperatures and increasing pest occurrence (Commonwealth of Massachusetts, 2022).

WILDFIRE HAZARDS

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 or even more rural areas of Massachusetts. 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. Most 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. The National Wildfire Coordinating Group (NWCG) classifies the severity of wildfires based on their acreage as follows:

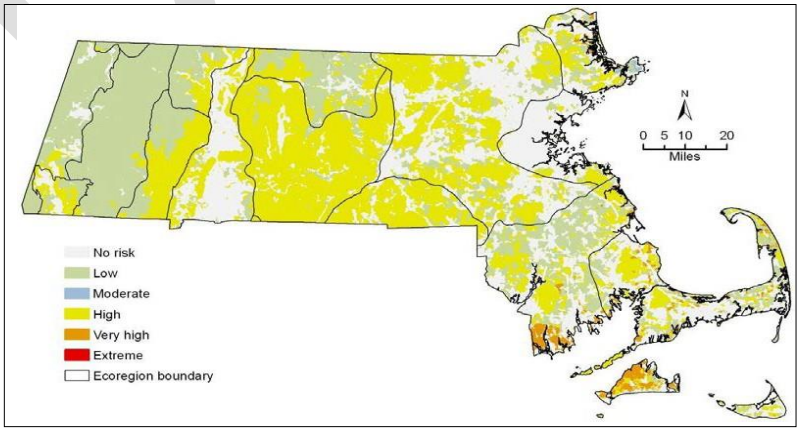
- Class A - one-fourth acre or less;
- Class B - more than one-fourth acre, but less than 10 acres;
- Class C - 10 acres or more, but less than 100 acres;
- Class D - 100 acres or more, but less than 300 acres;
- Class E - 300 acres or more, but less than 1,000 acres;
- Class F - 1,000 acres or more, but less than 5,000 acres;
- Class G - 5,000 acres or more (NWCG, 2023).

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. Fires can present a hazard where there is the potential to spread into developed or inhabited areas, particularly residential areas where sufficient fuel materials might exist to allow the fire 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. The most common cause of wildfires is the careless disposal of smoking materials and untended campfires.

Potential Wildfire Hazard Areas

The 2018 SHMCAP includes a map that depicts statewide fire risk incorporating three risk components: fuel, wildland-urban interface, and topography. See Figure 18 below for more information. The wildland-urban interface reflects communities where housing and vegetation intermingle, and fire can spread from structures to vegetated areas. Norfolk is in the high risk zone.

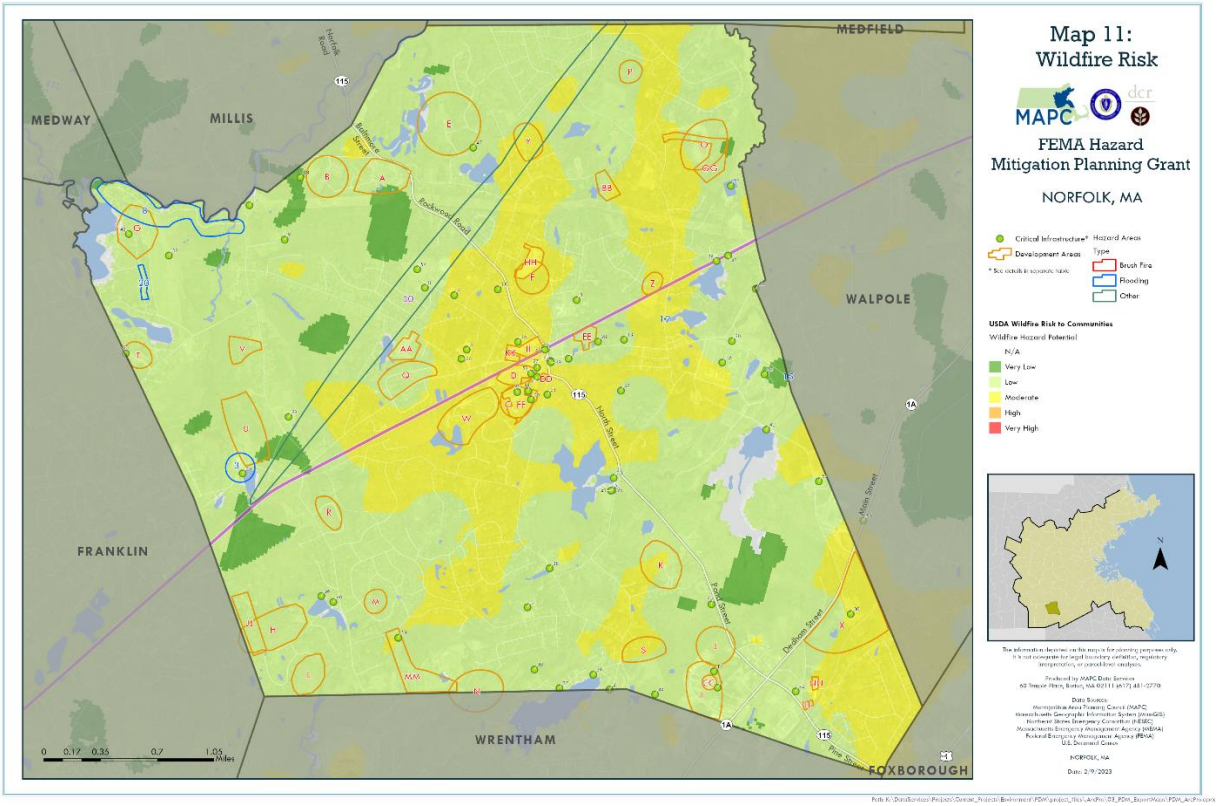
Figure 18: Wildfire Risk Areas in Massachusetts



Source: 2018 SHMCAP

The Wildfire Risk map shown in Figure 19 below and in Appendix A shows a more detailed view using USDA data for wildfire risk to communities. Norfolk is shown to have areas of very low, low, and moderate risk.

Figure 19: Wildfire Risk in Norfolk



Data source: USDA. Mapping by MAPC.

There are no recorded wildfire events for Norfolk County in NOAA's Storm Events Database (NOAA, 2022) and the Local Team considers the entire Town to be equally at risk to fires.

Potential vulnerabilities to wildfires include damage to structures and other improvements and impacts on natural resources such as wildlife habitat. Should a wildfire occur in Norfolk or in other nearby communities, the resulting smoke could have negative impacts on air quality. This could have public health impacts, particularly for those with respiratory conditions such as asthma. The Massachusetts Department of Public Health Bureau of Environmental Health states that Norfolk has a lower pediatric asthma prevalence in K-8 students, and a lower rate of asthma emergency department visits, than the state average (MA Dept of Public Health, 2022).

Wildfire and Climate Change

As the climate warms, drought and warmer temperatures may increase the risk of wildfire as vegetation dries out and becomes more flammable. Increasing drought and increasing damage to trees from pests, can also lead to greater fire risk. The 2022 Assessment cites

anticipated forest health degradation from increasing wildfire frequency for the Eastern Inland Region, where Norfolk is located (Commonwealth of Massachusetts, 2022).

INVASIVE SPECIES

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

According to Norfolk's Open Space and Recreation Plan, invasive insects and plants have damaged and, in some cases replaced, native species (PGC Associates, Inc., 2017). The Local Team cited particular challenges with gypsy moths from 2016-2018, which destroyed many white oaks, the most common tree type in Norfolk. Invasive species are considered a potential Town-wide risk.

Invasive Species and Climate Change

Massachusetts' 2022 Climate Change Assessment also states that climate change will lead to an increase in pests and pathogens that will impact forest health. Rising temperatures increase the warm seasons when invasive species thrive. The 2022 Assessment cites anticipated forest health degradation from increasing pest occurrence for the Eastern Inland Region, where Norfolk is located (Commonwealth of Massachusetts, 2022).

EXTREME WEATHER

Extreme weather includes wind-related hazards (such as hurricanes, tropical storms, tornadoes, and thunderstorms) as well as winter weather (such as Nor'easters, blizzards, and ice conditions). As with many communities, falling trees that result in downed power lines and power outages are a challenge in Norfolk. Every road is a "Scenic Roadway", which means that trees are close to the roadway and power lines and tree maintenance requirements also consider Norfolk's rural character. The Town has worked closely with Eversource to implement a vegetation management plan, increase tree budgets, and increase removal of hazardous trees. As a result of that work, power outages have significantly decreased over the last several years. Information on wind related hazards can be found on Map 5 in Appendix A, which indicates that the 100-year wind speed in Norfolk is 110 miles per hour.

HURRICANES AND TROPICAL STORMS

A hurricane is a violent wind and rainstorm with wind speeds over 74 miles per hour. A hurricane is strongest as it travels over the ocean and is particularly destructive to coastal property as the storm hits land. A tropical storm has similar characteristics, but wind speeds are between 34 and 73 miles per hour. Hurricanes are seasonal events that occur between June and November.

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 table below gives an overview of the wind speeds, surges, and range of damage caused by different hurricane categories:

Table 18: Saffir/Simpson Scale for Hurricanes

Scale No.	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

Previous Occurrences

Since 1900, 39 tropical storms have impacted New England (NESEC), and Massachusetts has experienced approximately 32 tropical storms, nine Category 1 hurricanes, five Category 2 hurricanes and one Category 3 hurricane. Hurricanes in Massachusetts since 1938 are shown in the table below.

Table 19: Hurricane Records for Massachusetts 1938 - 2021

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

Source: National Oceanic and Atmospheric Administration

The Town does not collect data for previous occurrences of hurricanes and tropical storms. The best available data is recorded for Norfolk County, where Norfolk is located, by NOAA's National Centers for Environmental Information (NCEI) Storm Events Database. There are zero recorded incidents of hurricanes, and five hurricanes and tropical storms events on record from December 2012 to December 2022, which caused zero deaths, zero injuries, and $45,000 in property damage. See the table below for more information.

Table 20: Norfolk County Hurricanes & Tropical Storms, 2012-2022

Date	Deaths	Injuries	Damages ($)
9/20/2017	0	0	35000
9/21/2017	0	0	3000
9/7/2019	0	0	4500
8/4/2020	0	0	5000
8/22/2021	0	0	500
TOTAL	**0**	**0**	**45000**

Source: NOAA, Centers For Environmental Information, Storm Events Database

As shown on Map 5 in Appendix A, five storms have tracked through Norfolk, including:

- 1869: Category 3 Hurricane
- 1888: Tropical Storm
- 1902: Tropical Depression
- 1915: Tropical Depression
- 2008: Tropical Depression

A hurricane storm track is the line that delineates the path of the eye of a hurricane or tropical storm. However tropical storms and hurricanes have regional impacts, and Norfolk can also experience the impacts of the wind and rain from hurricanes and tropical storms regardless of whether a storm track passes directly through the town.

Falling trees and branches are a significant impact of the high winds of hurricanes, which often results in power outages or block traffic and emergency routes when they fall on roads. Rainfall associated with hurricanes can cause flooding In the town's rivers and streams, as well as localized stormwater drainage flooding. Potential hurricane damages to Norfolk from a 100-year and 500-year hurricane have been estimated using HAZUS, and the results are included in Appendix B. Hurricanes and tropical storms are considered a town-wide hazard for Norfolk.

Hurricanes and Climate Change

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

SEVERE WINTER WEATHER

Nor'easters

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 20 to 40 mph with gusts of up to 60 mph. These storms are accompanied by heavy rain or snow, depending on temperatures (Commonwealth of Massachusetts, 2013).

Previous occurrences of nor'easters include the storm events included in the table below. 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.

Table 21: Nor'easter Events for Massachusetts, 1978 - 2021

Date	Nor'easter Event
February 1978	Blizzard of 1978
October 1991	Severe Coastal Storm ("Perfect Storm")
December 1992	Great Nor'easter of 1992
January 2005	Blizzard/Nor'easter
October 2005	Coastal Storm/Nor'easter
April 2007	Severe Storms, Inland & Coastal Flooding/Nor'easter
January 2011	Winter Storm/Nor'easter
October 2011	Severe Storm/Nor'easter
February 2013	Blizzard of 2013
January 2015	Blizzard of 2015
March 2015	March 2015 Nor'easters
January 2018	January 2018
March 2018	March 2018

Norfolk 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 stormwater ponding and localized flooding. Fallen tree limbs as well as heavy snow accumulation and intense rainfall can impede local transportation corridors, and block access for emergency vehicles.

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

Blizzards & Heavy Snow

Winter weather impacts including heavy snow, blizzards, and ice storms, are the most common and most familiar of the region's hazards that affect large geographic areas.

Winter storms are a combination hazard because they often involve wind, ice, and heavy snow fall. The National Weather Service defines "heavy snow fall" as an event generating at least four inches of snowfall within a 12-hour period (NOAA, 2009). Blizzards and winter storms are often associated with a nor'easter event (see nor'easters section above).

A blizzard is a winter snowstorm with sustained or frequent wind gusts to 35 mph or more, accompanied by falling or blowing snow which reduces visibility to or below ¼ mile. These conditions must be the predominant 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 Regional Snowfall Index (RSI) characterizes and ranks the severity of northeast snowstorms. RSI has five categories: Extreme, Crippling, Major, Significant, and Notable. RSI scores are a function of the area affected by the storm, the amount of snow, and the number of people living in the path of the storm. The largest RSI values result from storms producing heavy snowfall over large areas that include major metropolitan centers. The RSI categories are shown in the table below.

Table 22: Regional Snowfall Index

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

Source: 2018 SHMCAP

The most significant recent winter event was Winter Storm Kenan (January 29, 2022), which resulted in 30.9" of snow in Massachusetts (Stucker, 2022). The table below shows presidentially-declared disasters in Norfolk County related to winter weather since 1978.

Table 23: Norfolk County Winter Federal Disaster Declarations, 1978-2023

Disaster Name	Date of Event	Declared Areas
Coastal Storms, Flood, Ice & Snow	February 1978	Barnstable, Bristol, Dukes, Essex, Nantucket, Norfolk, Plymouth, Suffolk
Winter Coastal Storm	December 1992	Barnstable, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester
Blizzard	March 1993	Statewide
Blizzard	January 1996	Statewide
Snowstorm	March 2001	Berkshire, Essex, Franklin, Hampshire, Middlesex, Norfolk, Worcester
Snowstorm	February 2003	Statewide
Snowstorm	December 2003	Barnstable, Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, Worcester
Snowstorm	January 2005	Statewide
Severe Winter Storm, Snowstorm	January 2011	Berkshire, Essex, Hampden, Hampshire, Middlesex, Norfolk, Suffolk
Severe Winter Storm, Snowstorm, Flooding	February 2013	Statewide
Severe winter storm, snowstorm, flooding	January 2015	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester
Severe winter storm and Snowstorm	March 2018	Essex, Middlesex, Norfolk, Suffolk, Worcester
Severe winter storm and flooding	March 2018	Barnstable, Bristol, Essex, Nantucket, Norfolk, Plymouth
Severe winter storm and snowstorm	January 2022	Bristol, Norfolk, Plymouth, Suffolk

Sources: OpenFEMA Dataset: Disaster Declarations and FEMA Declared Disasters

The best available data on past occurrences and impacts of winter storm events are reported for Norfolk County by NOAA's National Centers for Environmental Information (NCEI) Storm Events Database. From December 2012 through December 2022, Norfolk County experienced 8 days with recorded blizzards and 27 days with heavy snow, as shown in the tables below.

Table 24: Blizzards in Norfolk County, 2012-2022

Date	Deaths	Injuries	Damages ($)
2/8/2013	0	0	353000
1/2/2014	0	0	5000
1/26/2015	0	0	0
2/14/2015	0	0	10000
1/23/2016	0	0	50000
2/8/2016	0	0	10000
3/13/2018	0	0	60000
1/28/2022	0	0	2500
TOTAL	**0**	**0**	**490500**

Source: NOAA, National Centers for Environmental Information, Storm Events Database

Table 25: Heavy Snow in Norfolk County, 2012-2022

Date	Deaths	Injuries	Damages ($)
2/8/2013	0	0	0
3/18/2013	0	0	0
12/14/2013	0	0	0
12/17/2013	0	0	0
1/2/2014	0	0	0
1/21/2014	0	0	0
2/5/2014	0	0	0
2/15/2014	0	0	5000
1/24/2015	0	0	0
1/26/2015	0	0	0
2/2/2015	0	0	0
2/8/2015	0	0	0
2/14/2015	0	0	0
3/5/2015	0	0	0
1/23/2016	0	0	0
2/5/2016	2	0	210000
2/8/2016	0	0	0
4/4/2016	0	0	0
3/14/2017	0	0	0
11/15/2018	0	0	0
10/30/2020	0	0	1800
12/16/2020	0	0	0
2/7/2021	0	0	0
1/7/2022	0	0	0
2/13/2022	0	0	0
2/25/2022	0	0	0
TOTAL	**2**	**0**	**216800**

Source: NOAA, National Centers for Environmental Information, Storm Events Database

Map 6 in Appendix A demonstrates that the average annual snowfall in Norfolk is between 36.1-48.0 inches. Winter storms are a potential town-wide hazard in Norfolk.

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.

A number of public safety issues can arise during snowstorms. Impassible streets are a challenge for emergency vehicles and affect residents and employers. 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.

Ice Storms

The ice storm category covers a range of different weather phenomena that collectively involve rain or snow being converted to ice in the lower atmosphere leading to potentially hazardous conditions on the ground. Ice storm conditions are defined by liquid rain falling and freezing on contact with cold objects, creating ice buildups of one-fourth of an inch or more. An ice storm warning, which is now included in the criteria for a winter storm warning, is issued when a half inch or more of accretion of freezing rain is expected.

Sleet and hail are other forms of frozen precipitation. Sleet occurs when raindrops fall into subfreezing air thick enough that the raindrops refreeze into ice before hitting the ground. The difference between sleet and hail is that sleet is a wintertime phenomenon whereas hail falls from convective clouds (usually thunderstorms), often during the warm spring and summer months (a description of hail is included in a subsequent report section).

The best available data on previous ice storm events are recorded at the county level through NOAA's National Centers for Environmental Information (NCEI) Storm Events Database. However, there are no recorded ice storm events recorded for Norfolk County over the last 70 years. Given the regional nature of ice storms, most of the damages occur in the western portions of Middlesex County, farther inland and at a higher elevation than Norfolk. The Town's location in the milder region closer to the coast and at lower elevations makes it less vulnerable to ice storms.

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 causing power outages and blocking roadways. The impacts of winter storms may also include roof collapses and property damage and injuries related to the weight of snow and ice.

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 known history of ice jams leading to flooding in Norfolk and the local team did not identify this hazard as an issue for the Town.

Winter Weather and Climate Change

As with hurricanes, warmer ocean water and air will provide more fuel for winter storms. According to the 2018 SHMCAP it appears that Atlantic coast nor'easters are increasing in frequency and intensity. Further, the SHMCAP notes that research suggests that warmer weather in the Artic is producing changes to atmospheric circulation patterns that favor the development of winter storms in the Eastern United States. There is also some indication that as winters warm, temperatures may be more likely to produce icing conditions. Massachusetts' 2022 Climate Change Assessment predicts more mild winters, increased precipitation in the winter months, and multiple freeze-thaw cycles every winter due to warming temperatures (Commonwealth of Massachusetts, 2022).

TORNADOES

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

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

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

Figure 20: Enhanced Fujita Scale

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

Source: SHMCAP 2018

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 occurred in Springfield in 2011, in Revere in 2014, and in Concord in 2016.

As shown on MAPC 5 in Appendix A, there have been no recorded tornados within the limits of the Town of Norfolk. Since 1953, there have been 12 tornadoes in Norfolk County recorded by the Tornado History Project, as summarized in the table below.

Table 26: Tornado Records for Norfolk County, 1950-2021

Date	Mag.	Fatalities	Injuries	Width	Length	Damage
6/9/1953	3	0	15	667	28	$2.50M
11/21/1956	2	0	0	17	0.1	$2.50K
8/9/1972	1	1	6	30	4.9	$25.0K
9/6/1973	1	0	0	10	1.1	$25.0K
7/10/1989	0	0	0	23	0.1	$2.50K
5/18/1990	0	0	0	10	0.2	$2.50K
5/18/1990	0	0	0	10	0.2	$2.50K
6/30/2001	0	0	0	80	0.1	$0.00K
8/21/2004	1	0	0	40	6	$1.50M
5/9/2013	EF0	0	0	50	0.38	$20.00K
6/23/2015	EF0	0	0	200	0.48	$20.00K
10/7/2020	EF0	0	0	--	--	$6.00K
Total		**1**	**21**			**44.106M**

Source: Tornado History Project; National Centers for Environmental Information

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. At this time, the Massachusetts State Building Code's provisions are the most cost-effective mitigation measure against tornados given the extremely low probability of occurrence.

Although tornadoes are a potential town-wide hazard in Norfolk, tornado impacts are relatively localized compared to severe storms and hurricanes. Damages from any tornado would greatly depend on the track of the tornado, as most the town is not densely developed.

Tornadoes and Climate Change

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. Massachusetts' 2022 Climate Change Assessment does not include information related to tornadoes.

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 thunder, lightning, strong winds, and rain and/or hail. Thunderstorms sometime give rise to tornados. On average, these storms are only around 15 miles in diameter and last for about 30 minutes. A severe thunderstorm can include winds of close to 60 mph and

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

The best available data on previous occurrences of thunderstorms in Norfolk is for is for Norfolk County through NOAA's National Centers for Environmental Information (NCEI) Storm Events Database. From December 2012 to December 2022, records show 44 thunderstorm events in Norfolk County. These storms resulted in a total of $648,100 in property damage. There were no injuries or deaths reported. See the table below for more information.

Table 27: Norfolk County Thunderstorm Events, 2012-2022

DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE ($)
6/17/2013	50	0	0	11,000
7/29/2013	50	0	0	20,500
7/3/2014	50	0	0	20,000
7/28/2014	60	0	0	50,000
6/23/2015	50	0	0	5,000
8/4/2015	50	0	0	30,000
8/15/2015	50	0	0	35,000
2/25/2016	50	0	0	94,000
6/7/2016	50	0	0	10,000
7/18/2016	50	0	0	90,000
7/22/2016	50	0	0	65,000
7/23/2016	40	0	0	35,000
8/14/2016	50	0	0	5,000
6/9/2017	45	0	0	1,000
6/13/2017	48	0	0	1,000
6/23/2017	50	0	0	1,000
8/2/2017	50	0	0	2,500
9/6/2017	50	0	0	1,000
7/17/2018	45	0	0	3,000
9/6/2018	50	0	0	6,000
11/3/2018	50	0	0	500
7/17/2019	50	0	0	5,000
7/31/2019	50	0	0	9,000
6/6/2020	50	0	0	10,000
6/28/2020	50	0	0	8,900
7/2/2020	50	0	0	31,000
7/5/2020	50	0	0	500
7/23/20	50	0	0	11,200

DATE	MAGNITUDE	DEATHS	INJURIES	PROPERTY DAMAGE ($)
8/22/2020	50	0	0	2,000
8/23/2020	50	0	0	5,600
10/7/2020	55	0	0	35,800
11/15/20	50	0	0	500
6/8/2021	50	0	0	12,200
6/29/2021	50	0	0	1,100
6/30/21	55	0	0	1,500
7/7/2021	550	0	0	4,700
7/8/2021	50	0	0	1,000
7/16/2021	50	0	0	500
7/21/2021	50	0	0	600
7/27/2021	52	0	0	7,300
11/13/2021	50	0	0	1000
5/22/2022	50	0	0	8600
8/5/2022	50	0	0	800
8/26/2022	50	0	0	0
TOTAL		**0**	**0**	**648100**

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

Additionally, the Local Team identified one hazard area related to wind. More information is included in the table below.

Table 28: Locally Identified Wind Hazard Area in Norfolk

Map ID	Name	Description
10	Microburst Hazard Area	In the fall of 2007, a microburst tracked through Norfolk. Damages from the windstorm caused the town to close portions of Main Street and Hanover Street for 3-4 hours. The storm also knocked down power lines and caused minor to major property damages from downed limbs and debris to homes on Main Street and Myrtle Street. This same area was hit by another severe wind event on April 13, 2020. Although the entire Town is concerned at-risk to extreme wind events, this particular area is still of concern to the Local Team.

Severe thunderstorms are a town-wide hazard for Norfolk. 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.

Thunderstorms and Climate Change

As noted previously, the intensity of rainfall events has increased significantly, and those trends are expected to continue. Neither the 2018 SHMCAP, nor the 2022 Massachusetts Climate Change Assessment, specifically address whether climate will affect the intensity or frequency of thunderstorms.

HAIL

Hail events are frequently associated with thunderstorms and other severe storm events. Hail size typically refers to the diameter of the hailstones. Warnings may report hail size through comparisons with real-world objects that correspond to certain diameters as shown in the table below.

Table 29: Hail Size Comparisons

Description	Diameter (inches)
Pea	0.25
Marble or mothball	0.50
Penny or dime	0.75
Nickel	0.88
Quarter	1.00
Half dollar	1.25
Walnut or ping pong ball	1.50
Golf ball	1.75
Hen's egg	2.00
Tennis ball	2.50
Baseball	2.75
Teacup	3.00
Grapefruit	4.00
Softball	4.50

Source: NOAA

Potential damages from larger-size hail could include damage to vehicles, windows, and other structures. The best available data on previous hail events are recorded for Norfolk County through NOAA's National Centers for Environmental Information (NCEI) Storm Events Database. There were 9 hail events recorded from December 2012 through December 2022, as shown in the table below. There was no property damage, injuries, or deaths reported for any of these hail events.

Table 30: Norfolk County Hail Events, 2012-2022

Date	Hail Size	Deaths	Injuries	Property Damage ($)
5/21/2013	0.75	0	0	0
9/1/2013	0.75	0	0	0
8/7/2014	0.75	0	0	0

5/12/2015	0.75	0	0	0
6/23/2015	1	0	0	0
8/4/2015	1	0	0	0
6/30/2019	0.75	0	0	0
6/28/2020	1.5	0	0	0
7/7/2021	1	0	0	0
TOTAL		**0**	**0**	**0**

Source: NOAA, National Centers for Environmental Information

**Magnitude refers to diameter of hail stones in inches*

Hail events are a potential town-wide hazard in Norfolk.

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 in the table below.

Table 31: 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

From 1668 to 2016, 408 earthquakes were recorded in Massachusetts (NESEC). Most have originated from the La Malbaie fault in Quebec or from the Cape Anne fault

located off the coast of Rockport. The region has experienced larger earthquakes in the distant past, including a magnitude 5.0 earthquake in 1727 and a 6.0 earthquake that struck in 1755 off the coast of Cape Anne. More recently, a pair of damaging earthquakes occurred near Ossipee, NH in 1940. A 4.0 earthquake centered in Hollis, Maine in October 2012 was felt in the Boston area. Historic records of some of the more significant earthquakes in the region are shown in the table below.

Table 32: Historic Earthquakes in Massachusetts or Surrounding Area

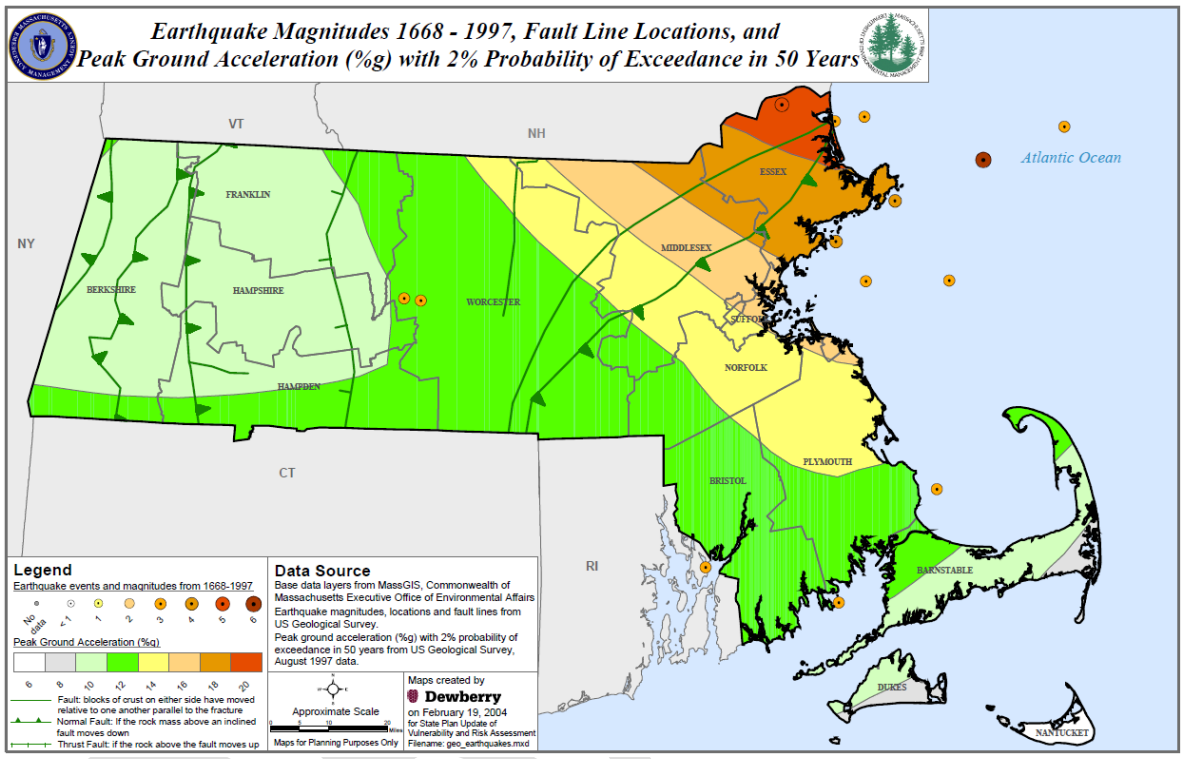
Location	Date	Magnitude
MA - Cape Ann	11/10/1727	5
MA - Cape Ann	12/29/1727	NA
MA - Cape Ann	2/10/1728	NA
MA - Cape Ann	3/30/1729	NA
MA - Cape Ann	12/9/1729	NA
MA - Cape Ann	2/20/1730	NA
MA - Cape Ann	3/9/1730	NA
MA – Boston	6/24/1741	NA
MA - Cape Ann	6/14/1744	4.7
MA – Salem	7/1/1744	NA
MA - Off Cape Ann	11/18/1755	6
MA - Off Cape Cod	11/23/1755	NA
MA – Boston	3/12/1761	4.6
MA - Off Cape Cod	2/2/1766	NA
MA – Offshore	1/2/1785	5.4
MA - Wareham/Taunton	12/25/1800	NA
MA – Woburn	10/5/1817	4.3
MA - Marblehead	8/25/1846	4.3
MA – Brewster	8/8/1847	4.2
MA – Boxford	5/12/1880	NA
MA – Newbury	11/7/1907	NA
MA - Wareham	4/25/1924	NA
MA - Cape Ann	1/7/1925	4
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, as shown in the figure below. Norfolk County is in the middle part of the range for Massachusetts, at 12-14g, making it a moderate area of earthquake risk relative to the state, although Massachusetts as a whole is considered to have a low risk of earthquakes compared to the rest of the country.

Figure 21: Massachusetts Earthquake Probability Map



Source: 2018 SHMCAP

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

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

Earthquakes are a potential town-wide hazard in Norfolk. Although new construction under the most recent building codes generally will be built to seismic standards, development in Town that pre-dates the most recent building code will be at risk. Potential earthquake damages in Norfolk have been estimated using HAZUS and the results are included in Appendix B. There have been no recorded earthquake epicenters within Norfolk. However, there is a recorded earthquake epicenter in Franklin near the border with Norfolk, which occurred on June 25, 2018. See Map 4 in Appendix A for more information.

LAND USE AND DEVELOPMENT

EXISTING LAND USE

The most recent land use statistics available from the state are from aerial imagery completed in 2016. Some change has certainly occurred in Norfolk since then, but this data still provides the most detailed town-wide descriptions of land use available. Land use is shown on Map 2 in Appendix A. The table below shows overlap between land use types in Norfolk and FEMA Flood Zones.

Table 33: Town of Norfolk Land Use

Land Use Type	Flood Zone	Acres of Overlap
Commercial	A	0.054256585
Commercial	AE	5.799675122
Commercial	X	0.771154661
Industrial	A	0.016475428
Industrial	AE	0.989218046
Industrial	X	0.26014781
Residential - multi-family	A	0.255986881
Residential - multi-family	AE	5.437829755
Residential - multi-family	X	0.187224939
Residential - single family	A	0.376285771
Residential - single family	AE	24.1343214
Residential - single family	X	4.212292823

Source: MassGIS 2016 Land Use Database

For more information on how the land use statistics were developed and the definitions of the categories, please go to https://www.mass.gov/info-details/massgis-data-2016-land-coverland-use. Refer to the "Community Profile" section for more information on Norfolk's natural, cultural, and historic resources.

DEVELOPMENT TRENDS

Norfolk has experience moderate growth since the last Hazard Mitigation was approved in 2010, most of which was residential. Changes in development did not impact the Town's overall vulnerability, as most developments did not overlap with flood hazard areas and all are in a "low incidence" landslides area. The following information on new developments was provided by Norfolk's Director of Planning & Development and MAPC's MassBuilds Development Database. More information on new, completed development, as well as pending or potential future development, is included in the tables below.

Table 34: New Development in Norfolk Since 2010

Name	Type	Detail	Status
Shire Development	Commercial	20 lot subdivision	Complete
Maple Park Estates	Residential	15-20 unit subdivision	Complete
Noon Hill Acres	Residential	4 lot subdivision	Complete
Canterbury Estates	Residential	30-unit single family subdivision	Complete
Avoca Village	Residential	17 single family subdivision	Complete
Sandy Knoll	Residential	4 lot subdivision	Complete
Old Mill	Residential	5 single family lot subdivision	Complete
Village at River's Edge	Mixed use	Over 55 developments. 162 residential units, one restaurant, and 2 small office spaces	Complete
Pine Oaks	Residential	Over 55 residential 32-unit development	Complete
Christina Estates	Residential	52-unit subdivision	Complete
Bristol Pond	Residential	23-unit single family home subdivision	Complete
Norfolk Commons	Residential	40B project, 60 detached townhouse units	Complete
Lakeland Farms	Residential	40B-single family subdivision, ownership, 32 units	Complete
Norfolk Police Headquarters	Institutional	28,291 square feet	Complete
18 Union St	Commercial	8 small multi-family residential housing units. 5,800 square feet for retail.	Complete
Boyde's Crossing	Residential	40B, single family subdivision, ownership, 40 units	Complete
Meeting House Village	Residential	40B, single family, ownership townhouse, 20 units	Complete
Fox Run	Residential	48-unit single family subdivision	Complete

Table 35: Summary of Pending & Potential Future Developments

Name	Type	Detail	Status
Norfolk Commons Commercial Development	Commercial	Future retail development	Not Complete

Name	Type	Detail	Status
Oak Knoll Estates	Residential	3-unit single family subdivision	Permitted complete
Saddle Ridge	Residential	5-unit single family home subdivision	Permitted complete
Preserve at Keeney Pond	Residential	Large lot single family home subdivision	90% complete
Fern Ridge Estates	Residential	15-unit single family subdivision	Permitted complete
Buckley & Mann Property	Residential	There is hazardous waste on this parcel which will need to be properly mitigated prior to development.	No permitted project at this time
Norway Farms Subdivision	Residential	14-unit single family subdivision	3/4 built out
Lakeland Hills	Residential	40B-single family, ownership, 44 units	Road under construction
The Enclave	Residential	40B, 55 and over single family ownership	Homes under construction
The Village at Norfolk	Residential	40B single family ownership 36 units	halfway built out
Waite's Crossing	Residential	40B single family ownership 64 units	site cleared, started laying out roadway
Norfolk Station	Residential	40B single family ownership 36 units	Permitted
35 Pine St	Residential	40B single family ownership 8 units	Permitted, roads under construction
Seven Hill	Residential	18 duplex units	1/4 built out

Table 36: Developments that Overlap with Flood Zones

Name	Flood Zone
Sandy Knoll	10.22% in A: 1% Annual Chance of Flooding, no BFE
Longobardi Farm	23.39% in AE: 1% Annual Chance of Flooding, with BFE , and 2.72% in X: 0.2% Annual Chance of Flooding
Myrtle Street Development	43.56% in AE: 1% Annual Chance of Flooding, with BFE , and 5.54% in X: 0.2% Annual Chance of Flooding
Christina Estates	4.84% in AE: 1% Annual Chance of Flooding, with BFE , and 0.13% in X: 0.2% Annual Chance of Flooding
Airport Development	3.29% in AE: 1% Annual Chance of Flooding, with BFE , and 2.17% in X: 0.2% Annual Chance of Flooding
Buckley & Mann Property	1.22% in AE: 1% Annual Chance of Flooding, with BFE , and 0.08% in X: 0.2% Annual Chance of Flooding
Lakeland Hills	0.0% in AE: 1% Annual Chance of Flooding, with BFE , and 0.85% in X: 0.2% Annual Chance of Flooding

CRITICAL INFRASTRUCTURE IN HAZARD AREAS

Critical infrastructure includes facilities that are important for disaster response and evacuation (such as emergency operations centers, fire stations, water pump stations, etc.) and facilities where additional assistance might be needed during an emergency (such as nursing homes, elderly housing, day care centers, etc.). There were 60 critical facilities identified in Norfolk. These are listed in the table below and shown on the maps in Appendix A. All critical facilities are in "low incidence" risk areas for landslides and all are in areas with an average annual snowfall of 36.1 - 48.0 inches. Six are in FEMA Flood zones and one overlaps with a locally identified area of flooding. No critical facilities are in brush fire hazard areas, and one is in an extreme heat "hot spot."

Table 37: Relationship of Critical Infrastructure to Hazard Area

ID	Name	Type	FEMA Flood Zone	Locally Identified Area of Flooding	Brush Fire Area	Hot Spot
1	Fire Department	Fire Station	No	No	No	No
2	Freeman Kennedy School	School	No	No	No	No
3	H.O. Day School	School	No	No	No	No
4	King Philip Regional Middle School	School	No	No	No	Yes
5	Town Hall	Municipal	No	No	No	No
6	Senior Center	Senior Center	No	No	No	No
7	DPW Facility	Municipal	No	No	No	No
8	Gold Steet Well	Well	No	No	No	No
9	Spruce Rd Well	Well	No	No	No	No
10	Norfolk Ice Arena	Place of Assembly	No	No	No	No
11	MCI Norfolk	Correctional Facility	No	No	No	No
12	St. Jude Church	Church	No	No	No	No
13	Federated Church	Church	No	No	No	No
14	Emmanuel Baptist Church	Church	No	No	No	No
15	Hillcrest Village Elder Housing	Elder Housing	No	No	No	No
16	Pondville Water Tank	Water Tank	No	No	No	No
17	Police Station/MECC	Police Station	No	No	No	No
18	Weeber Water Tank	Water Tank	No	No	No	No
19	Warren Drive Booster Pump	Water Structure	No	No	No	No
20	Prison Connection/Mete	Water Structure	No	No	No	No

ID	Name	Type	FEMA Flood Zone	Locally Identified Area of Flooding	Brush Fire Area	Hot Spot
	r Pit					
21	Wrentham Inter-Connection	Water Structure	No	No	No	No
22	Walpole Inter-Connection	Water Structure	No	No	No	No
23	Franklin Inter-Connection	Water Structure	No	No	No	No
24	Holbrook Street Wellfield	Water Structure	No	No	No	No
25	Stony Brook Nature Center	Natural Resource	No	No	No	No
26	Kunde Conservation Land	Natural Resource	No	No	No	No
27	Library	Library	No	No	No	No
28	Garage	Town Facility	No	No	No	No
29	W.T. Holmes Transportation	Transportation	No	No	No	No
30	Former Southwood Community Hospital	Hazardous Site	No	No	No	No
31	MBTA Commuter Rail Station	Transportation	No	No	No	No
32	Leland Wild	Natural Resource	AE: 1% Annual Chance of Flooding; with BFE	No	No	No
33	Bristol Blake State Reservoir Dam	Dam	AE: Regulatory Floodway	No	No	No
34	Highland Lake Dam	Dam	No	No	No	No
35	City Mills Pond Dam	Dam	AE: Regulatory Floodway	City Mills Bridge and 2 Culverts	No	No
36	Bush Pond #2 Dam	Dam	AE: Regulatory Floodway	No	No	No
37	Sharp's Pond Dam	Dam	No	No	No	No
38	Mirror Lake Dam	Dam	No	No	No	No
39	Mirror Lake Dike	Dam	No	No	No	No
40	Industries Drive Dam	Dam	AE: Regulatory Floodway	No	No	No

ID	Name	Type	FEMA Flood Zone	Locally Identified Area of Flooding	Brush Fire Area	Hot Spot
41	Bristol Blake State Reservation	Natural Resource	No	No	No	No
42	Harold Campbell Forest	Natural Resource	No	No	No	No
43	Fales Memorial Park Preserve	Natural Resource	No	No	No	No
44	Lind Farm Conservation Land	Natural Resource	No	No	No	No
45	Pondville Conservation Land	Natural Resource	No	No	No	No
46	Meetinghouse Road Wastewater Treatment Facility (WWTF)	Wastewater	No	No	No	No
47	Laurie S. Hayes Preschool	Child Care	No	No	No	No
48	Laura Lawson Preschool	Child Care	No	No	No	No
49	Norfolk Cooperative Preschool	Child Care	No	No	No	No
50	Stony Brook Nature Preschool	Child Care	No	No	No	No
51	Story Heights Montessori Childcare Center, Inc.	Child Care	No	No	No	No
52	Pondville Medical Center	Medical	No	No	No	No
53	3 Liberty Lane	Pharmacy	No	No	No	No
54	Solar Array	Solar	No	No	No	No
55	Solar Array	Solar	X: 0.2% Annual Chance of Flooding	No	No	No
56	Solar Array	Solar	No	No	No	No
57	Pondville Correctional Center	Correctional Facility	No	No	No	No
58	Bay State Correctional Center	Correctional Facility	No	No	No	No
59	MCI-Cedar Junction	Correctional Facility	No	No	No	No

ID	Name	Type	FEMA Flood Zone	Locally Identified Area of Flooding	Brush Fire Area	Hot Spot
60	Buckley Mann	Hazardous Site	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. The methodology used for hurricanes and earthquakes was the HAZUS software.

Introduction to HAZUS

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

> "FEMA's Hazus Program provides standardized tools and data for estimating risk from earthquakes, floods, tsunamis, and hurricanes. Hazus models combine expertise from many disciplines to create actionable risk information that increases community resilience. Hazus software is distributed as a GIS-based desktop application with a growing collection of simplified open-source tools. Risk assessment resources from the Hazus program are always freely available and transparently developed. The Hazus Program is managed by FEMA's Natural Hazards Risk Assessment Program (NHRAP), within the Risk Management Directorate."

There are three modules included with the HAZUS software: hurricane, flooding, and earthquakes. There are also three levels at which HAZUS 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 Norfolk, 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. Refer to the Hazus exports in Appendix B for more information.

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 5.0 event occurred in 1963. Refer to the Hazus exports in Appendix B for more information.

Estimated Damages from Flooding

The HAZUS flooding module allows users to model the potential damage caused by a 100-year flood event and a 500-year flood event. Refer to the Hazus exports in Appendix B for more information.

SECTION 5 HAZARD MITIGATION GOALS

The Local Team reviewed and discussed the goals from the 2010 Hazard Mitigation Plan. These remain the Town's goals, with the addition of two new goals related to incorporating climate change and environmental justice. All of these goals are considered critical for the Town, and they are not listed in order of importance.

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

2. Identify and seek funding for measures to mitigate or eliminate natural hazards.

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 impacts of climate change and incorporate climate sustainability and resiliency into the Town's planning, policies, and projects.

10. Incorporate environmental justice considerations throughout natural hazard mitigation – including in supporting climate vulnerable populations, the outreach and engagement process, analysis of hazard impacts, and development and implementation of mitigation measures.

SECTION 6 EXISTING MITIGATION MEASURES

The existing protections in the Town of Norfolk are a combination of land use, infrastructure maintenance and drainage improvement projects, and public outreach. These more expensive projects are subject to the capital budget process and securing funding is one of the biggest challenges to execute and complete some of these strategies. The Town's existing mitigation measures are listed by hazard type in the descriptions below, which incorporate updates since the 2010 HMP. All of the Town's existing mitigation measures are considered to be effective.

MULTIPLE HAZARD MITIGATION

Comprehensive Emergency Management Plan (CEMP)
The Town has a CEMP that addresses mitigation, preparedness, response and recovery from a variety of natural and man-made emergencies.

2019 Regional Emergency Planning Committee (REPC) Plan
An update is needed by 2024. The Town is in the process of training and working on data inputs and meets regularly to discuss.

Massachusetts State Building Code
Regulates wind loads, earthquake resistant design, flood-proofing and snow loads. The Town is staying up to date with the State building code.

Multi-Department Review of Developments
Multiple departments within Town review site plans before development. This is done in person or on Zoom. For major projects (for example, the gun range or Fire Department project) the Town has done a good job of making sure that different departments have an opportunity to review and share input. The Local Team feels that this process could be made more efficient for the larger scale residential projects, in order to reach a resolution quicker.

MEMA Tankers
MEMA has several tankers that can be deployed in the Town if needed.

Metacomet Emergency Communications Center (MECC)
MECC is the new regional dispatch and emergency operations center for Norfolk, Wrentham, Plainville, Franklin, Millville, and Mendon, and was completed in 2019. This serves as an operations center during emergencies (whereas a command post would be local). MECC plans to add more towns over the next year and will expand the number of stations more than 100%.

2020 Municipal Vulnerability Preparedness (MVP) Community Resilience Program
As part of this process, the Town convened key stakeholders to discuss climate change risks, local strengths and vulnerabilities, and recommended action items.

2021 Risk & Resilience Assessment (RRA) and Emergency Response Plan (ERP)

These reports considered natural hazard impacts to water infrastructure, and related countermeasures. These reports are federally mandated, and the Town is up-to-date in meeting these plan documentation requirements.

Work with Vulnerable Populations
The Fire Department will do welfare checks to see if folks need support before or after extreme events. The Fire Department also coordinated with Eversource and was present on site at Hillcrest Village during a recent power outage. This is a high priority area for the Town.

Emergency Shelter
Town Departments discuss and coordinate in the event that a shelter may be needed, including the Fire Chief, Schools, and the Town Administration. The Town has plans in place that can be quickly implemented. The Town's typical shelter is the Council on Aging. The Town could use the Freeman School during a particularly large event. Both facilities have backup power to support life safety, heating, and cooling. The Town also has PPE and water on-hand in case of these events.

Inter-municipal Communication
The Town participates in regular SWAP meetings through MAPC. DPW is also a member of SERSG, which hosts monthly meeting with 26 towns involved. Additionally, DPW Directors and Assistant DPW Directors from Bellingham, Medway, Franklin, Millis, Medfield, and Norfolk meet every couple of months and speak more frequently as needed to discuss challenges. The Town Building Department is part of statewide Directors of Facilities website and listserve to receive information and updates. The Town also participates in MIIA along with 40 other communities for OSHA training.

FLOOD RELATED HAZARDS

GENERAL FLOOD MITIGATION

Participation in the National Flood Insurance Program (NFIP)
Homeowners in the floodplain can purchase flood insurance through. The Town encourages all eligible homeowners to obtain insurance. According to the Community Information System report shared by DCR:

- Policies in force: 24
- Insurance in force: $5,408,500
- Number of Paid Losses: 54
- Total Losses Paid: $155,135
- Substantial Damage Claims Since 1978: 0

Street Sweeping
Every street gets swept once a year or as needed. High traffic areas are swept more regularly.

Catch Basin Cleaning

All catch basins are cleaned out once a year, with a secondary cleaning as required by MS4 compliance at locations found to be more than 50% full at the initial cleaning.

Equipment for flooding
The Town completed an audit of equipment for flooding issues and is aware of the equipment that they currently have on-hand.

Community Preservation Act (CPA)
The town adopted CPA in 2001.

Portable Pumps for Public Safety
There have been several major rain events where portable pumps were needed. For example, the 2010 event flooded a pond and half of Rockland Road and Tucker Rd were underwater. The Town received a grant to get a new trash pump and inspected the two current trash pumps this winter.

Infrastructure Improvements
Infrastructure improvements include culverts, bridges, roads, and drainage systems. A summary of key work is included below, although the Town is pursuing many efforts.

- DPW is working on engineering and design to upgrade the culvert at Seekonk St, which is a main throughway with a wetland to the south. During a storm, water goes across the road and can become dangerous if a car is moving quickly through. There have also been issues with beavers damming up wetland upstream. The Town acquired funding to complete engineering and design work to replace the culverts and update the water main. The Town is now seeking funding for the construction phase of work. This area is considered a high concern for the Town and the project is a high priority for the Charles River Watershed Association, based on the results of their recent regional flood modeling work.
- DPW is working with Pare Engineering on redesign of the bridge and realignment of the culvert near City Mills Pond.
- Union Street culvert was upgraded and is kept maintained.
- The 2019 Business District Drainage Evaluation was completed by Pare Engineering.

Regulations, Bylaws, and Plans
The Town updated its Zoning Bylaw for the flood district based on the model from FEMA and DCR at Spring Town meeting in 2021. The Town will also be impacted by the Charles Watershed RiskMAP mapping update for Norfolk, Plymouth and Suffolk Counties. This process is expected to result in a Letter of Final Determination (LFD) from FEMA by late December 2023 or January 2024. The Town will need to adopt an updated floodplain bylaw to reflect the new mapping before the updated Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS) will become effective in June or July 2024. See the "Locally Identified Flood Hazard Areas" section for more information.

Culvert inventory
The Town completed an updated inventory and survey of culverts that need upgrades, which was a recommended action item in their 2020 MVP plan.

Massachusetts Stormwater Regulations

This policy is applied to all developments within the jurisdiction of the Conservation Commission, Planning Board, and DPW. The Town has updated bylaws and implemented new policies based on the MS4 Permit. See "MS4 Compliance" below for more information.

MS4 COMPLIANCE

September 2018

Norfolk developed a Notice of Intent (NOI) to request authorization to discharge stormwater. The NOI was submitted to the EPA and MassDEP on October 1, 2018. It includes information about the Town's plan for compliance with the NPDES stormwater program, a summary of waterbodies within Town that receive stormwater discharges, and best management practices (BMPs) the Town will implement to address the six (6) Minimum Control Measures (MCMs) and meet Total Maximum Daily Load (TMDLs) requirements for the Charles River Basin.

February 2019

EPA and MassDEP reviewed Norfolk's NOI and granted authorization to discharge stormwater under the NPDES permit program.

September 2019 - Year 1

The Town submitted its first annual report to the EPA and MassDEP, and prepared a detailed Stormwater Management Plan (SWMP) to summarize Norfolk 's stormwater management program and plan for compliance with the NPDES permit program in greater detail.

September 2020 – Year 2

The Town submitted its second annual report to the EPA and MassDEP, along with its Phosphorous Control Plan Phase 1 – Legal Analysis. Due to the Town's location within the Charles River Watershed, the Town is required by the MS4 General Permit to develop a Phosphorus Control Plan (PCP) designed to reduce the amount of phosphorus in stormwater discharges from its system to the Charles River and its tributaries.

September 2021 – Year 3

The Town submitted its third annual report to the EPA and MassDEP which included meeting Year 3 and Annual requirements such as; inspecting and screening all outfalls (280), updating outfall priority ranking, implementing an updated Stormwater bylaw, street sweeping, catch basin cleaning, record keeping and a host of other compliance requirements.

MS4 Minimum Control Measures (MCM's) - Annually

1. Public Education and Outreach
2. Public Involvement and Participation
3. Illicit Discharge Detection and Elimination (IDDE) Program
4. Construction Site Stormwater Runoff Control
5. Stormwater Management in New Development & Redevelopment
6. Pollution Prevention/Good Housekeeping

Total Maximum Daily Loads (TMDLs)

- Impaired Waterbody Requirements

- Charles River Phosphorous Reduction 23%

DAM-RELATED FLOOD MITIGATION MEASURES

DCR Dam Safety Regulations

The state has enacted dam safety regulations mandating inspections and emergency action plans. The Town is up to date with their EAPs for Town-owned dams. The current status of additional dam-related work in Norfolk is summarized below.

Mirror Lake Dam and Dike

Mirror Lake Dam Phase 1 Inspections – 9/23/2021
Mirror Lake Dike Phase 1 Inspections – 9/23/2021
Mirror Lake Dike Follow-Up Inspection – 10/12/22

City Mills Structures

1. Dam
2. Two Culverts
3. Bridge

1. 2017 DPW Funded - Poor Condition Follow-Up Inspection, May 2017: Pare performed an inspection of the City Mills Dam in response to a Dam Safety Order issued by the Massachusetts Department of Recreation and Conservation (MADCR) Office of Dam Safety (ODS)

2. 2017 DPW Funded - Inspection of Dam Outlet Culvert, August 2017: Pare performed an inspection of the existing primary spillway outlet culvert to observe the general condition of the structure and document any visible deficiencies in the reinforced concrete T-beam structure. Structure was generally in good shape, with some areas deteriorated concrete and corroded reinforcing bars noted in the culvert roof.

3. 2017 DPW Funded - Preliminary Structure Evaluation, September 2017: Based on the general condition and deficiencies noted in the culvert inspection report (Item 2), Pare prepared a Preliminary Structure Evaluation (PSE) to determine the effectiveness of repairing the culvert in place versus replacement with a new structure. The recommendation was to rehabilitate the existing structure and to complete a load rating analysis to determine the capacity of the existing structure to support vehicle loads.

4. 2018 Grant Funded - Poor Condition Follow-Up Inspection, November 2018: Pare performed a second follow-up inspection of the City Mills Dam to satisfy the requirement of the Dam Safety Order issued in April 2017.

5. 2018 Grant Funded - Hydrologic and Hydraulic (H&H) Evaluation, December 2018: Pare perform and H&H evaluation of the existing dam to determine inflow volumes to the dam and corresponding impoundment elevations. The analysis was used to determine the capacity of the existing dam to convey the Spillway Design Flood (SDF), which is the 100-year event for Significant hazard dams like City Mills Pond Dam. The H&H analysis indicated that the existing dam is incapable of passing the SDF without overtopping. Recommended rehabilitation to increase the storm capacity to satisfy Dam Safety Regulations includes lowering the existing primary spillway weir crest and replace the

existing secondary spillway with a larger one. H&H Report delivered to the Client on February 27, 2019. – Preliminary plans were developed and discussions were had regarding possible options of culvert relocation, bridge relocation and other mitigation measures

6. 2019 Grant Funded ($50,000) - Dam Tree Removal and Safety Improvements, March 2019 - Present: Pare prepared a plan for removal of trees and woody vegetation along the upstream dam slope, regrade, and loam and seed the slope once complete. The vegetation removal is needed to address one of the several deficiencies noted in the Dam Safety Order. Notice of Intent (NOI) filed with the Norfolk Conservation Commission and Order of Conditions issued in April 2019. M.G.L. Chapter 253 Dam Safety Permit for tree clearing issued by the Massachusetts Office of Dam Safety in May 2019. Completed By DPW in 2020

7. 2019 Grant Funded - Interim Bridge Repairs, November 2018 – January 2018: Based on the results and recommendations contained in the PSE, Pare prepared plans and specifications for concrete repairs to address concrete deterioration in numerous locations throughout the dam outlet culvert roof. Anticipated construction advertising contingent upon funding. Additional upgrades to the substandard railing are also necessary and will be addressed in a future assignment.

8. 2019 Grant Funded - Emergency Action Plan (EAP) Preparation, January 2019 – December 2019: Pare has prepared an EAP for the dam, in accordance with dam safety regulations and the Dam Safety Order issued to the Town on December 10, 2018. The Dam Safety Order requires the EAP to completed and submitted to ODS by December 31, 2019. EAP is substantially complete, with final sign-off and checks required by project partners. Completion of the plan requires cooperation of all involved agencies including Town police, fire, and EMD as well as MEMA and ODS.

9. City Mills Pond Dam Phase 1 Inspections – 9/23/2021

10. 2021 to Present – Preliminary engineering and design options for bridge construction, roadway realignment and culvert upgrades and or replacement

BRUSH FIRE RELATED HAZARDS

Permits required for outdoor burning.
The Fire Department requires a written permit for outdoor burning. The permit must be obtained from the Fire Dept.

Fire Hydrant Installation
Subdivision regulations state that subdivisions must be connected to municipal water. Requirements for installing fire hydrants are specified in the regulations. Plans are reviewed by the Fire Chief and DPW for fire hydrant locations. Any proposed development needs to be provisioned for hydrants to be located every 350 ft. Throughout the process, DPW also inspects fire hydrants.

Subdivision Review

The Fire Department is involved in reviewing all subdivision plans.

Fire Road Maintenance
The fire road is located at the end of Turner Road to Mass Ave. DPW maintains this access road from time to time. The Fire Department needs an 8 ft. width, and brush trucks are designed to go through thick brush.

Burn Season Regulations & Public Education
When burn season starts, the Town puts the regulations on website, which also includes an FAQ section. Residents receive the fact sheet (listing rules and parameters) when receiving a permit. The website gets more traffic during burn season, which is therefore a good time for public education. The Town hasn't had a large incident of urban interface fires that have damaged structures, but the potential exists, especially as more homes are built that encroach on forested areas.

Portable Water Pumps & Interconnections for Fire Suppression
Rivers and ponds in town are available to be tapped into for water supply if necessary. The Town could isolate an area with gates if needed, and does have interconnections with surrounding communities, in case wells went down. The Fire Department could use the interconnections for fire suppression strictly in an emergency situation if needed. However, the current water system is good. The Town also has a tanker and plans for use of tanker shuttles, to go to a hydrant and shuttle water in if needed. Rivers and ponds in town are available to be tapped into for water supply if necessary. For example, the Town could use City Mills pond in a significant emergency. This would be non-potable water.

Fire Engine
The Town got a fire engine funded, which will arrive in October 2023 and will reduce the average age of the Town's fleet significantly.

GEOLOGIC HAZARDS

The Massachusetts State Building Code
The town enforces the Massachusetts State Building Code. Geologic hazards are not considered a high risk or high priority for the Town.

WIND HAZARDS

Tree-Trimming
Over the past 4 years, DPW and Eversource have worked together to implement a vegetation management plan and increase removal of hazardous trees. DPW has also increased the tree budget every year.

WINTER-RELATED HAZARDS

Roadway Treatments

The Highway Department stays up to date with roadway treatments, snow removal and disposal during winter storms. Winter weather is not considered a high risk for the Town because Norfolk is well prepared to deal with this impacts.

Winter Weather Warnings
DPW has been sharing winter warnings through their Facebook page. The Town also puts out information about warming shelters. These alerts include:

- All Town – Town Website, Reverse 911 and Facebook Page Updates
- There is a resident portal on the Town Website for residents to sign up to receive Emergency Updates.
- Norfolk DPW – Town/ DPW Website Reverse 911 and Facebook Page Updates
- Norfolk PD – Town/ PD Website Reverse 911 and Facebook Page Updates
- Norfolk FD – Town/ FD Website Reverse 911 and Facebook Page Updates
- Norfolk Council on Aging – Town/ COA Website Reverse 911 and Facebook Page Updates

EXTREME TEMPERATURE HAZARDS

Heat Wave Alerts
The Senior center shared a robo-call during a past heat wave, to call attention to the available cooling center.

Invasive Species Monitoring
The Town's Conservation Committee regularly looks at invasive species status on a project to project basis.

DROUGHT HAZARDS

Bylaws for Water Regulations
The Town has a water use restriction bylaw to protect, preserve and maintain the public health and safety whenever there is a state of Water Supply Conservation or State of Water Emergency.

Water-Related Public Education
The Town shares public education on water resources such as flood prevention and stormwater management. The Town publishes consumer confidence reports annually and publishes water conservation tips, and water use restrictions during droughts. DPW posts on Facebook and on the DPW website. The Town publishes lead and copper sampling results, and PFAS results. The Town also conducts public education and outreach as part of MS4 Permit requirements, including annual messaging related to the disposal of grass clippings, phosphorous reduction, pet waste management, septic system management, and disposal of leaf litter.

SECTION 7 MITIGATION MEASURES FROM THE PREVIOUS PLAN

IMPLEMENTATION OF THE PREVIOUS PLAN

The Local Team reviewed the recommended mitigation measures identified in the Town's 2010 HMP 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 2023 HMP update. The decision on whether to delete or retain a particular measure was based on the Local Team's assessment of the continued relevance or effectiveness of the measure. The table below summarizes the status of mitigation measures from the 2010 plan.

Table 38: Status of High Priority Mitigation Measures from the 2010 Plan

Mitigation Measure	Current Status	Include in 2023 HMP
Public Safety Building Mitigation	Partially complete and ongoing. In 2018, the new police station came online. The septic system was updated. By 2024, the potential new fire station may be online. Some improvements were also made to address roof leakage, but there are still some minor roof leaks. The Town put a section of new roof on but after 2010, another section failed. The Town may be replacing a section of roof soon.	Yes
Campbell Street Mitigation	Not complete, and not relevant. Campbell street does not flood and ownership of this area is complex and in question.	No
City Mills Pond Dam Mitigation	Partially complete and ongoing – there are multiple stages of work. Two culvert structures along with the bridge are currently being looked at for replacement. A series of studies were done, and 25% design plans were submitted with rough cost estimates.	Yes
Redirect Drainage on Shirley Lane	Not complete and no longer relevant. There is no flooding at Shirley Lane.	No
Fire Fighting and Emergency Response Equipment	Complete. The Town has two brush trucks that are smaller, have four-wheel drive, are off-road capable, and can work in snow and inclement weather. The Town also has a boat that they can use for ice rescue, and an ice rescue sled. The Fire Department could work with DPW to use a plow if needed.	No
Acquire GIS & Mapping Technology	Partially complete and ongoing. The Town did purchase a GPS unit, which is now out of date, and no longer used. The Town also updated its online GIS capabilities for internal and public facing	Yes

Mitigation Measure	Current Status	Include in 2023 HMP
	work. The Town will continue to update its technology as needed.	
Protection of Open Space	Complete but ongoing. The Town has acquired land since 2010. The Town has also started the process of updating the Master Plan and will be identifying land protection options. The Town's OSRP will be due for an update in 2024 and the Town is convening an open space committee to guide that work.	Yes
Revisions to Development Bylaws and Regulations	Completed but ongoing. The Town updated its bylaw for the flood district based on the model from FEMA and DCR. The stormwater management bylaw was also updated in 2021. The Town anticipates this topic will be part of the Master Plan update process, and the Town will also need to adopt an updated floodplain bylaw to reflect FEMA's RiskMap update by 2024.	Yes

Table 39: Status of Medium Priority Mitigation Measures from the 2010 Plan

Mitigation Measure	Current Status	Include in 2023 HMP
Enlarge Culvert at Union Street and Grove Castle	Complete. There have been no flooding issues since the culvert was upgraded and maintained.	No
Brush Fire Regulations	Partially complete and ongoing. The Town plans to introduce an open burning bylaw, which would have specific setbacks and rules for what can be burned and would help prevent potential violations	Yes
Inter-municipal Communication	Complete but ongoing. The Town participates in regular SWAP meetings through MAPC. DPW is also a member of SERSG, which hosts monthly meeting with 26 towns involved. Additionally, DPW Directors and Assistant DPW Directors from Bellingham, Medway, Franklin, Millis, Medfield, and Norfolk meet every couple of months and speak more frequently as needed to discuss challenges. The Town Building Department is part of statewide Directors of Facilities website and listserve to receive information and updates. The Town also participates in MIIA along with 40 other communities for OSHA training.	Yes, included in Section 6 as an ongoing existing mitigation measure
Water-Related Public Education	Complete but ongoing. The Town shares public education on water resources such as flood prevention and stormwater management. The Town publishes consumer confidence reports annually and publishes water conservation tips, and water	Yes, included in Section 6 as an ongoing

Mitigation Measure	Current Status	Include in 2023 HMP
	use restrictions during droughts. DPW posts on Facebook and on the DPW website. The Town publishes lead and copper sampling results, and PFAS results. The Town also conducts public education and outreach as part of MS4 Permit requirements, including annual messaging related to the disposal of grass clippings, phosphorous reduction, pet waste management, septic system management, and disposal of leaf litter.	existing mitigation measure
Water Main & Hydrant Improvements	Partially complete and ongoing. The Town did complete improvements to hydrants on Dedham Street (Route 115) in the southern portion of town. The Town is still interested in fire protection related improvements to the water main and hydrants west of Park Street, including extending water mains and adding hydrants in areas that don't have them. The Town is also continually looking at new source development, water main expansion, water main looping projects, and AC pipe replacement. The Town has also discussed, when doing maintenance, also painting bonnets of hydrants based on flow. This helps the Fire Department visually identify the flow of water to expect from each hydrant, which is important information when fighting fires.	Yes
Communications for Emergency Operations	Partially complete and ongoing. The Town has done some work to upgrade wireless communications. The Town is interested in acquiring radio over IP Gateway, to take advance of how robust cell service is, allow backup means of communication, and be more efficient and more cost effective for interoperability and communication between departments. See Section 8 for more information.	Yes

Table 40: Status of "Other" Priority Mitigation Measures from the 2010 Plan

Mitigation Measure	Current Status	Include in 2023 HMP
Miller Street Bridge Mitigation	Not complete and not relevant. The bridge is designed to flood and there has been no flooding in this location in the last 5 years.	No
Mirror Lake Mitigation	Partially complete and ongoing. The Phase 1 inspection was completed on both the dam and dike, and the follow-up inspection to the Phase I dike inspection was complete. DPW monitors overflow structure during weather related events	Yes

Mitigation Measure	Current Status	Include in 2023 HMP
	and there has been no flooding within the last 5 years. The Town continues to look at the whole structure of the dam, dike, and culvert.	
River Road Mitigation	Not complete, and not relevant. These are private properties.	No
Clark Street Mitigation	Not complete, and not relevant. There are no flooding issues at this location.	No

TRANSITIONING TO THE 2023 UPDATED PLAN

As indicated in the tables above, the Town has made progress implementing mitigation measures identified in the 2010 HMP. As described in the tables above:

- 2 projects were completed, including efforts related to fire fighting and emergency response equipment, and culvert upgrades.
- 11 of the mitigation measures from the 2010 plan were carried over to this 2023 plan update, some of which are partially complete or ongoing action items. All have been updated in their descriptions and retain the same priority.
- 4 mitigation measures from the 2010 plan were not completed and were not carried over to this plan update, as they are no longer relevant.

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

SECTION 8 HAZARD MITIGATION STRATEGY

WHAT IS HAZARD MITIGATION?

Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, education programs, infrastructure projects and other activities. FEMA currently has three mitigation grant programs: the Hazards Mitigation Grant Program (HGMP), the Building Resilient Infrastructure and Communities (BRIC) grant, 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/grants/mitigation/building-resilient-infrastructure-communities
- https://www.fema.gov/flood-mitigation-assistance-grant-program

According to FEMA Local Multi-Hazard Mitigation Planning Guidance, identified measures can generally be sorted into the following groups:

- Prevention: Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include planning and zoning, building codes, capital improvement programs, open space preservation, and stormwater management regulations.
- Property Protection: Actions that involve the modification of existing buildings or infrastructure to protect them from a hazard or removal from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, flood proofing, storm shutters, and shatter resistant glass.
- Public Education & Awareness: Actions to inform and educate citizens, elected officials, and property owners about the potential risks from hazards and potential ways to mitigate them. Such actions include outreach projects, real estate disclosure, hazard information centers, and school-age and adult education programs.
- Natural Resource Protection: Actions that, in addition to minimizing hazard losses also preserve or restore the functions of natural systems. These actions include sediment and erosion control, 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.

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 suburban communities such as those in the metropolitan Boston region, 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 local and state agencies including the Town of Norfolk, the Department of Conservation and Recreation (DCR), and the Massachusetts Department of Transportation (MassDOT). 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.

REGIONAL ISSUES

The Town of Norfolk is aware that most communities within the region share common concerns including the following:

- The regional impacts of drought, as many other towns also rely on local groundwater sources for public drinking water.
- The regional risks of flooding in the Charles River watershed, as documented in the Charles River Water Shed Association's Flood Model.
- Maintenance and drainage from state highways
- Inspection and maintenance of state and privately owned dams
- Coordinated response to wildfires on state and privately owned properties
- Emergency Planning through Local Emergency Planning Committees (LEPC) and Regional Emergency Planning Committees (REPC)

See the "Community Overview" section for a list of regional facilities in Norfolk.

NEW DEVELOPMENT AND INFRASTRUCTURE

As part of the process of developing recommendations for mitigation measures for this plan update, the Town considered the issues related to new development, redevelopment, and infrastructure needs in order limit future risks. Taking into consideration the Town's updated bylaw for the flood district, updated stormwater management bylaw, updated water use restriction bylaw for drought conditions, the ongoing Master Plan update, and the future Open Space and Recreation Plan update, 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. Incorporating climate change in Town plans and operations is envisioned as part of this plan, and as part of the ongoing Master Plan update.

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 Team has limited access to detailed analyses of the cost and benefits of any given measure, so prioritization is based on the committee member's knowledge of the existing and potential hazard impacts and an approximate sense of the costs associated with pursuing any given measure.

Priority setting was based on local knowledge of the hazard areas, including impacts of hazard events and the extent of the area impacted and the relation of a given mitigation measure to the Town's identified goals. In addition, through the discussion, the local team also took into consideration factors such as homes or 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 the Town currently had the technical and administrative capability to carry out the mitigation measures, whether any environmental constraints existed, and whether the Town would be able to justify the costs relative to the anticipated benefits.

The table below summarizes the factors considered for prioritizing the recommended hazard mitigation measures. For each mitigation measure, the geographic extent of the potential benefiting area is identified as well as an estimate of the overall benefit and estimated cost of the mitigation measures. The overall priority of each measure was evaluated in terms of these factors.

Table 41: Factors for Prioritizing Mitigation Measures

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 $200,000
Medium	Estimated costs between $50,000 to $200,000
Low	Estimated costs less than $50,000 and/or staff time
Mitigation 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

RECOMMENDED MITIGATION MEASURES FOR 2023 HMP UPDATE

INTRODUCTION TO MITIGATION MEASURES TABLE

Mitigation Measure – name, location, or category of the action item.

Description– Each mitigation measure is provided with a brief description.

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

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

Estimated Cost – The Local Hazard Mitigation Team assigned a cost category as follows:

Low: <$50,000 and/or staff time
Medium: $$50,000 to $200,000
High: >$200,000

Potential Funding Sources – This column attempts to identify the most likely sources of funding for each recommended mitigation 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. 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. The best way to determine eligibility for a particular funding source is to review the project with a staff person at the funding agency. Upon adoption of this plan, the local committee responsible for its implementation should begin to explore the funding sources in more detail.

Priority – As described above, the designation of high, medium, or low priority was done considering potential benefits and estimated project costs.

Abbreviations used in the Table below include:

- DCR: MA Department of Conservation and Recreation
- BRIC: Building Resilient Infrastructure and Communities
- EEA: Massachusetts Executive Office of Energy and Environmental Affairs
- MassDOT: Massachusetts Department of Transportation
- TON: Town of Norfolk
- DEP: Department of Environmental Protection
- MAPC: Metropolitan Area Planning Council
- TAP: Technical Assistance Program (an MAPC Grant)
- ACR: Accelerating Climate Resilience (An MAPC Grant)
- PPA: Power Purchase Agreement
- EMPG: MEMA Emergency Management Performance Grant
- CCP: MEMA Citizen Corps Program
- MET: Massachusetts Environmental Trust
- "General fund" refers to funding from the Town

RECOMMENDED MITIGATION MEASURES

Table 42: Mitigation Measures Carried Over from the 2010 HMP

Mitigation Measure	Description	Lead Implementation	Time Frame	Estimated Cost	Potential Funding Sources	Priority
Potential New Fire Station	The Town approved the construction of a new fire station.	Fire Department	2024	$26M	FEMA BRIC, General fund	H
City Mills Pond Structures (Dam, 2 Culverts, and Bridge) Mitigation	Next steps to advance the most recent work completed (Preliminary engineering and design options for bridge construction, roadway realignment and culvert upgrades and or replacement).	DPW	1-5 years	$10-$12M	State Earmark Funds, DER Culvert Replacement Municipal Assistance Grant Program	H
Fire Fighting Equipment	Replace ladder truck. The current Ladder truck is old, and outside of compliance.	Fire Department	2026	$1.5M	AFG Grant	H
Improve GIS Mapping Capabilities.	Continue updating and improving capabilities. Purchase a new GPS unit. Complete the current effort to update GIS in the Land Use Department.	DPW, Land Use Department	Land Use: 2023. GPS unit: 2024	<$50,000, staff time	General fund	M
Update Open Space and Recreation Plan	Consider hazard mitigation and resilience in the updated OSRP. Create a permanent Open Space Committee.	Land Use Department	Summer 2024	Low cost category: <$50,000, staff time	EEA Planning Assistance Grant, MAPC TAP Grant	H
Update Town Master Plan	Consider hazard mitigation and resilience in the updated Master Plan. Identify land for acquisition and protection. Revise and strengthen existing regulations and bylaws. Evaluate the need to amend the Town's existing scenic tree by-law.	Land Use Department, MAPC	2025	$140,000 ($90k appropriated, Town will submit for the last $50k)	Department of Revenue, Community Compact Grant Program: funding already secured	M
Improve Fire Protection through Water Main and Fire Hydrant Installation and Extensions	Extend water mains, add hydrants in areas that don't have them, continue to look at new source development, water main expansion, water main looping projects, and AC pipe replacement.	Fire Department and DPW	2024	High cost category: >$200,000	FEMA BRIC	H

Mitigation Measure	Description	Lead Implementation	Time Frame	Estimated Cost	Potential Funding Sources	Priority
Open Burning Bylaw	Introduce an open burning bylaw that specifies when burning season is, what is permissible outside of burning season, burn limitations, required distance from other structures, and maximum height of wood stack. Caution that the Town has the right to extinguish fires in the event of a complaint or nuisance.	Fire Department	Draft anticipated by Annual Town meeting May 2023	Staff time	N/A	L
Public Education on Fire Prevention	Share educational materials about fire risk during burn season. Leverage the current website and fact sheet. Improve urban interface education through FireWise by sharing information on pruning bushes, keeping separation between home and vegetation, raking yard, leaf litter, creating a natural stop around perimeter of your home to limit structure fire, and more.	Fire Department	2024	Low cost category: <$50,000, staff time	FEMA Fire Prevention and Safety Grant (FP&S), Department of Fire Services Student Awareness of Fire Education (S.A.F.E.) and Senior SAFE	L
Paint hydrant bonnets	When doing maintenance, paint hydrant bonnets based on flow, to indicate to the Fire Department what flow of water to expect from the hydrant.	DPW Water Department	Updated workflow completed in 2023	Low cost category: <$50,000, staff time	General fund	M
Upgrade communications for Emergency Operations	Acquire radio over IP Gateway to use any smart phone as a radio, talk over any frequency, and get direct contact with staff across departments. This would take advance of how robust cell service is, allow backup means of communication, and increase cost effectiveness for interoperability. DPW, Police, and Fire could communicate with each other without needing a new radio system.	Fire Department	2024 or 2025	$26k for 10 licenses and a 5-year commitment	General fund: could share across department budgets for Police, Fire, and DPW	M
Mirror Lake Dam, Dike, and Culvert Mitigation	Next steps to upgrade culvert, tree removal on dike, and complete additional recommendations to address deficiencies identified during the Phase 1 Evaluations.	DPW	1-5 years	High cost category: >$200,000	EEA Dam and Seawall Repair or Removal Program	H

RECOMMENDED MITIGATION MEASURES

Table 43: New Mitigation Measures for the 2023 Plan Update

Mitigation Measure	Description	Lead Implementation	Time Frame	Estimated Cost	Potential Funding Sources	Priority
MULTI-HAZARD MITIGATION						
Install solar arrays	This may include solar canopies and roof mount on the current police station and adding solar to the elementary school and potentially the new fire station, if viable.	DPW, Building Department	1-5 years	High cost category: >$200,000	PPA	H
Multi-Department Review of Developments	Identify improvements to make the process more efficient for larger scale residential projects.	Land Use Department, DPW, Fire Department	2023	Staff time	N/A	M
Senior Center Parking lot	Improve safety and address potential liability issues at the current Senior Center Parking lot by implementing the current design.	Council on Aging, Building Department	1-5 years	High cost category: >$200,000	ARPA funds and $25k grant from State Senate	H
Improve Shelters	Bolster schools and emergency shelters to incorporate sanitation aspects (i.e., showers) to allow for longer term occupancy of displaced residents	Building Department, Council on Aging, Schools	• Construction documents by 2024. • Apply for construction funds by 2025 • Complete by 2026 or later	$50,000 to $200,000	MEMA EMPG, MEMA CCP Grant	M
Invasive species	Continue monitoring of invasive species for reporting. Conduct a public outreach program for education related to invasives.	Conservation Commission, Open Space Committee	1-5 years (ongoing)	Low cost category: <$50,000	Public education: MAPC TAP Grant, MAPC ACR Grant	L
Soils and Hazardous Waste Sites	Develop an inventory of contaminated sites, evaluate possible remedies and redevelopment options to existing contaminated sites. The Town is currently working on the Southwood Hospital Site.	Land Use Department, DPW	1-5 years	High cost category: >$200,000	MassDEP Technical Assistance Grants for Waste Site Cleanup, Mass Development Brownfields grants	H
FLOOD HAZARDS						

Mitigation Measure	Description	Lead Implementation	Time Frame	Estimated Cost	Potential Funding Sources	Priority
Coordination with private dam owners	For privately owned significant hazard dams, the Town will work with ownership to ensure proper management plans and communications are in place for extreme rain events	DPW, Land Use and Conservation	2024	Staff time	N/A	M
Address flooding on Seekonk Street	AC main replacement and culvert upgrade at the crossing on Seekonk Street. The Town is currently at 75% Design Plan.	DPW	1-5 years	Water main: $1M Culvert: $1.5M	DER Culvert Replacement Grant, ARPA, Water Enterprise Funds, General fund	H
Acquire trash pump	Town is has received a grant to get a new trash pump.	DPW	2023	$1800	EMPG grant	M
Stormwater Management	Complete next steps for the Town's MS4 work, including: • Green Infrastructure Report – 2023 • List of Municipal Retrofit Opportunities – 2023 • Phosphorus removal program	DPW, Land Use	1-5 years	High cost category: >$200,000	ARPA FY23, FY24 and possibly FY25. Considering a stormwater utility.	H
Stormwater utility	Consider establishing a stormwater utility to support the Town's MS4 work	Town Administration, Land Use, Conservation, DPW	1-5 years	Staff time	N/A	M
Dams	Consider decommissioning existing dams, potentially including City Mills and Mirror Lake	TON, DCR, DEP	3-5 years	High cost category: >$200,000	EEA Dam and Seawall Repair or Removal Program, MET Grants, DEP Priority Projects	L
WIND HAZARDS						
Vegetation management	Continue to build on work with Eversource and implementation of vegetation management plan. Seek additional budget, training, and staff resources for the Tree Warden's management of wind hazards.	Tree Warden	1-5 years	Staff time	General fund	M
WINTER HAZARDS						
Acquire a new truck for	Acquire a new truck that would allow the	DPW	2-5 years	$50,000 to	Chapter 90,	L

Mitigation Measure	Description	Lead Implementation	Time Frame	Estimated Cost	Potential Funding Sources	Priority
pre-treatment	Town to do roadway pre-treatment with magnesium chloride, to lower the amount of sodium going on the roadways. This will allow for less salt per storm and more concise applications, and is a best practice for snow and stormwater management. The Town's current truck is from 1986.			$200,000	Winter Streets & Spaces Grant, General fund	
GEOLOGIC HAZARDS						
Address occasional rock slides on Lawrence Street	The occasional rockslides impact the roadway. DPW will address this hazard while reconstructing Lawrence street. A developer is extending a water main project.	DPW	1-3 years	High cost category: >$200,000	The current project is already funded.	L
EXTREME HEAT HAZARDS						
Adopt Site Design Guidelines to increase tree plantings	Adopt Site Design guidelines for new development and redevelopment to increase tree plantings near buildings, increase the percentage of trees used in parking areas, and along public ways.	Land Use	2-3 years	Staff time	N/A	L
DROUGHT HAZARDS						
Promote drought tolerant landscaping and site design measures	Adopt site development guidelines promoting drought-tolerant landscaping and site design measures. Both the Fire Station and the Kennedy School projects include LID design and drought tolerant landscaping. Any new municipal projects should do the same.	Building Department, Land Use	2-3 years	Staff time	N/A	L
Water supply-related measures	Public education and community outreach related to water supply and conservation. Strict enforcement of water use restrictions. Pursue new well locations.	DPW, Select Board and Town Administration	2026: new well location 1-5 years: public education	New well exploration - $600,000	Public education: MAPC TAP Grant, MAPC ACR Grant	H
Revisions to private well regulations	This spring, the Board of Health will look at doing revisions to private well regulations, including regarding irrigation wells and looking at standards for PFAS for private wells.	Board of Health	2024	Staff time	N/A	H
FIRE HAZARDS						

Mitigation Measure	Description	Lead Implementation	Time Frame	Estimated Cost	Potential Funding Sources	Priority
Campbell Forest Access Road	Brush trucks are designed to go over small saplings and firefighters carry chain saws and a winch for clearing as needed. Create a biannual schedule for minimum cleanup and clearing of access roads by DPW that would allow Fire Department trucks to traverse as needed. This could be included as part of DPW's typical tree trimming on roadways.	Fire Department, DPW, Forest Warden	1-2 years: creating schedule. 1-5 years:: brush clearing of access roads	Staff time	N/A	L

SECTION 9 PLAN ADOPTION AND MAINTENANCE

PLAN ADOPTION

The Norfolk Hazard Mitigation Plan was adopted by the Select Board on [DATE TBD]. See Appendix F for adoption documentation. The plan was approved by FEMA on [DATE TBD] for a five-year period that will expire on [DATE TBD].

PLAN MAINTENANCE

MAPC worked with the Local Team to prepare this plan. After approval of the plan by FEMA, the Local Team will meet on a regular basis to function as the hazard mitigation implementation team, with the Assistant Director of Public Works and the Director of Planning & Development designated as the team coordinators. Additional members could be added to the local implementation team from other Town departments, local 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 Local Team, these will be placed on the project's website, and any meetings of the Local Team will be publicly noticed in accordance with town and state open meeting laws.

IMPLEMENTATION AND EVALUATION SCHEDULE

Mid-Term Survey on Progress – The coordinators of the Local Team will prepare and distribute a survey in year three of the plan. The survey will be distributed to all of 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 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 Local Team will have primary responsibility for tracking progress, evaluating, and updating the plan.

Begin to Prepare for the next Plan Update -- FEMA's approval of this plan is valid for five years, by which time an updated plan must be approved by FEMA in order to maintain the town's approved plan status and its eligibility for FEMA mitigation grants. Given the lead time needed to secure funding and conduct the planning process, the Local 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 Local 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 Building Resilient Infrastructure and

Communities 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 Local 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 Local Team decides to update the plan, the group will need to review the current FEMA hazard mitigation plan guidelines for any changes in requirements. Once the next draft plan update is prepared, the Town will submit it to MEMA and FEMA for review and approval and adopt the plan update to obtain formal FEMA approval of the plan.

INTEGRATION OF THE PLANS WITH OTHER PLANNING INITIATIVES

Upon approval of the Norfolk Hazard Mitigation Plan 2023 Update, the Local Team will provide all interested parties and implementing departments with a copy of the plan and will initiate a discussion regarding how the plan can be integrated into that department's ongoing work. At a minimum, the plan will be reviewed and discussed with the following departments:

- Fire Department
- Police Department
- Department of Public Works
- Planning Board
- Board of Health
- Building Department

Other groups that will be coordinated will include land conservation organizations, watershed groups, business groups, and nonprofit institutions. The posting of the plan on the Town's website will include a mechanism for citizen feedback such as an e-mail address to send comments.

The Town of Norfolk took steps to implement findings from the 2010 HMP into policy and plans, including their 2020 MVP plan, updating the bylaw for the flood district, updating the stormwater management bylaw, and updating the water use restriction bylaw for drought conditions. Moving forward, the Hazard Mitigation Plan 2023 Update will be integrated into other town plans and policies as they are updated and renewed, including the currently ongoing Master Plan update, Open Space and Recreation Plan, and Comprehensive Emergency Management Plan.

SECTION 10 REFERENCE LIST

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APPENDIX A: HAZARD MAPPING

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

The map series consists of twelve panels displaying the following information:

1.	ation Density
1b.	nmental Justice
2.	Use
3.	Zones
3b.	Claims from March 2010 Disaster Declaration
4.	quakes and Landslides
5.	anes and Tornadoes
6.	ge Snowfall
7.	osite Natural Hazards
8.	Hazard Areas
10	ne Heat
11	ires

Map 1: Population Density – This map uses the US Census block data for 2020 and shows population density as the number of people per acre in seven categories with 60 or more people per acre representing the highest density areas.

Map 1b: Environmental Justice – This map shows Environmental Justice (EJ) populations using 2020 data. EJ designations from the State include English isolation, income, and minority residents.

Map 2: Land Use – This map shows land cover and land use from MassGIS' 2016 Land Cover/Land Use dataset.

Map 3: Flood Zones – The map of flood zones used the FEMA NFIP Flood Zones for Middlesex County as its source. For more information, refer to the FEMA Map Service Center website http://www.msc.fema.gov. The definitions of the flood zones are described in detail on this site as well. The flood zone map for each community also shows critical infrastructure and municipally owned and protected open space.

Map3b: Flood Claims – This map shows flood insurance and disaster claim records from March 2010. The March 29, 2010 federal disaster declaration associated with severe rainfall and flooding triggered the launch of the Federal Emergency Management Agency's (FEMA's) Individual Assistance Program through which residential property owners, businesses, and institutions without flood insurance were eligible to apply for relief to pay for storm-related expenditures and repairs. Across the seven counties, over 27,000 individual claims were approved for nearly $59 million in disaster assistance,

while reimbursements to state and local governments totaled $25 million. In the MAPC region, 18,400 claims were approved for $30 million dollars in disaster assistance.

Map 4: Earthquakes and Landslides (Regional) – This map depicts landslide risk and recorded earthquake epicenters in the community and surrounding region. This information came from NESEC. For most communities, there was no data for earthquakes because only the epicenters of an earthquake are mapped.

The landslide information shows areas with either a low susceptibility or a moderate susceptibility to landslides based on mapping of geological formations. This mapping is highly general in nature. For more information on how landslide susceptibility was mapped, refer to http://pubs.usgs.gov/pp/p1183/pp1183.html.

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

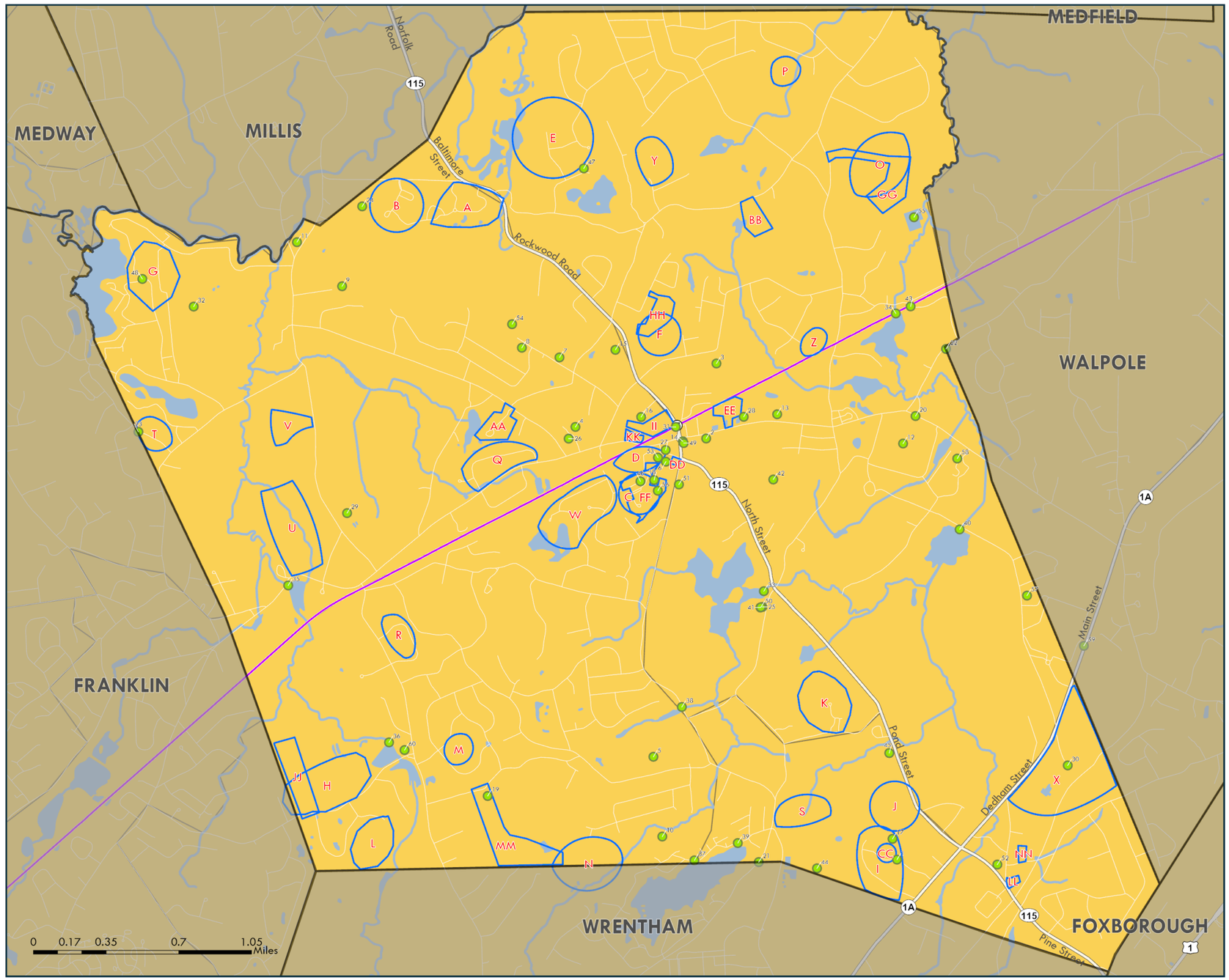
Map 6: Average Snowfall (Regional) - This map shows the average snowfall in the community and the surrounding region.

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

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

Map 10: Extreme Heat – MAPC's Statewide Land Surface Temperature (LST) Index was created by combining estimates of surface temperature from days in 2018, 2019, and 2020 where the daily air temperature maximum exceeded 70 degrees Fahrenheit. The Statewide LST Index "Hot Spots" data depicts the 5% highest LST index areas in each Regional Planning Agency (RPA) region. The data was generated by identifying pixels whose LST index values are equal to or greater than 95% of LST index values in the region, and then delineating cohesive regions where pixels meet this criterion as polygons. Map 9 represents the "Hot Spots" relative to the MAPC region, mapped on top of the National Land Cover Database's 2016 30-m tree canopy data.

Map 11: Wildfires – This map shows wildfire risk to the community using USDA data. Wildfire risk is classified as very low, low, moderate, high, and very high.



Map 1: Population Density

MAPC dcr

FEMA Hazard Mitigation Planning Grant

NORFOLK, MA

- Critical Infrastructure*
- Development Areas

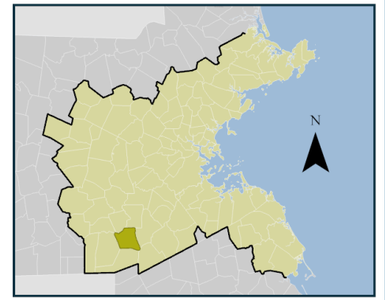
* See details in separate table

- Water Bodies
- Commuter Rail

Census 2020 Block Groups

Population Density: People per acre

- 0 or No Data
- 0.1 - 5.0
- 5.1 - 15.0
- 15.1 - 30.0
- More than 30



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

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

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

NORFOLK, MA

Date: 3/16/2023

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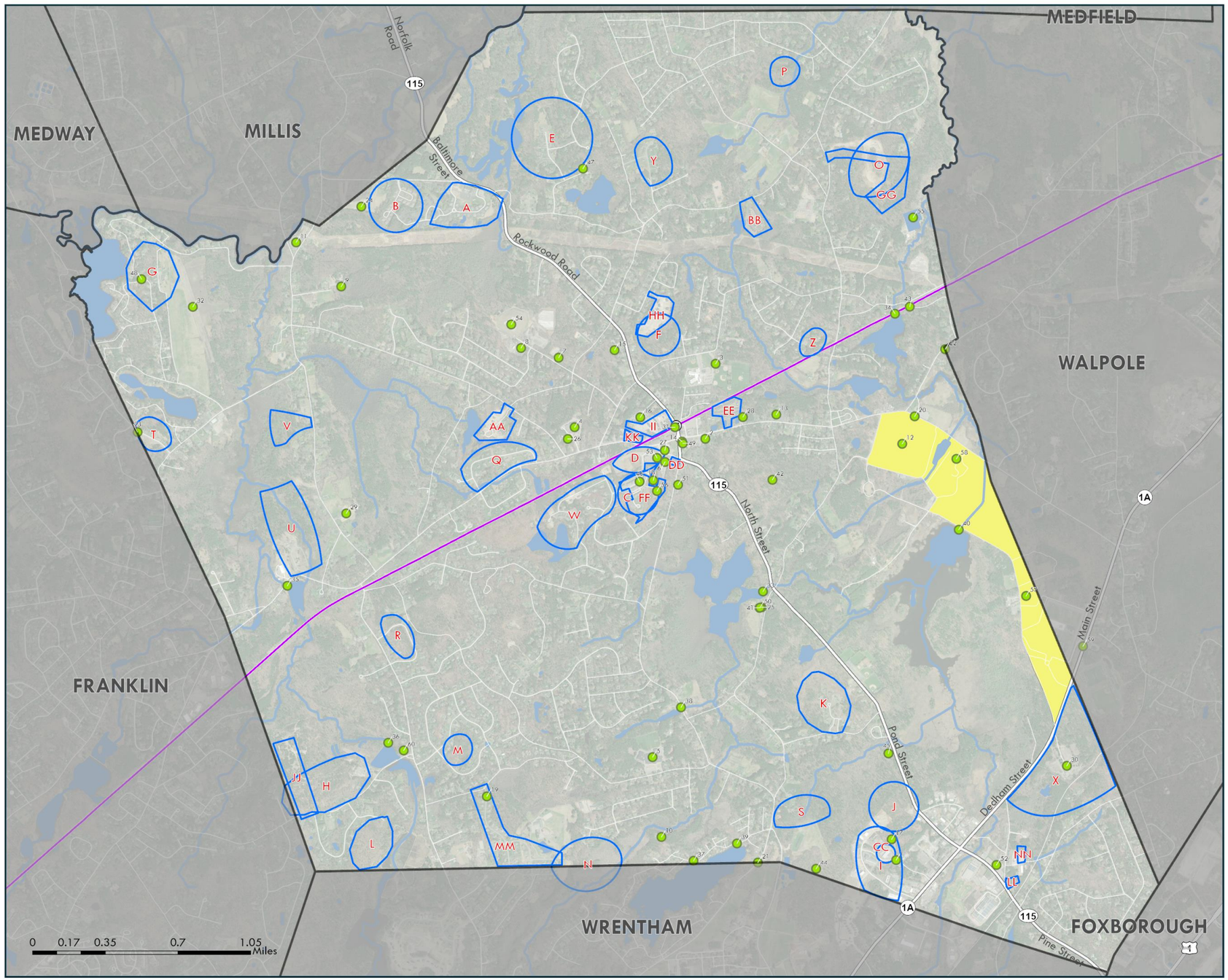


Map 1a: Environmental Justice

MAPC dcr

FEMA Hazard Mitigation Planning Grant

NORFOLK, MA

- Critical Infrastructure*
- Development Areas

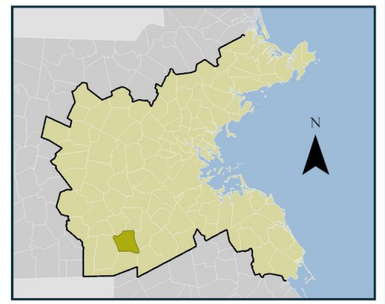
* See details in separate table

- Water Bodies
- Commuter Rail

Environmental Justice Populations 2020

EJ Criteria Description

- English isolation
- Income
- Income and English isolation
- Minority
- Minority and English isolation
- Minority and income
- Minority, income and English isolation



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NORFOLK, MA

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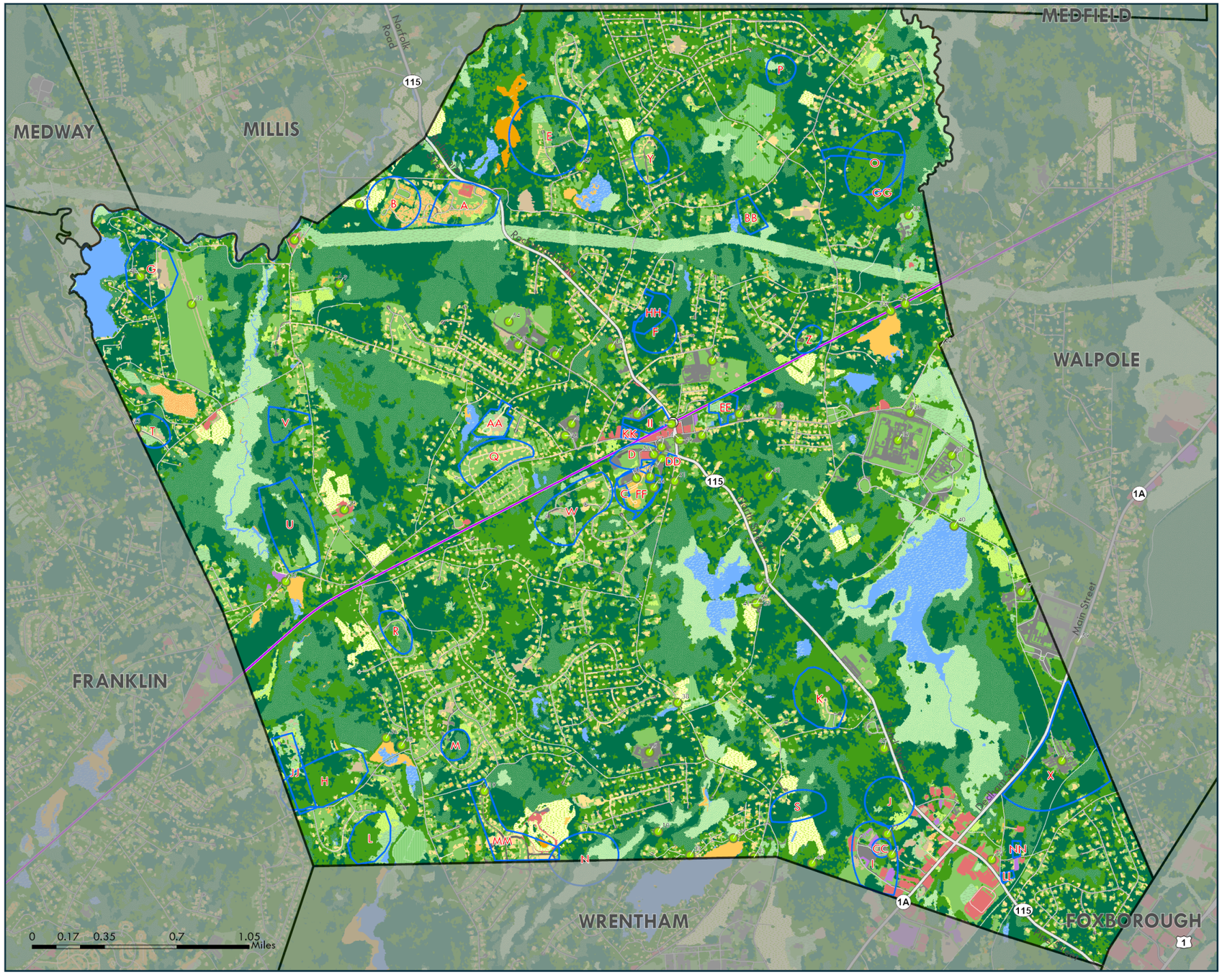


Map 2: Land Use

FEMA Hazard Mitigation Planning Grant

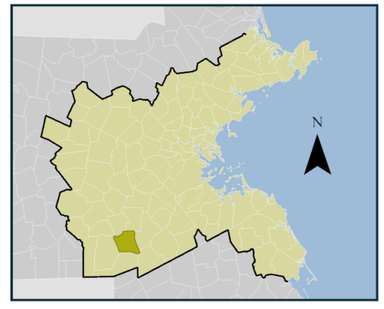
NORFOLK, MA

- Critical Infrastructure*
- Development Areas
- Commuter Rail

* See details in separate table

Land Cover-Land Use (2016)

- Residential - Single Family
- Residential - Multi-Family
- Residential - Other
- Commercial
- Industrial
- Mixed Use - Primarily Residential
- Mixed Use - Primarily Commercial
- Mixed Use - Other
- Other Impervious
- Right-of-way
- Cultivated
- Pasture/Hay
- Developed Open Space
- Deciduous Forest
- Evergreen Forest
- Grassland
- Scrub/Shrub
- Bare Land
- Forested Wetland
- Non-forested Wetland
- Saltwater Wetland
- Water
- Unconsolidated Shore
- Aquatic Bed



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NORFOLK, MA

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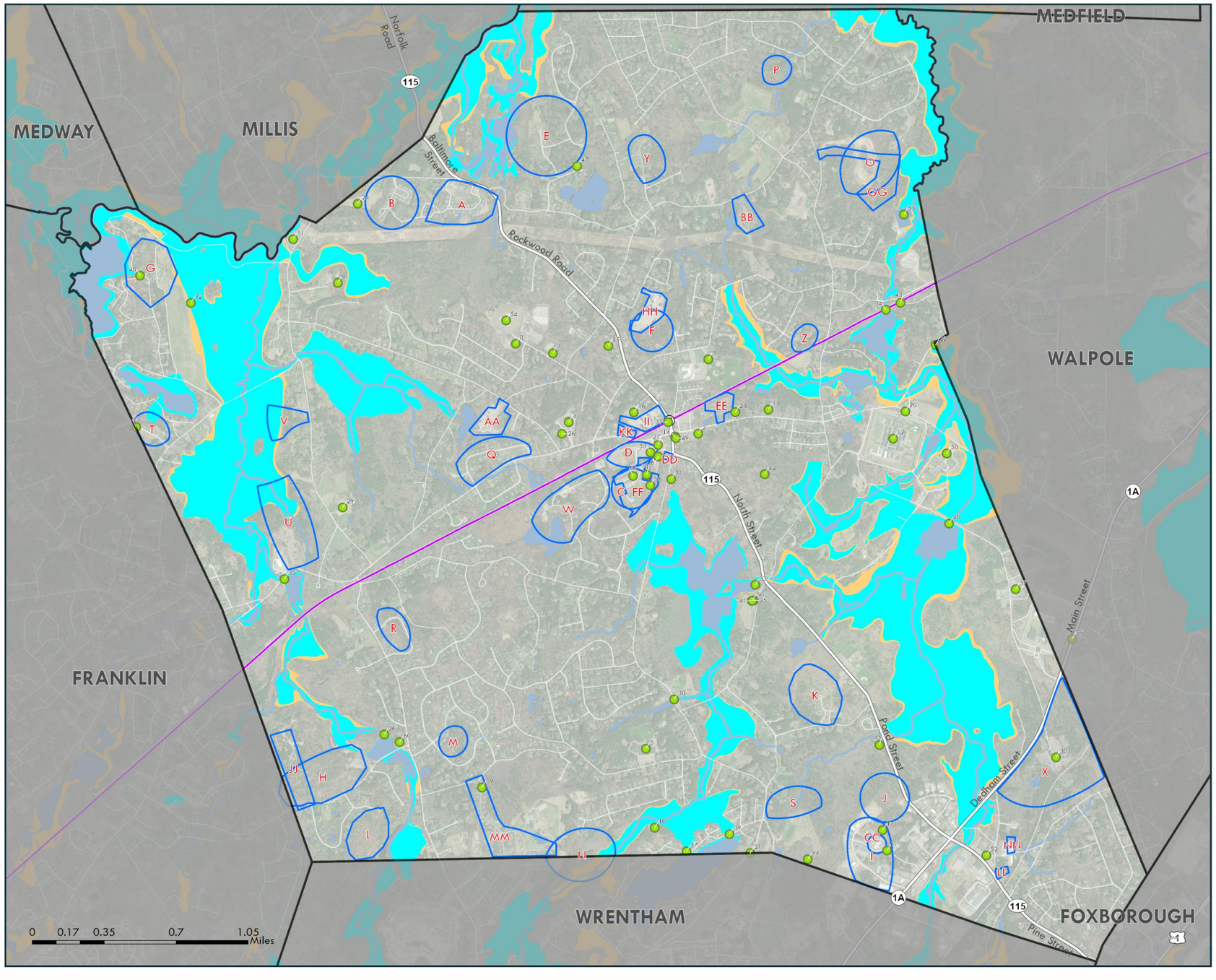


Map 3: Flood Zones

MAPC dcr

FEMA Hazard Mitigation Planning Grant

NORFOLK, MA

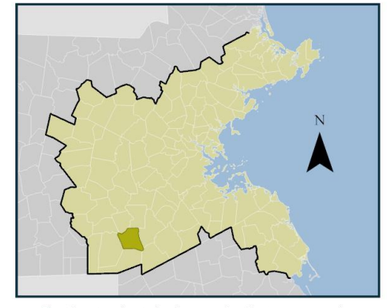
- Critical Infrastructure*
- Development Areas

* See details in separate table

- Water Bodies
- Commuter Rail

FEMA 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



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NORFOLK, MA

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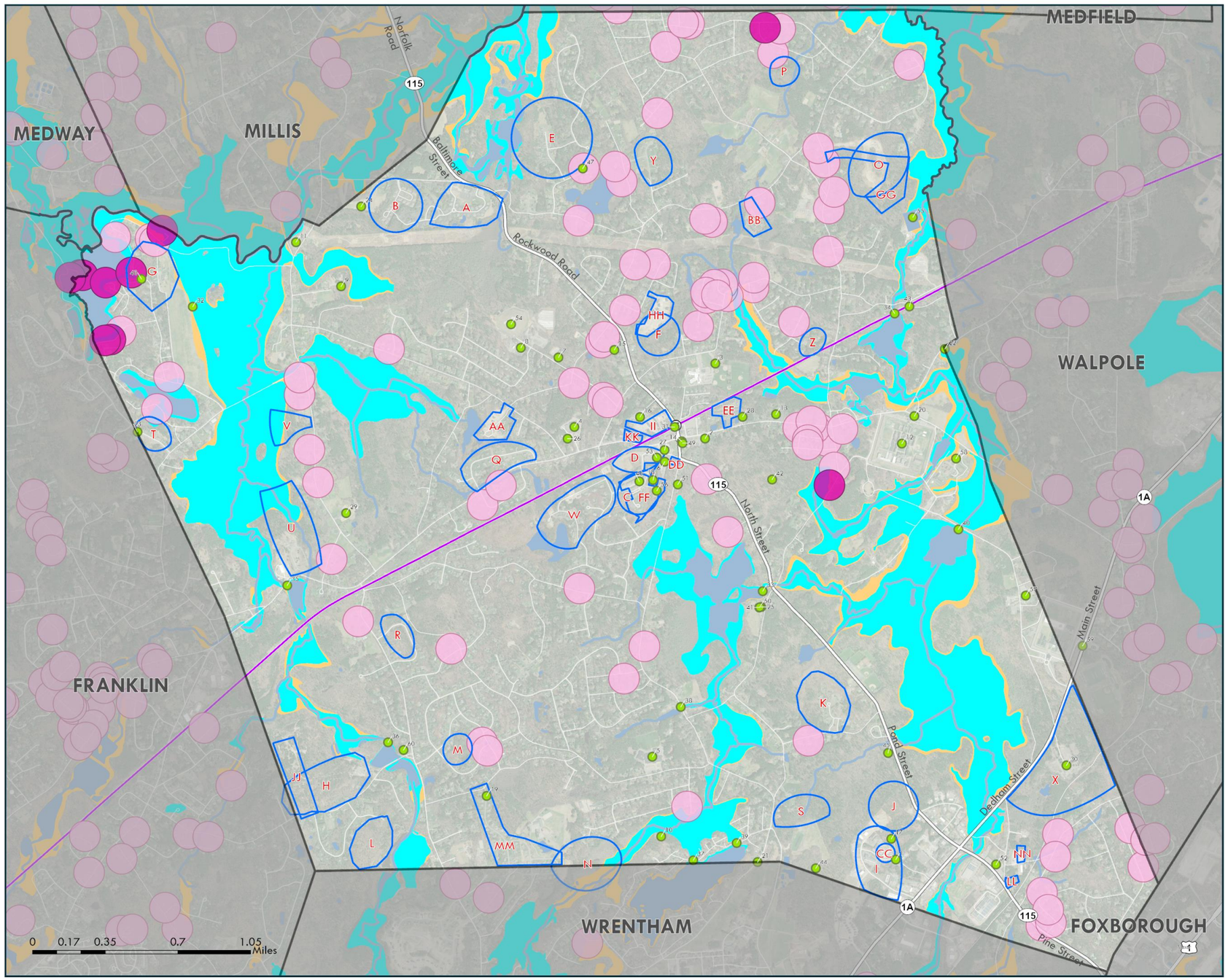


Map 3b: Flood Zones and 2010 Flood Claims

MAPC dcr

FEMA Hazard Mitigation Planning Grant

NORFOLK, MA

- Critical Infrastructure*
- Development Areas

* See details in separate table

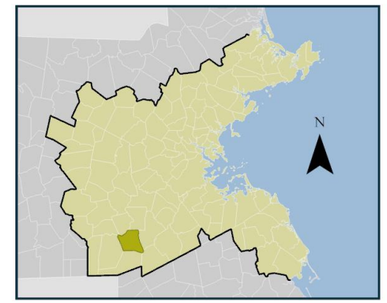
- Water Bodies
- Commuter Rail

FEMA 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

2010 Flood Claims

- Disaster Assistance
- Flood Insurance



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NORFOLK, MA

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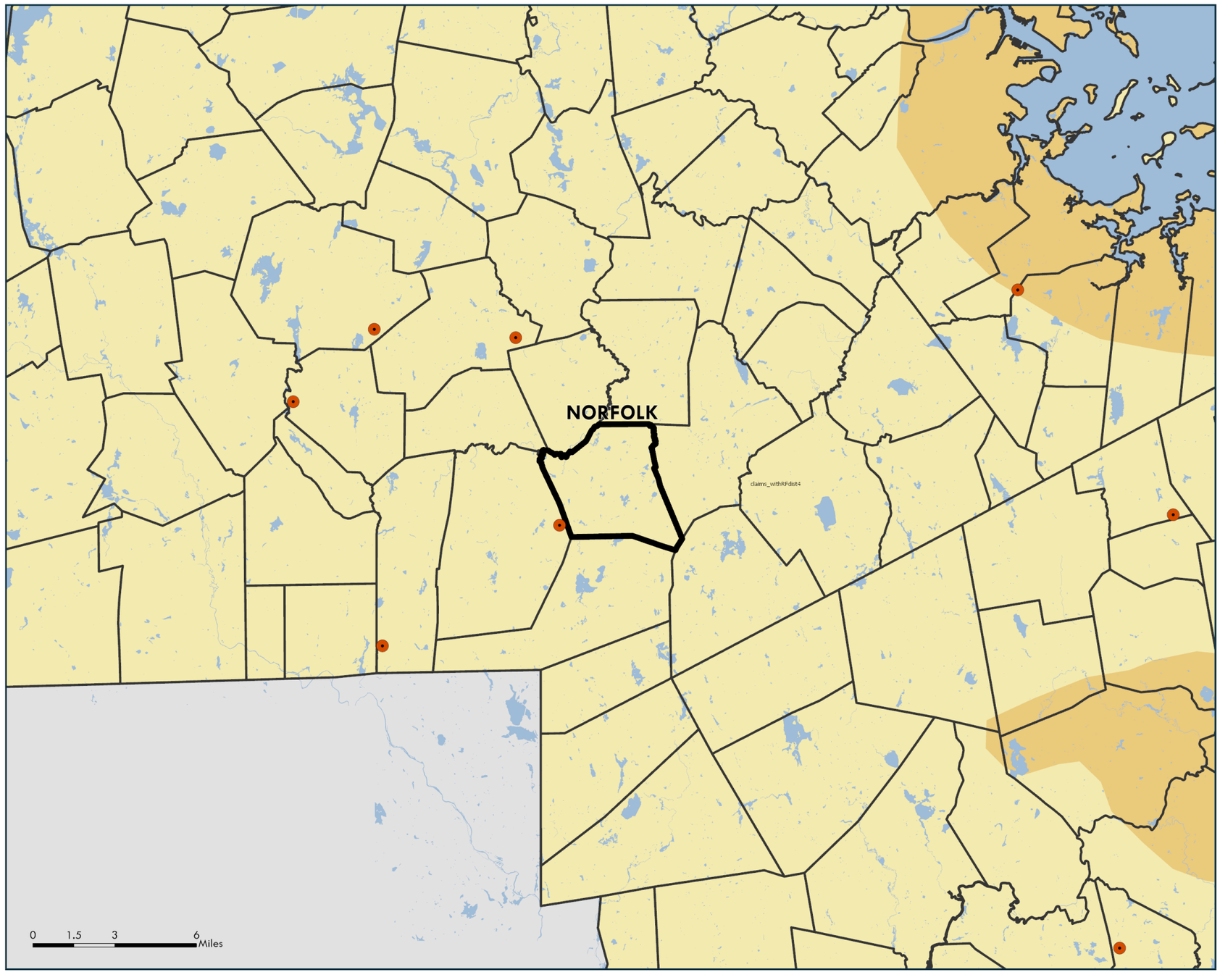


Map 4: Earthquakes and Landslides

MAPC dcr

FEMA Hazard Mitigation Planning Grant

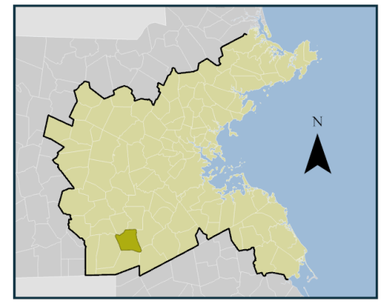
NORFOLK, MA

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

Earthquakes

- Epicenters



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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)
U.S. Decennial Census

NORFOLK, MA

Date: 3/16/2023

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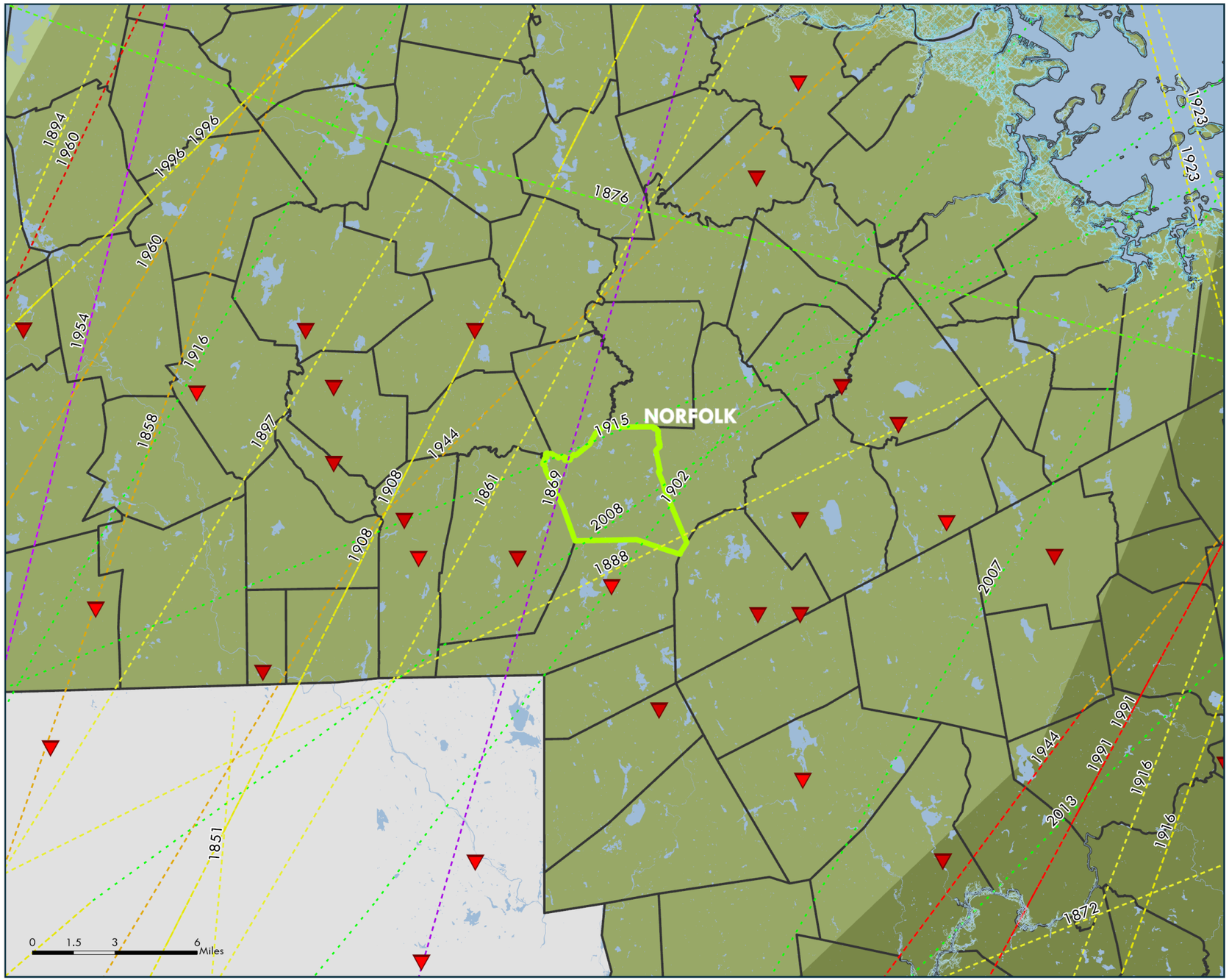


Map 5: Hurricanes and Tornadoes

MAPC dcr

FEMA Hazard Mitigation Planning Grant
NORFOLK, MA

Hurricane Surge Inundation Area

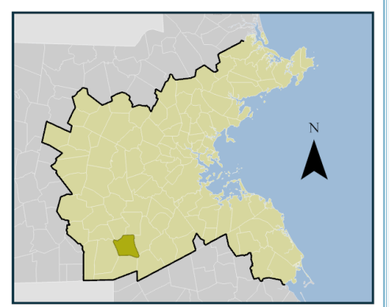
Tornado

Storm Tracks

- Tropical Depression
- Tropical Storm
- Category 1 Hurricane
- Category 2 Hurricane
- Category 3 Hurricane

100 Year Wind Speeds
Miles Per Hour

- 90 MPH
- 100 MPH
- 110 MPH
- 120 MPH
- 130 MPH



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NORFOLK, MA

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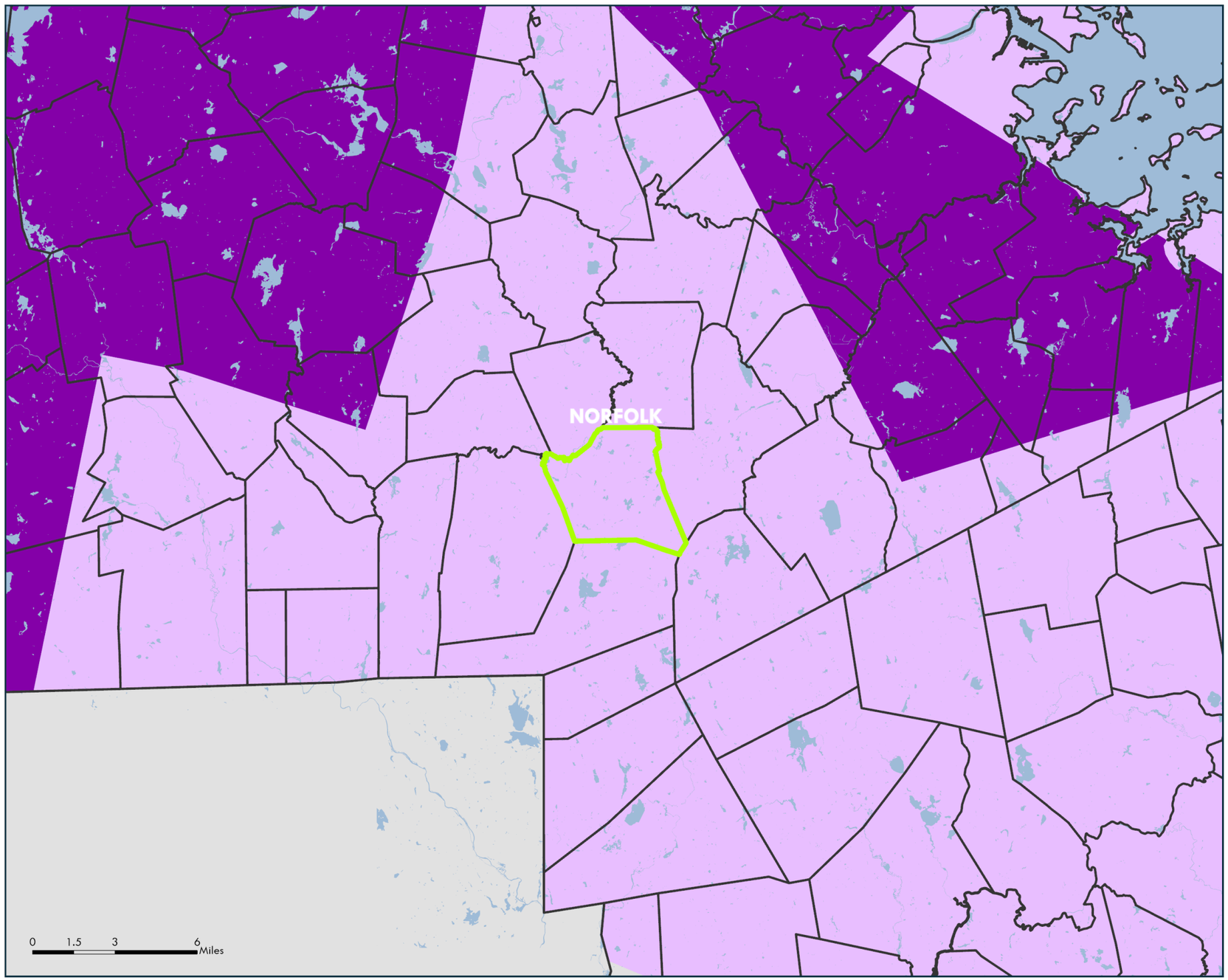


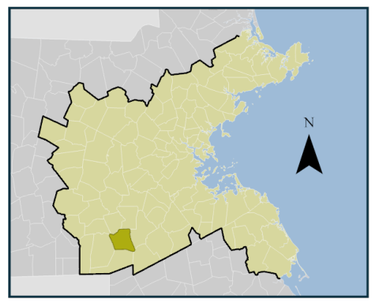
Map 6:
Average Snowfall

MAPC dcr

FEMA Hazard
Mitigation Planning Grant

NORFOLK, MA

Average Annual Snowfall
Inches
G 36.1 - 48.0
H 48.1 - 72.0



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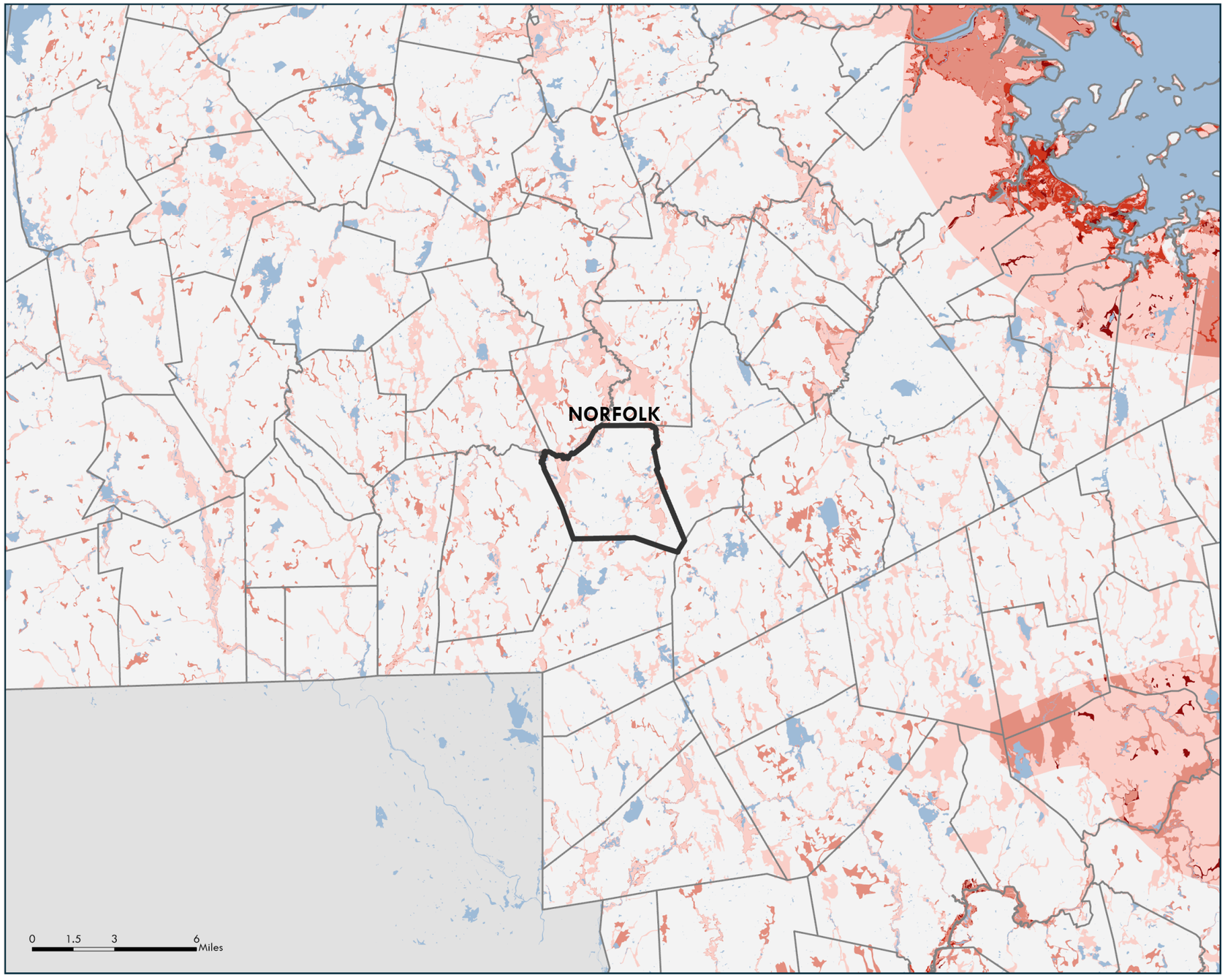


Map 7: Composite Natural Hazards

MAPC dcr

FEMA Hazard Mitigation Planning Grant

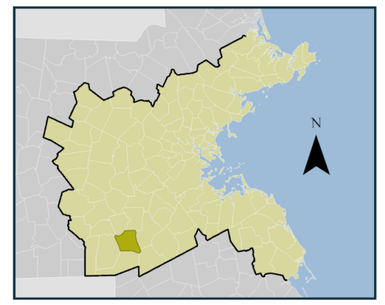
NORFOLK, MA

Composite Natural Hazards

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

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

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



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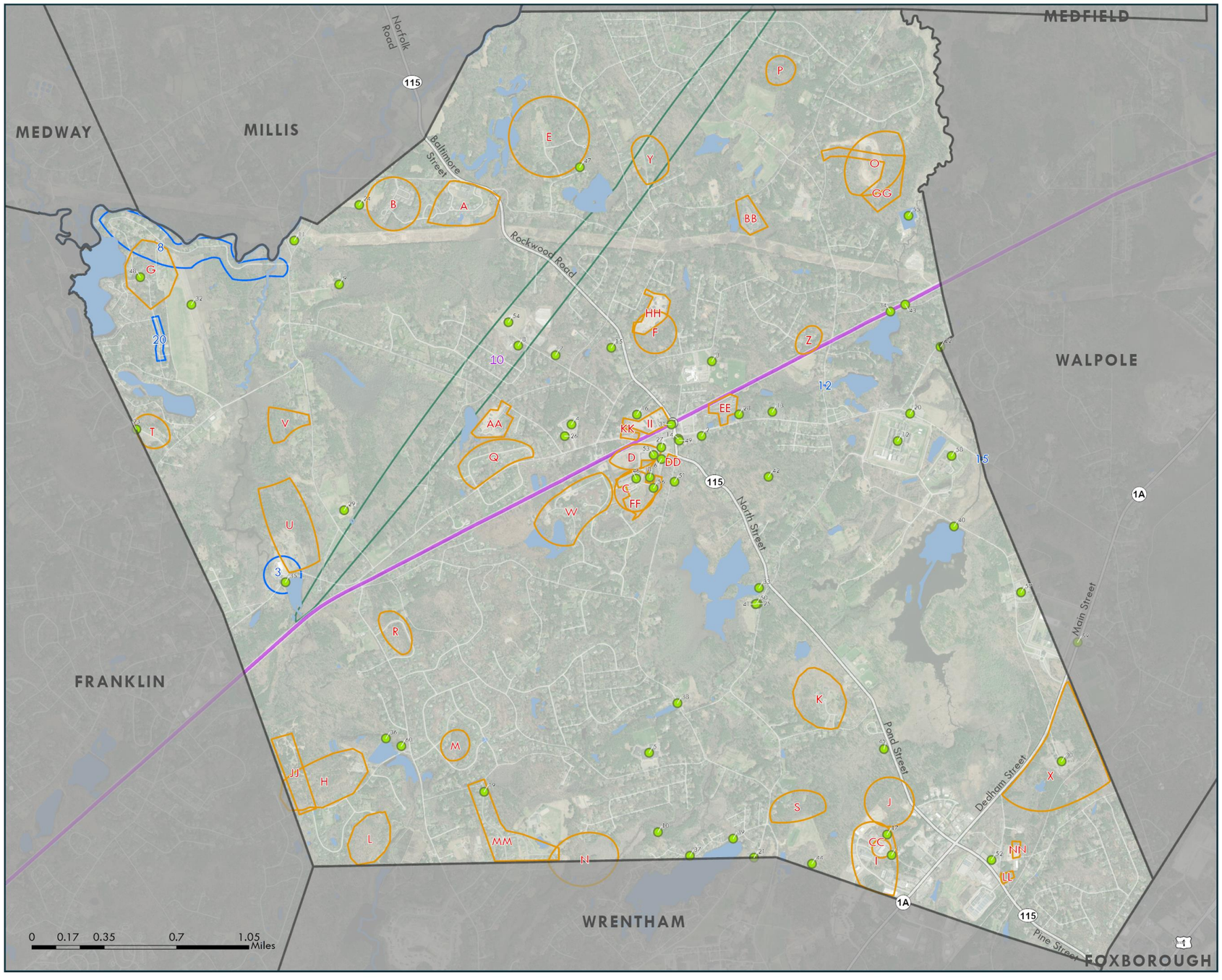


Map 8: Local Hazard Areas

MAPC dcr

FEMA Hazard Mitigation Planning Grant

NORFOLK, MA

- Critical Infrastructure*
- Development Areas

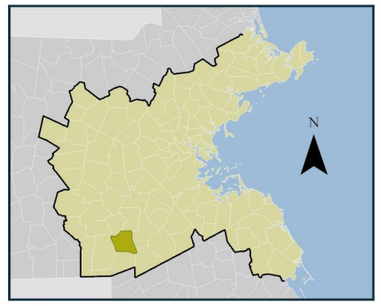
* See details in separate table

- Water Bodies
- Commuter Rail

Hazard Areas

Type

- Brush Fire
- Flooding
- Other



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NORFOLK, MA

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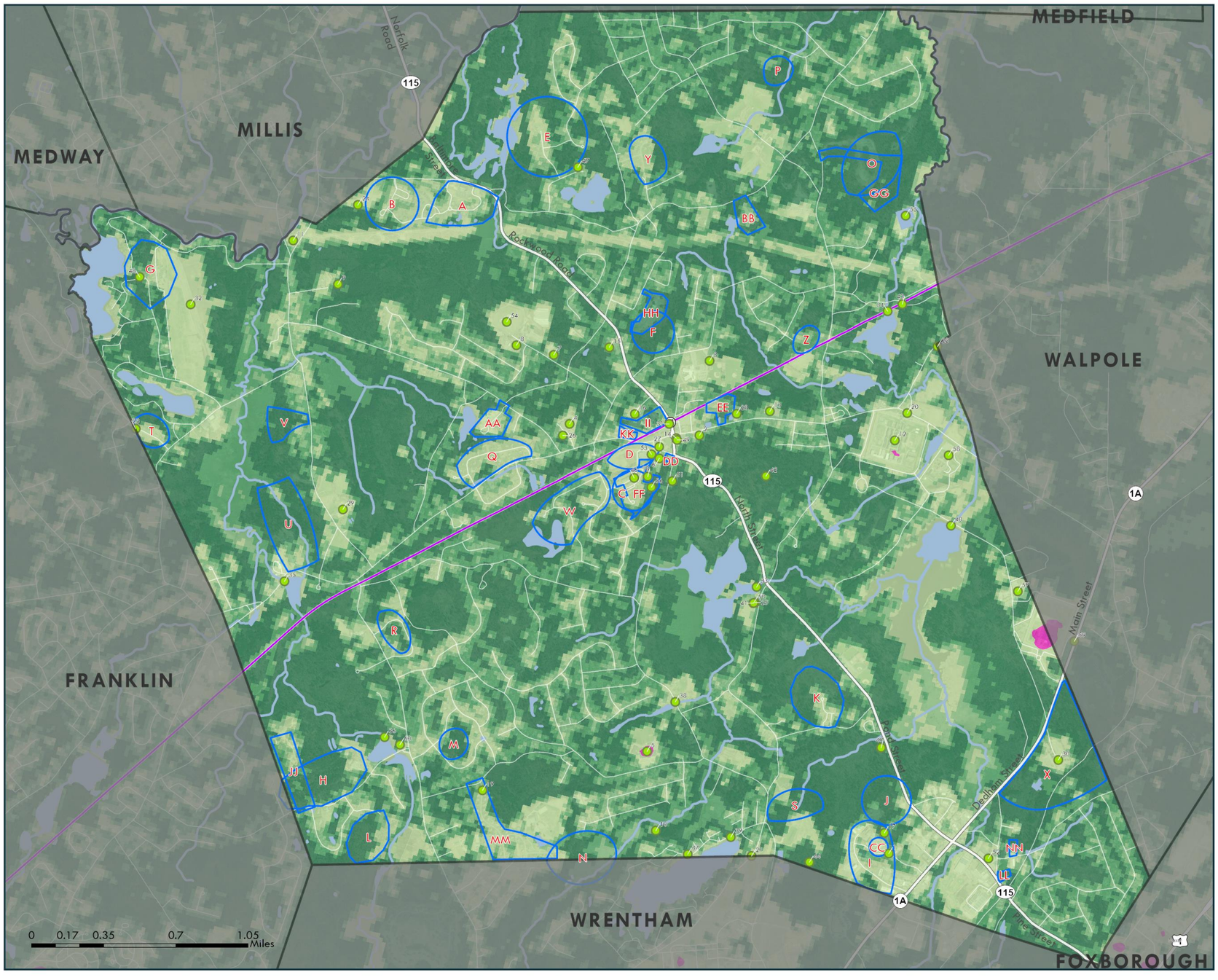


Map 9: Land Surface Temperature

MAPC dcr

FEMA Hazard Mitigation Planning Grant
NORFOLK, MA

- Critical Infrastructure*
- Development Areas

* See details in separate table

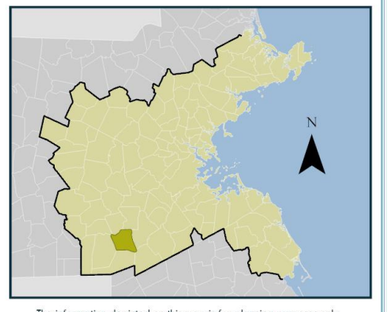
- Water Bodies
- Commuter Rail

Tree Canopy Coverage (2016 - 30m)

- Hottest 5% of region's land area

% Canopy Coverage

- 0 - 25%
- 25 - 50%
- 50 - 75%
- 75 - 100%



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NORFOLK, MA

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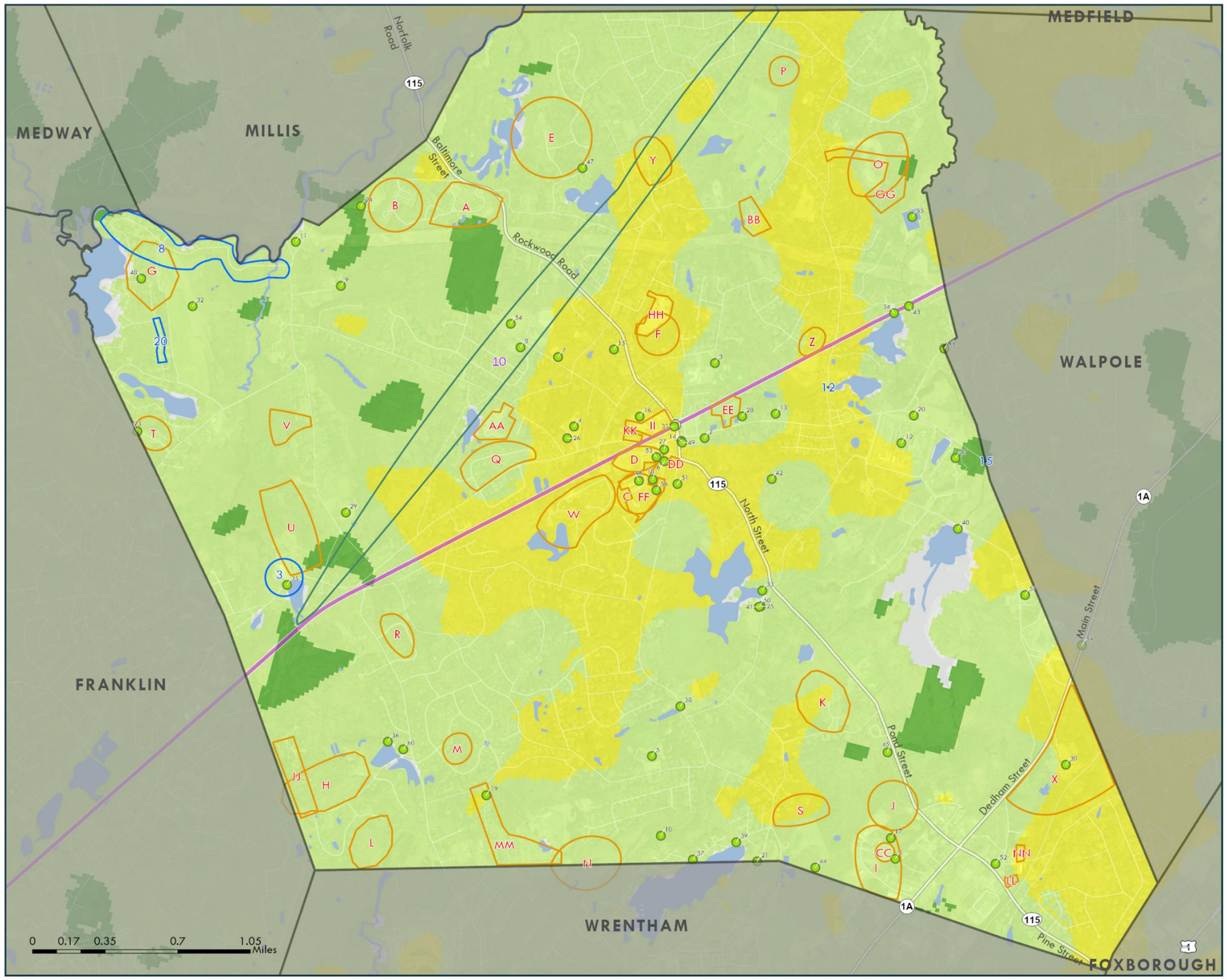


Map 11: Wildfire Risk

MAPC dcr

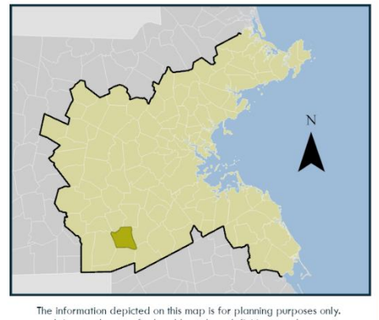
FEMA Hazard Mitigation Planning Grant

NORFOLK, MA

Critical Infrastructure*
Development Areas
* See details in separate table

Hazard Areas Type
- Brush Fire
- Flooding
- Other

USDA Wildfire Risk to Communities
Wildfire Hazard Potential
- N/A
- Very Low
- Low
- Moderate
- High
- Very High



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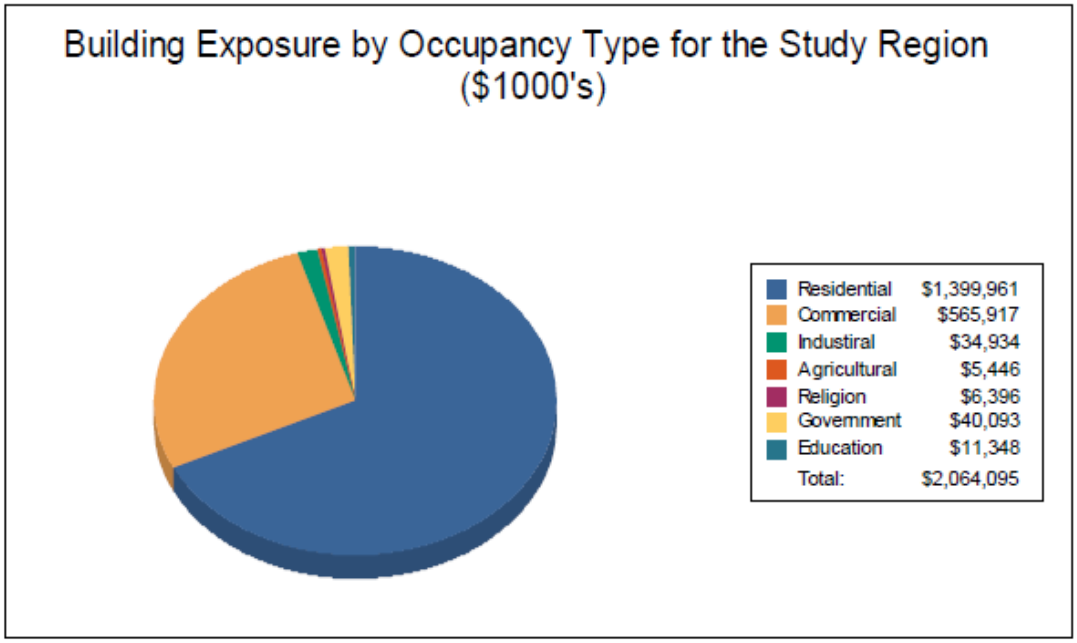
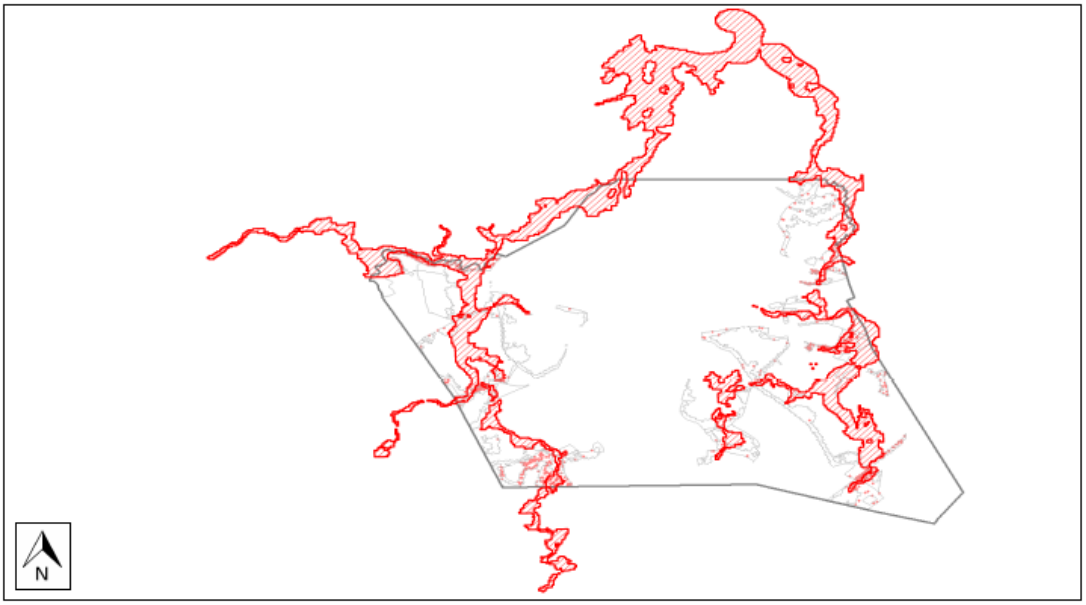
APPENDIX B: HAZUS: FLOODING

ESTIMATED DAMAGES FROM A 100-YEAR (1% ANNUAL CHANCE) FLOOD

Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,399,961	67.8%
Commercial	565,917	27.4%
Industrial	34,934	1.7%
Agricultural	5,446	0.3%
Religion	6,396	0.3%
Government	40,093	1.9%
Education	11,348	0.5%
Total	**2,064,095**	**100%**





APPENDIX B: HAZUS: FLOODING

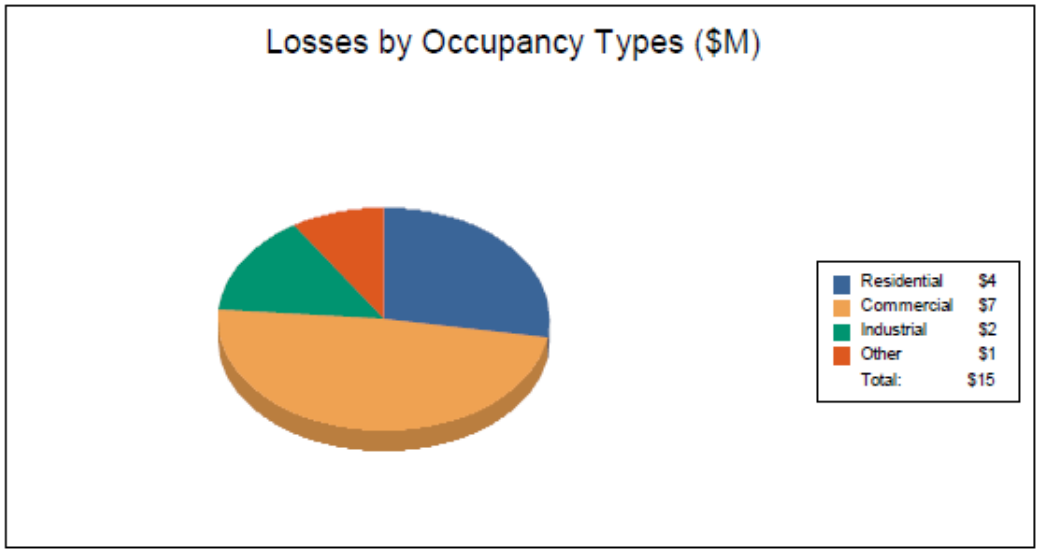
ESTIMATED DAMAGES FROM A 100-YEAR (1% ANNUAL CHANCE) FLOOD

Expected Building Damage by Occupancy (number of buildings)

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	8	80	2	20	0	0	0	0	0	0
Total	**0**		**8**		**2**		**0**		**0**		**0**	

Expected Building Related Economic Loss (millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	2.37	1.06	0.44	0.05	3.93
	Content	1.01	3.00	1.42	0.27	5.70
	Inventory	0.00	0.15	0.19	0.00	0.35
	Subtotal	**3.38**	**4.22**	**2.05**	**0.33**	**9.97**
Business Interruption						
	Income	0.00	1.01	0.04	0.09	1.14
	Relocation	0.52	0.39	0.04	0.05	1.01
	Rental Income	0.31	0.28	0.01	0.01	0.61
	Wage	0.00	1.48	0.06	0.92	2.46
	Subtotal	**0.83**	**3.16**	**0.16**	**1.07**	**5.22**
ALL	**Total**	**4.20**	**7.38**	**2.21**	**1.40**	**15.19**



APPENDIX B: HAZUS: FLOODING

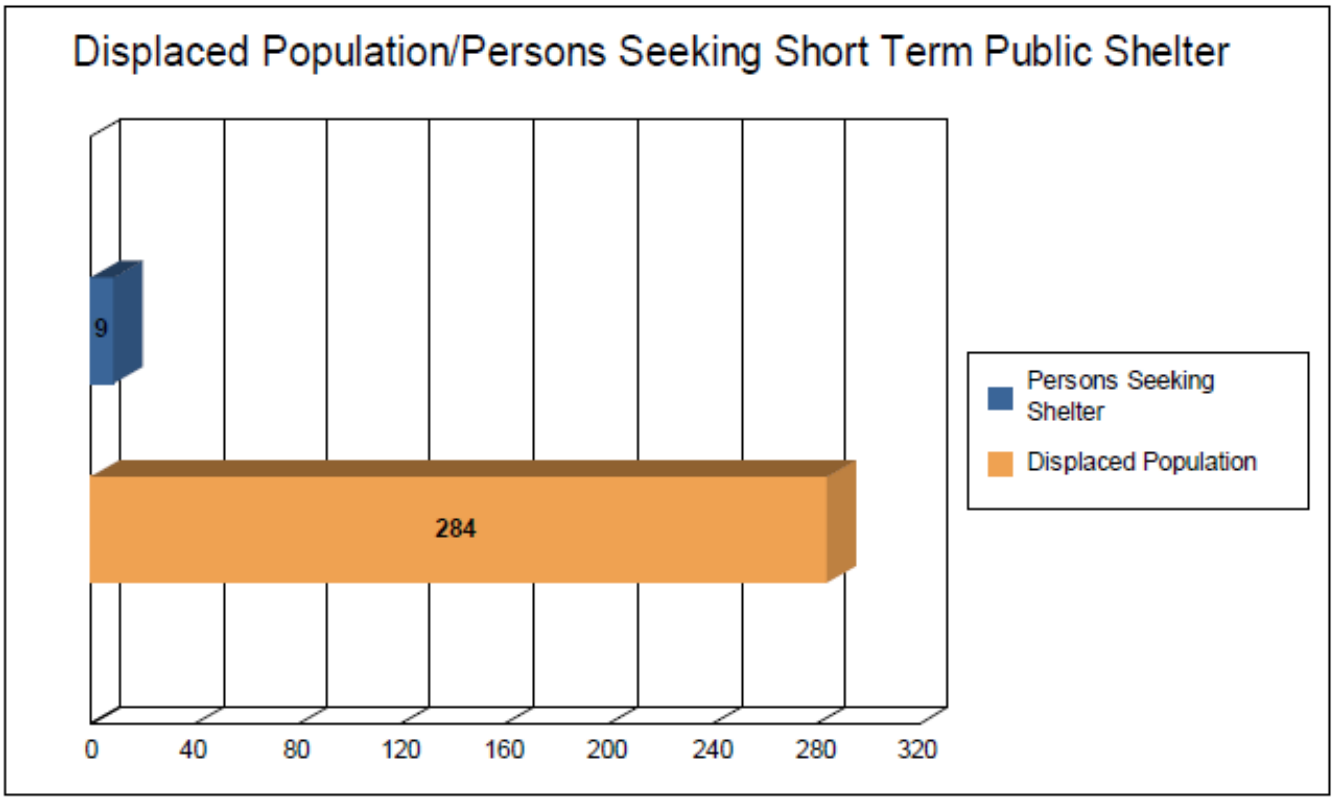
ESTIMATED DAMAGES FROM A 100-YEAR (1% ANNUAL CHANCE) FLOOD

Expected Damage to Essential Facilities.

Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	1	0	0	0
Hospitals	0	0	0	0
Police Stations	1	0	0	0
Schools	3	0	0	0

Expected Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 95 households (or 284 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 9 people (out of a total population of 11,227) will seek temporary shelter in public shelters.

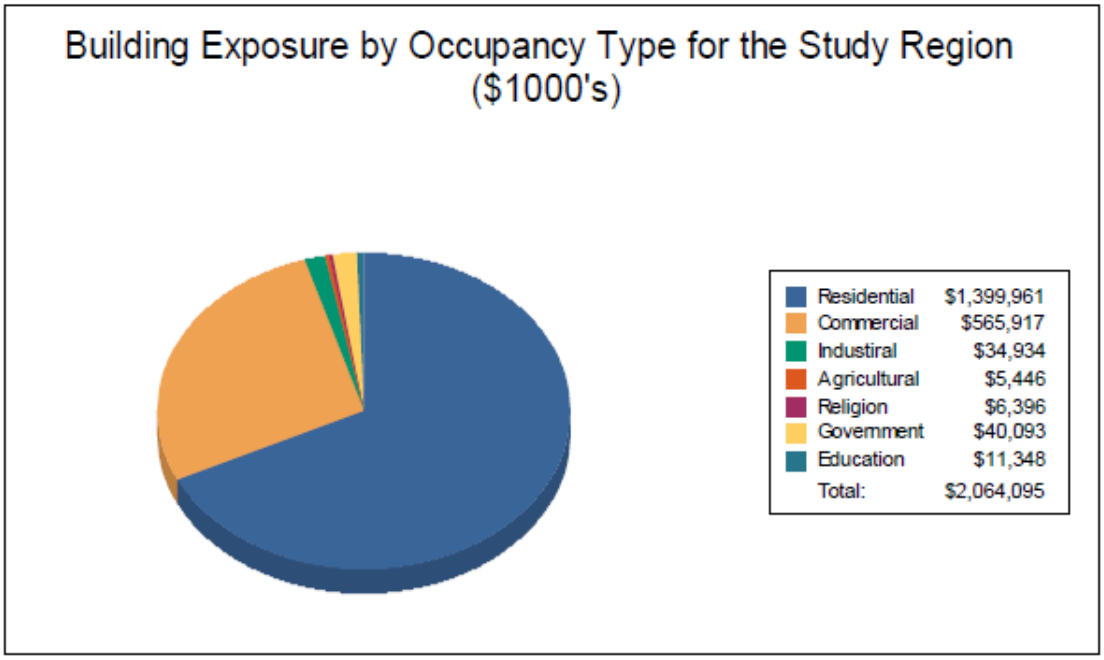


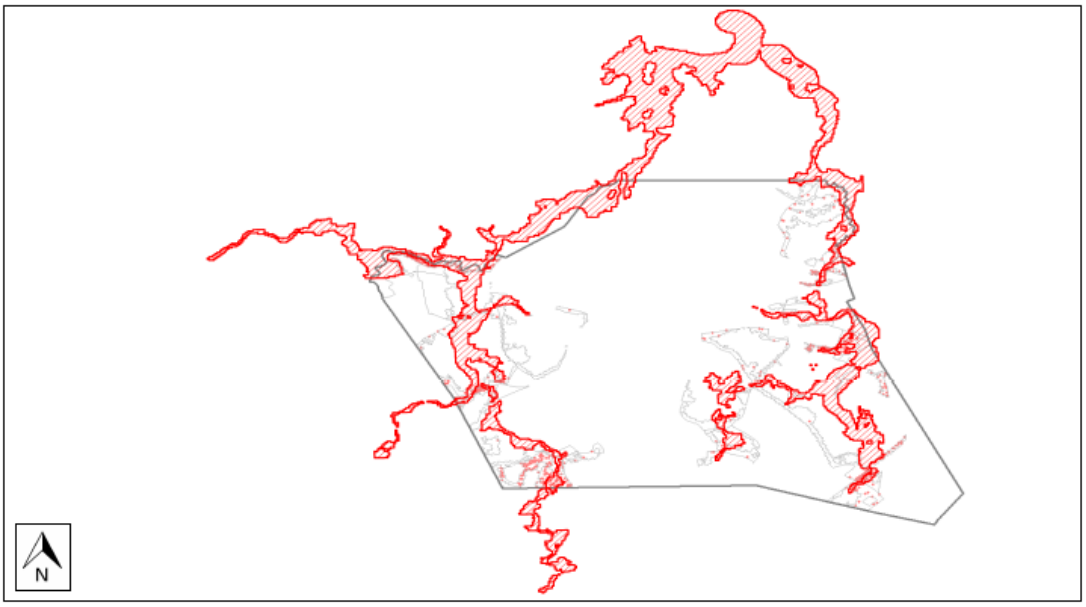
APPENDIX B: HAZUS: FLOODING

ESTIMATED DAMAGES FROM A 500-YEAR (0.2% ANNUAL CHANCE) FLOOD

Building Exposure by Occupancy

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,399,961	67.8%
Commercial	565,917	27.4%
Industrial	34,934	1.7%
Agricultural	5,446	0.3%
Religion	6,396	0.3%
Government	40,093	1.9%
Education	11,348	0.5%
Total	**2,064,095**	**100%**





APPENDIX B: HAZUS: FLOODING

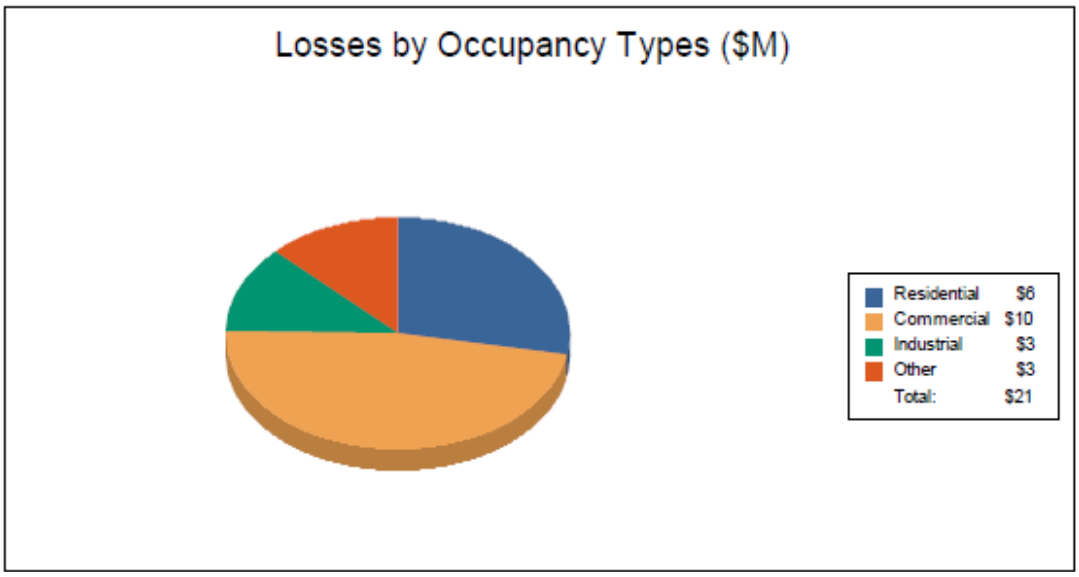
ESTIMATED DAMAGES FROM A 500-YEAR (0.2% ANNUAL CHANCE) FLOOD

Expected Building Damage by Occupancy (number of buildings)

	1-10		11-20		21-30		31-40		41-50		>50	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Education	0	0	0	0	0	0	0	0	0	0	0	0
Government	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Religion	0	0	0	0	0	0	0	0	0	0	0	0
Residential	1	8	7	58	3	25	1	8	0	0	0	0
Total	**1**		**7**		**3**		**1**		**0**		**0**	

Expected Building Related Economic Loss (millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	3.29	1.31	0.55	0.09	5.23
	Content	1.68	3.68	1.67	0.41	7.43
	Inventory	0.00	0.18	0.22	0.01	0.41
	Subtotal	**4.97**	**5.17**	**2.43**	**0.50**	**13.07**
Business Interruption						
	Income	0.00	1.45	0.05	0.16	1.66
	Relocation	0.65	0.66	0.05	0.11	1.46
	Rental Income	0.41	0.47	0.01	0.02	0.91
	Wage	0.00	2.34	0.08	1.89	4.31
	Subtotal	**1.06**	**4.91**	**0.20**	**2.18**	**8.34**
ALL	**Total**	**6.02**	**10.08**	**2.63**	**2.68**	**21.42**



APPENDIX B: HAZUS: HURRICANES

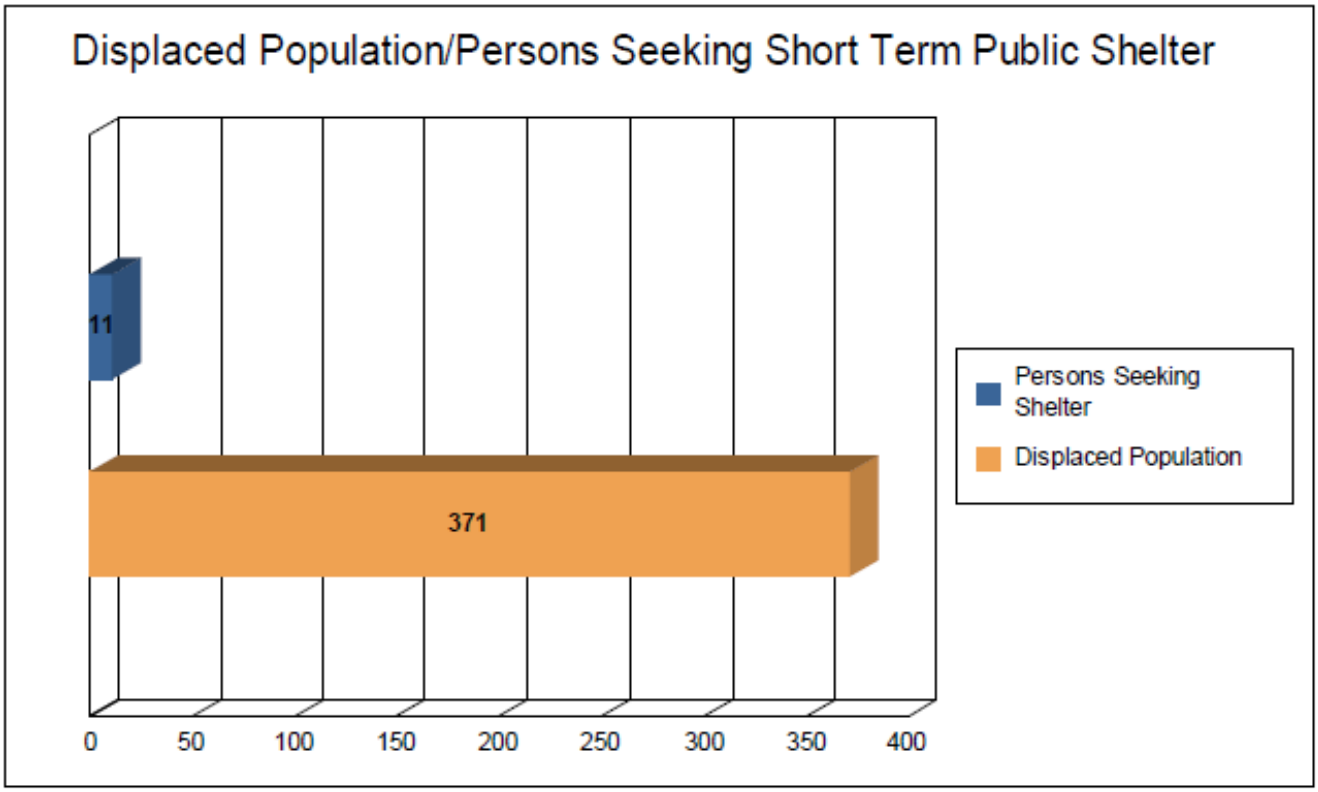
ESTIMATED DAMAGES FROM A 500-YEAR (0.2% ANNUAL CHANCE) FLOOD

Expected Damage to Essential Facilities.

Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Emergency Operation Centers	0	0	0	0
Fire Stations	1	0	0	0
Hospitals	0	0	0	0
Police Stations	1	0	0	0
Schools	3	0	0	0

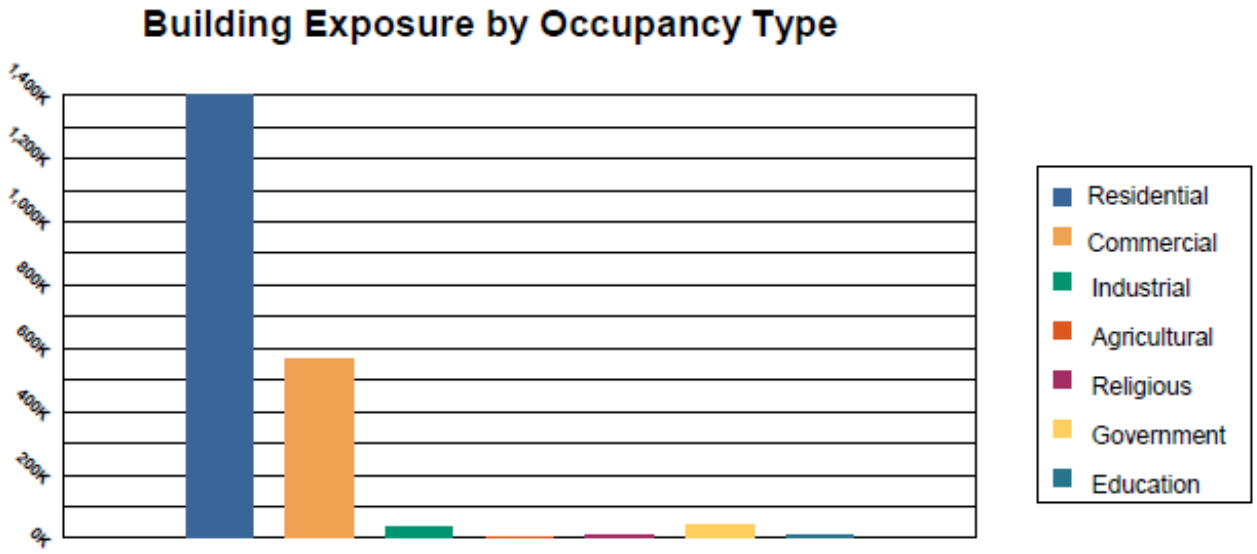
Expected Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 124 households (or 371 of people) will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 11 people (out of a total population of 11,227) will seek temporary shelter in public shelters.



APPENDIX B: HAZUS: HURRICANES

ESTIMATED DAMAGES FROM A 100-YEAR (1% ANNUAL) CHANCE HURRICANE



Expected Building Damage by Occupancy (number of buildings)

	None		Minor		Moderate		Severe		Destruction	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	17.22	95.67	0.64	3.56	0.10	0.54	0.04	0.22	0.00	0.01
Commercial	214.17	96.47	6.71	3.02	1.01	0.46	0.10	0.05	0.00	0.00
Education	4.86	97.13	0.14	2.77	0.01	0.10	0.00	0.00	0.00	0.00
Government	21.31	96.84	0.67	3.04	0.03	0.12	0.00	0.00	0.00	0.00
Industrial	61.06	96.92	1.81	2.88	0.11	0.17	0.02	0.03	0.00	0.00
Religion	5.83	97.14	0.17	2.76	0.01	0.09	0.00	0.01	0.00	0.00
Residential	2,904.41	95.70	124.46	4.10	6.08	0.20	0.04	0.00	0.00	0.00
Total	**3,228.86**		**134.60**		**7.34**		**0.20**		**0.01**	

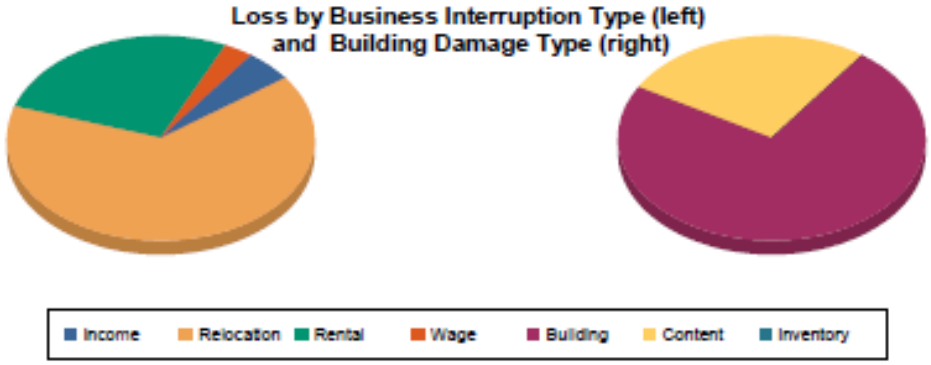
Expected Damage to Essential Facilities (number of facilities)

Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	3	0	0	3

APPENDIX B: HAZUS: HURRICANES

ESTIMATED DAMAGES FROM A 100-YEAR (1% ANNUAL) CHANCE HURRICANE

Expected Building Related Economic Loss (millions of dollars)



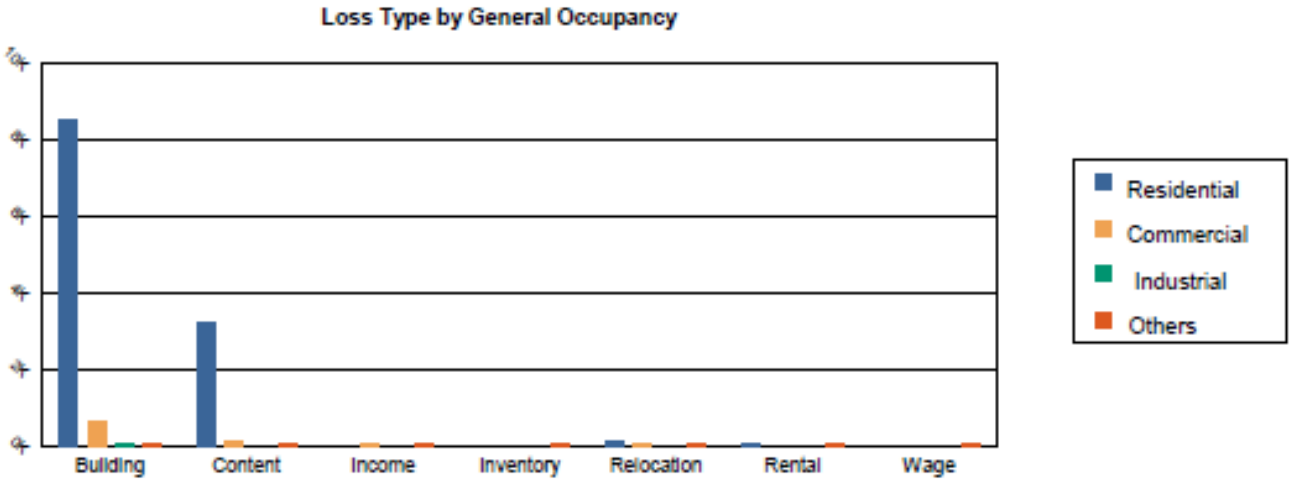


Table 5: Building-Related Economic Loss Estimates

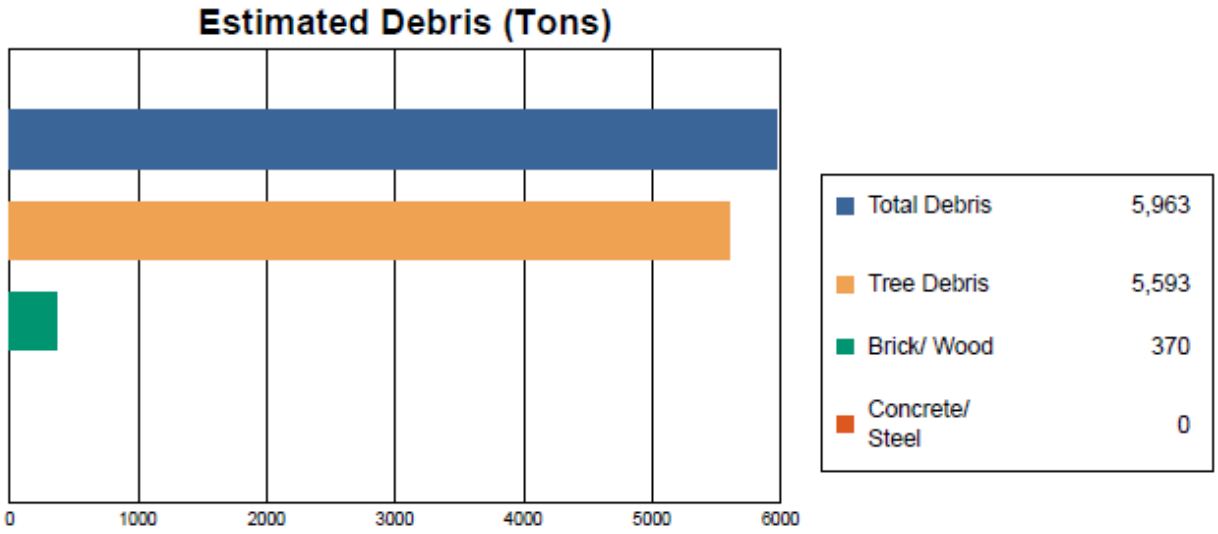
(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	8,467.58	641.60	25.34	48.61	9,183.13
	Content	3,230.34	89.64	4.20	3.59	3,327.77
	Inventory	0.00	0.87	0.60	0.19	1.67
	Subtotal	**11,697.91**	**732.11**	**30.16**	**52.40**	**12,512.58**
Business Interruption Loss						
	Income	0.00	10.28	0.06	1.17	11.51
	Relocation	131.25	18.28	0.47	1.44	151.44
	Rental	57.60	5.12	0.05	0.08	62.85
	Wage	0.00	4.19	0.10	2.74	7.03
	Subtotal	**188.86**	**37.87**	**0.68**	**5.43**	**232.83**
	Total	**11,886.77**	**769.97**	**30.83**	**57.83**	**12,746.40**

APPENDIX B: HAZUS: HURRICANES

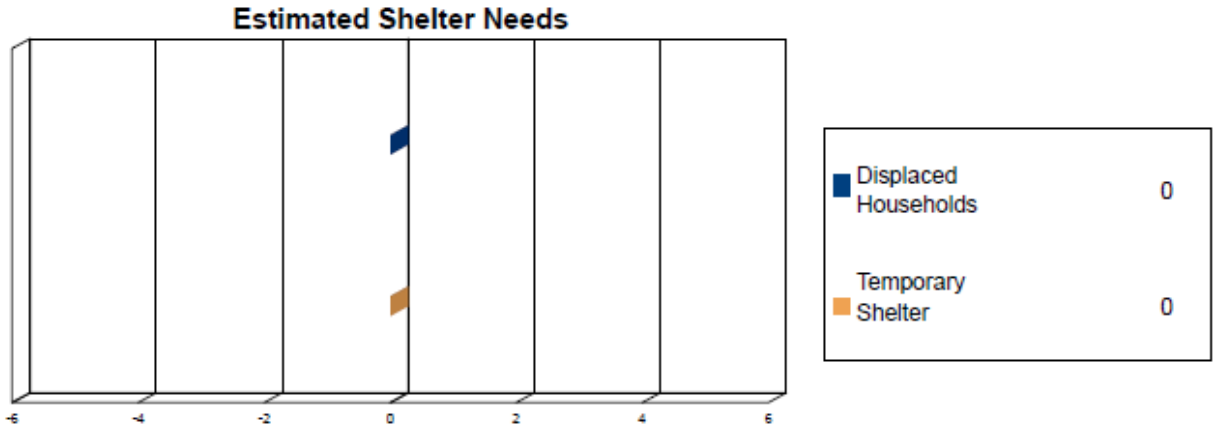
ESTIMATED DAMAGES FROM A 100-YEAR (1% ANNUAL CHANCE) HURRICANE

Expected Debris Generation



The model estimates that a total of 5,963 tons of debris will be generated. Of the total amount, 4,082 tons (68%) is Other Tree Debris. Of the remaining 1,881 tons, Brick/Wood comprises 20% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 15 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 1,511 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

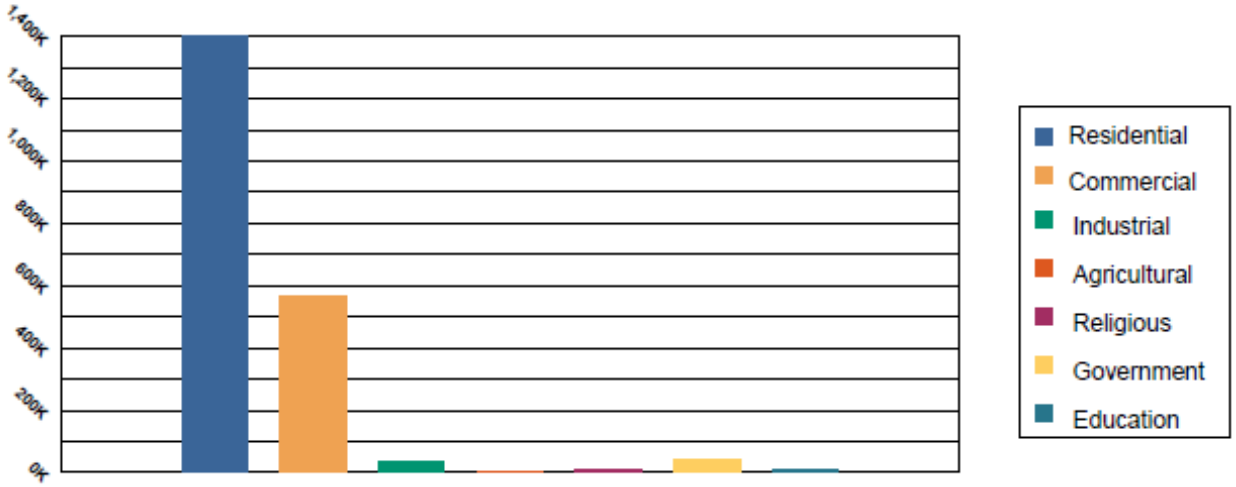
Expected Shelter Needs



APPENDIX B: HAZUS: HURRICANES

ESTIMATED DAMAGES FROM A 500-YEAR (0.2% ANNUAL CHANCE) HURRICANE

Building Exposure by Occupancy Type



Expected Building Damage by Occupancy (number of buildings)

	None		Minor		Moderate		Severe		Destruction	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	13.97	77.61	2.85	15.84	0.76	4.24	0.37	2.06	0.04	0.24
Commercial	181.81	81.89	29.99	13.51	8.63	3.89	1.56	0.70	0.01	0.00
Education	4.20	84.02	0.66	13.27	0.13	2.57	0.01	0.13	0.00	0.00
Government	18.39	83.57	2.92	13.27	0.65	2.97	0.04	0.18	0.00	0.00
Industrial	52.21	82.87	8.37	13.28	2.08	3.30	0.32	0.51	0.02	0.04
Religion	5.02	83.69	0.85	14.12	0.13	2.10	0.01	0.10	0.00	0.00
Residential	2,336.31	76.98	601.99	19.84	88.51	2.92	5.05	0.17	3.14	0.10
Total	**2,611.90**		**647.64**		**100.89**		**7.35**		**3.22**	

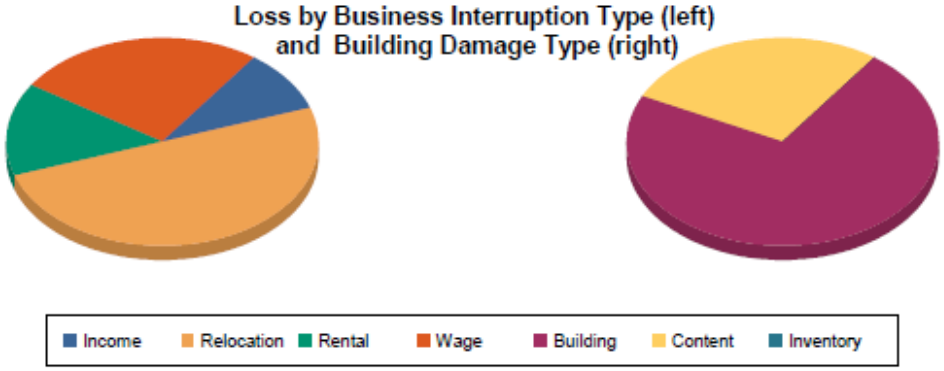
Expected Damage to Essential Facilities (number of facilities)

Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day
Fire Stations	1	0	0	1
Police Stations	1	0	0	1
Schools	3	0	0	3

APPENDIX B: HAZUS: HURRICANES

ESTIMATED DAMAGES FROM A 500-YEAR (0.2% ANNUAL CHANCE) HURRICANE

Expected Building Related Economic Loss (millions of dollars)



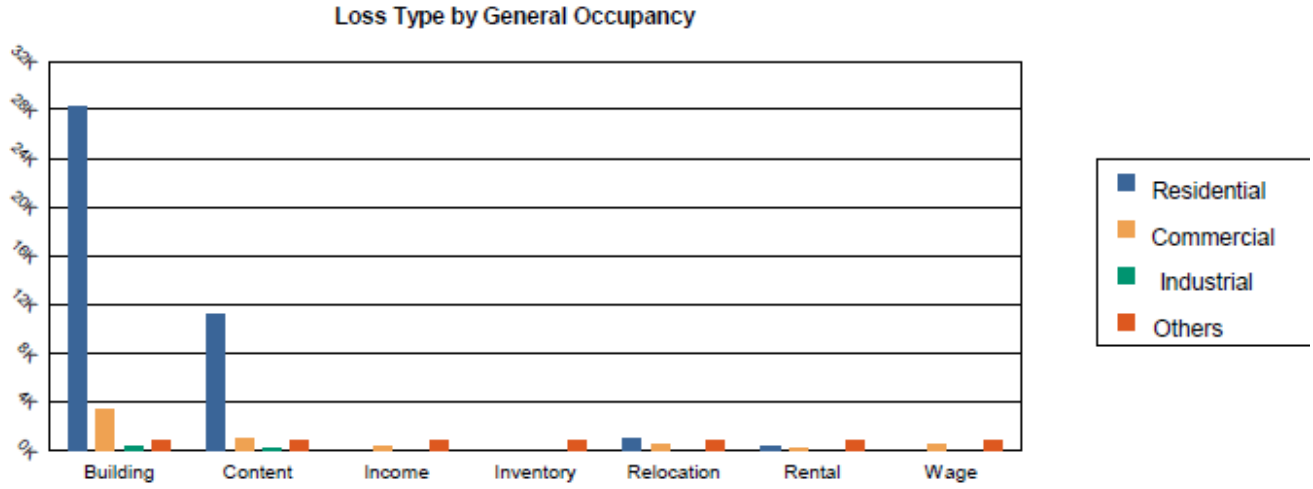


Table 5: Building-Related Economic Loss Estimates

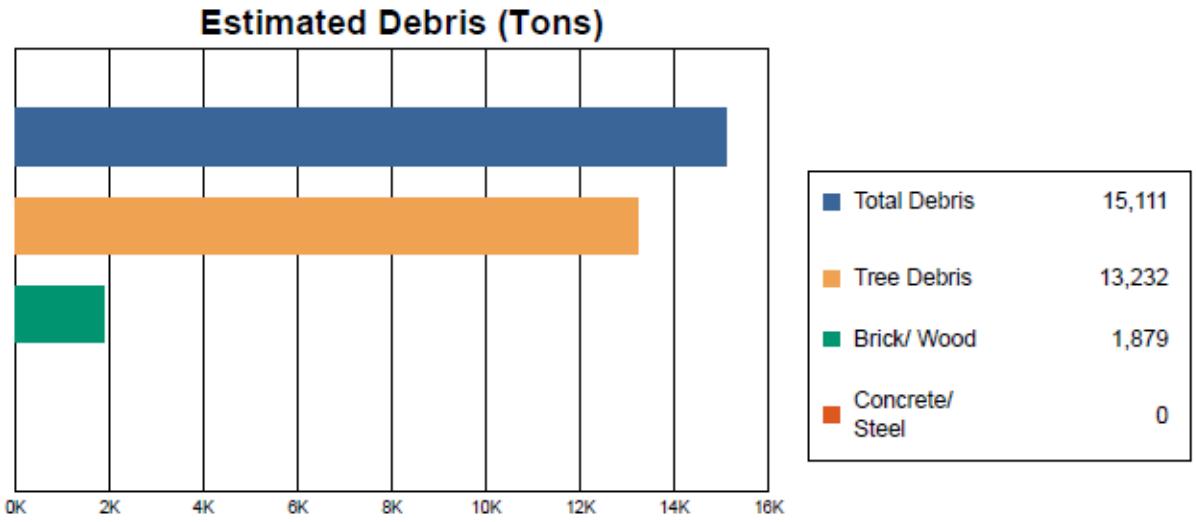
(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	28,178.89	3,286.64	202.52	327.84	31,995.89
	Content	11,166.04	993.75	86.14	79.08	12,325.01
	Inventory	0.00	9.93	10.96	2.50	23.39
	Subtotal	**39,344.94**	**4,290.32**	**299.62**	**409.42**	**44,344.30**
Business Interruption Loss						
	Income	0.00	257.35	2.71	20.47	280.53
	Relocation	859.86	500.85	15.85	63.79	1,440.35
	Rental	304.79	95.99	1.89	14.03	416.69
	Wage	0.00	450.77	4.43	291.39	746.59
	Subtotal	**1,164.64**	**1,304.96**	**24.88**	**389.68**	**2,884.17**
	Total	**40,509.58**	**5,595.29**	**324.50**	**799.10**	**47,228.46**

APPENDIX B: HAZUS: HURRICANES

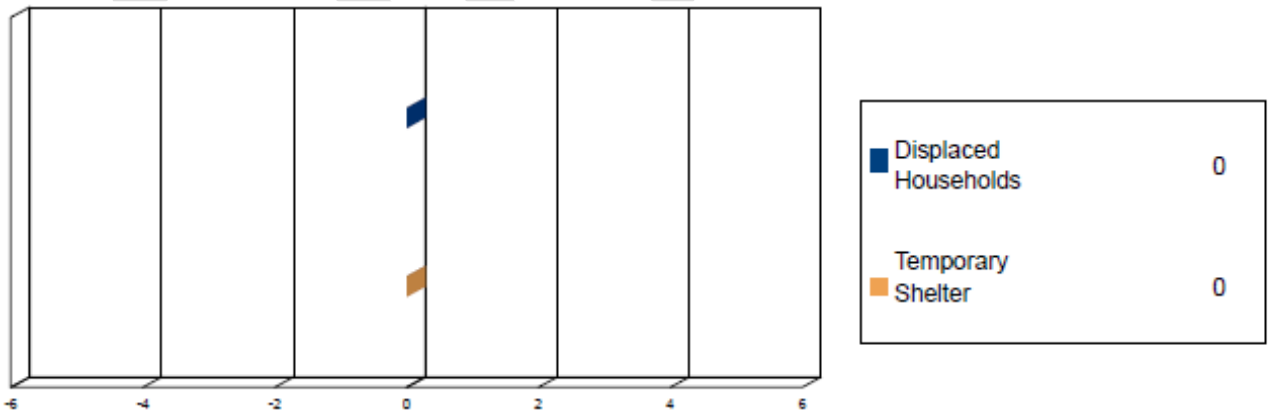
ESTIMATED DAMAGES FROM A 500-YEAR (0.2% ANNUAL CHANCE) HURRICANE

Expected Debris Generation



The model estimates that a total of 15,111 tons of debris will be generated. Of the total amount, 9,607 tons (64%) is Other Tree Debris. Of the remaining 5,504 tons, Brick/Wood comprises 34% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 75 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 3,625 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Expected Shelter Needs



APPENDIX B: HAZUS: EARTHQUAKES

ESTIMATED DAMAGES FROM A MAGNITUDE 5 EARTHQUAKE

Expected Damage by Building Type

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	18.00	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commercial	222.00	6.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Education	5.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Government	22.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industrial	63.00	1.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Residential	62.00	1.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Religion	6.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Single Family	2973.00	88.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	3,371		0		0		0		0	

Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	0	0	0	0
Schools	3	0	0	3
EOCs	0	0	0	0
PoliceStations	1	0	0	1
FireStations	1	0	0	1

Expected Debris Generation and Shelter Needs

a

The model estimates that a total of 0 tons of debris will be generated. Of the total amount, Brick/Wood comprises % of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Displaced Households/ Persons Seeking Short Term Public Shelter

Displaced households as a result of the earthquake	Persons seeking temporary public shelter
0	0

APPENDIX B: HAZUS: EARTHQUAKES

ESTIMATED DAMAGES FROM A MAGNITUDE 5 EARTHQUAKE

Expected Casualties

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	0.00	0.00	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.00	0.00	0.00	0.00
	Other-Residential	0.00	0.00	0.00	0.00
	Single Family	0.00	0.00	0.00	0.00
	Total	0	0	0	0
2 PM	Commercial	0.00	0.00	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.00	0.00	0.00	0.00
	Other-Residential	0.00	0.00	0.00	0.00
	Single Family	0.00	0.00	0.00	0.00
	Total	0	0	0	0
5 PM	Commercial	0.00	0.00	0.00	0.00
	Commuting	0.00	0.00	0.00	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	0.00	0.00	0.00	0.00
	Other-Residential	0.00	0.00	0.00	0.00
	Single Family	0.00	0.00	0.00	0.00
	Total	0	0	0	0

APPENDIX C: LOCAL HAZARD MITIGATION TEAM MEETINGS

MAPC
METROPOLITAN AREA PLANNING COUNCIL

Smart Growth & Regional Collaboration

Agenda

Norfolk Hazard Mitigation Plan (HMP) Update
Kickoff Meeting
July 26, 2022
2:00-3:00PM

1. Introductions

2. Project Overview
   - Timeline
   - Roles
   - Communication with stakeholders and Town staff
   - Information request

3. Priority Next Steps
   - Develop Local Team List
   - Identify date for a Local Team Meeting

4. Wrap Up & Action Items

APPENDIX C: LOCAL HAZARD MITIGATION TEAM MEETINGS

MAPC
METROPOLITAN AREA PLANNING COUNCIL

Smart Growth & Regional Collaboration

Agenda

Norfolk Hazard Mitigation Plan (HMP) Update
Local Team Meeting #1
Wednesday, September 14, 2022
9:00 – 10:30 AM

1. Welcome & Introductions

2. Overview of the HMP Project
   - Overview of the FEMA Hazard Mitigation Plans
   - Project tasks and schedule

3. Getting Started: Local Data Updates from the 2010 Plan
   - We will use two worksheets to update local data from the 2010 plan:
     - Worksheet #1: Local Hazard Areas of Concern
     - Worksheet #2: Critical Facilities
   - *MAPC's GIS Planner will join to map new or revised sites using the online platform Google MyMaps*

4. Next steps:
   - Share additional feedback on Worksheet #1 and Worksheet #2 by September 21st
   - Follow-up discussion on development
   - Stay tuned for an invitation to Local Team Meeting #2

5. Wrap Up & Action Items

APPENDIX C: LOCAL HAZARD MITIGATION TEAM MEETINGS

MAPC
METROPOLITAN AREA PLANNING COUNCIL

Smart Growth & Regional Collaboration

Agenda

Norfolk Hazard Mitigation Plan (HMP) Update
Local Team Meeting #2
November 3, 2022
1:00 PM

1. Welcome
2. Update on HMP Project Progress
3. Discuss & Update Hazard Mitigation Goals
4. Discuss & Update Existing Mitigation Measures
5. Prepare for Public Meeting #1
6. Wrap Up & Action Items

aa

APPENDIX C: LOCAL HAZARD MITIGATION TEAM MEETINGS

MAPC
METROPOLITAN AREA PLANNING COUNCIL

Smart Growth & Regional Collaboration

Agenda

Norfolk Hazard Mitigation Plan (HMP) Update
Local Team Meeting #3
December 7, 2022
10:30 AM

1. **Worksheet #6:** Status of Recommended Mitigation Measures from the 2010 Plan

2. **Public Meeting #1**
    a. Thursday, December 15th at 7:00PM
    b. Check-in on webpage content and social media posts
    c. The "ask" for the Local Team: share the e-blast and flyer (Public Meeting 1 Flyer.pdf)

3. **Wrap Up & Action Items**
    a. Share additional feedback on Worksheet #6 by Friday, December 16th
    b. Help us share the public survey after December 15th (Survey Flyer.pdf)
    c. Stay tuned for a Doodle poll for Local Team Meeting #4, where we will:
        i. Develop new Recommended Mitigation Measures
        ii. Prepare for Public Meeting #2

APPENDIX B: LOCAL HAZARD MITIGATION TEAM MEETINGS

MAPC
METROPOLITAN AREA PLANNING COUNCIL

Smart Growth & Regional Collaboration

Agenda

Norfolk Hazard Mitigation Plan (HMP) Update
Local Team Meeting #4
January 9, 2023

1. **Worksheet #7:** New Mitigation Measures

2. **Public Survey**
    a. Update on responses and next steps for distribution

3. **Public Meetings**
    a. Debrief from Public Meeting #1
    b. Discuss approach for Public Meeting #2

4. **Wrap Up & Action Items**
    a. Share additional feedback on Worksheet #7 by Monday, January 16th
    b. Help us share the public survey (Survey Flyer.pdf)

APPENDIX B: LOCAL HAZARD MITIGATION TEAM MEETINGS

MAPC
METROPOLITAN AREA PLANNING COUNCIL

Smart Growth & Regional Collaboration

Agenda

Norfolk HMP Update
Mapping Meeting
February 2, 2023

1. Mapping discussion – confirm the following updates:
   - Locally identified hazard areas
   - Critical infrastructure
   - Development

2. Additional mapping materials
   - HAZUS Analysis
   - Hazard map series

3. Wrap up and next steps

APPENDIX B: LOCAL HAZARD MITIGATION TEAM MEETINGS

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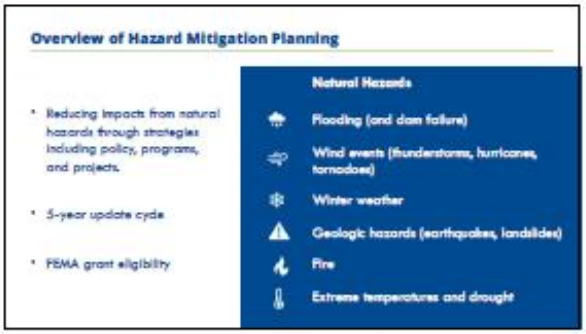

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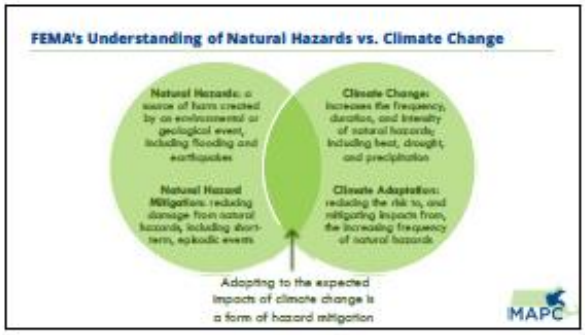

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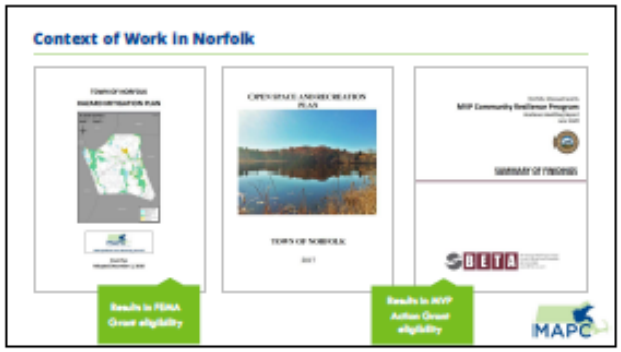
APPENDIX B: LOCAL HAZARD MITIGATION TEAM MEETINGS



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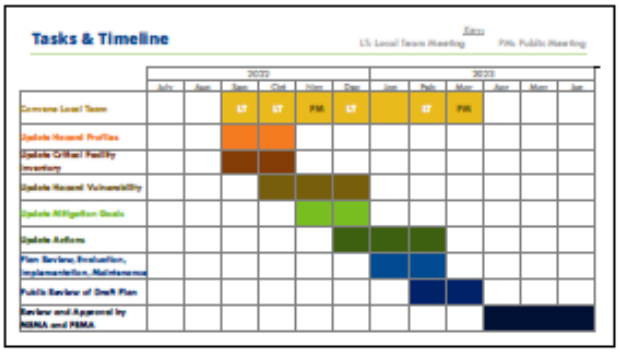

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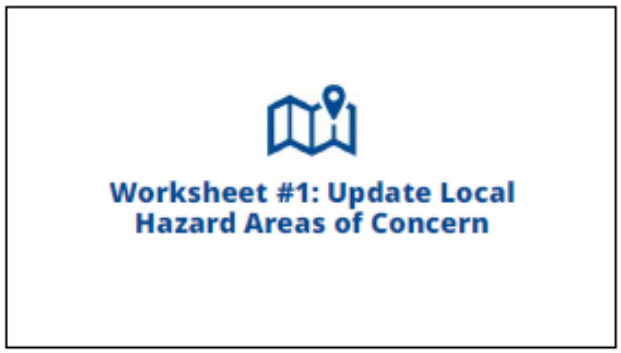

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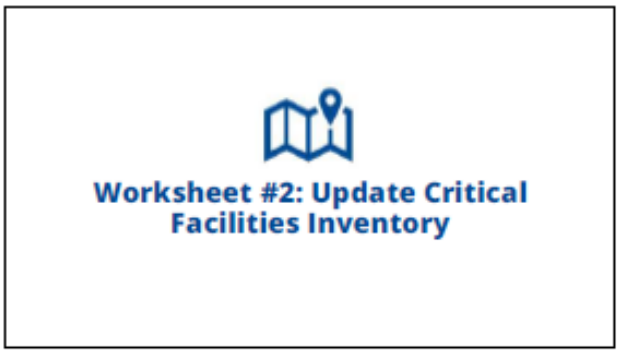

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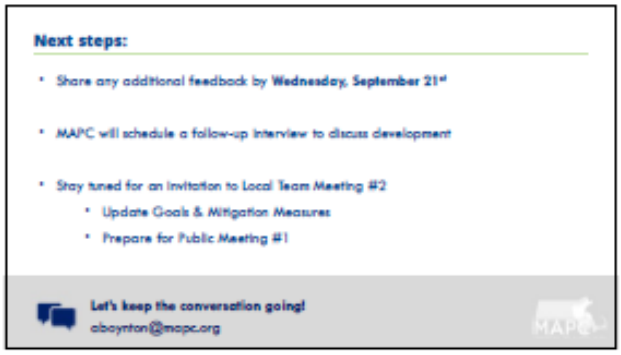

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APPENDIX C: PUBLIC MEETINGS

Norfolk Hazard Mitigation Plan Update
Public Meeting

When	Thursday December 15, 2022 7:00 PM
Where	This meeting will be held virtually
How	**Join the Zoom:** https://us02web.zoom.us/j/9266999773 **Meeting ID:** 926 699 9773 *(Optional Dial-in: 305-224-1968)*

Norfolk experiences natural hazard impacts including flooding and increasingly frequent and severe storms.

The Town is updating its Hazard Mitigation Plan to help assess vulnerability to natural hazards and identify strategies to increase the resilience of our community, infrastructure, and natural resources.

We want to hear from you! Join us to share your experiences and recommendations.

If you have any questions or comments, please email Rich McCarthy, Town Planner at rmccarthy@norfolk.ma.us

MAPC
METROPOLITAN AREA PLANNING COUNCIL

Town of Norfolk
Massachusetts

APPENDIX C: PUBLIC MEETINGS

[Materials from the 2nd public meeting will be added to the final draft]

APPENDIX E: COMMENTS ON THE DRAFT PLAN

[Any public comment received will be added to this Appendix]

APPENDIX C: PUBLIC MEETINGS

MAPC
METROPOLITAN AREA PLANNING COUNCIL

Smart Growth & Regional Collaboration

Agenda

Norfolk Hazard Mitigation Plan (HMP) Update
Public Meeting #1
Thursday, December 15, 2022 | 7:00 PM

How to Join the Meeting:
Click to Join the Zoom Meeting: https://us02web.zoom.us/j/9266999773
Meeting ID: 926 699 9773
(Optional Dial-in: 305-224-1968)

Welcome & Introductions

Presentation

- Introduction to Natural Hazard Mitigation Planning
- Natural Hazard Impacts in Norfolk
- HMP Update Project Overview

Polling / Information Gathering

- What's your connection to the Town?
- What brought you to tonight's meeting?
- What natural hazards are you most concerned about?
- What's your top priority for this project?

Q&A Discussion

Wrap Up, Thank You, Next Steps

- Take the survey before January 20th: tinyurl.com/NorfolkHMPsurvey
- Visit the project webpage for more information

APPENDIX C: PUBLIC MEETINGS

Norfolk Hazard Mitigation Plan Update
Public Survey

Norfolk experiences natural hazard impacts including flooding and increasingly frequent and severe storms.

The Town is updating its Hazard Mitigation Plan (HMP) to help assess vulnerability to natural hazards and identify strategies to increase the resilience of our community, infrastructure, and natural resources.

We want to hear from you! Take our survey to share your experiences and recommendations. Scan the QR code or type the link below into a web browser. The survey will close on January 20, 2023.

tinyurl.com/NorfolkHMPsurvey

Norfolk Woods fire along Seekonk Street. Photo from the Norfolk Fire Department, 2022.

If you have any questions or comments, please email Rich McCarthy, Town Planner at rmccarthy@norfolk.ma.us

MAPC
METROPOLITAN AREA PLANNING COUNCIL

Town of Norfolk Massachusetts

APPENDIX F: PLAN ADOPTION

<PRINT ON TOWN LETTERHEAD>

CERTIFICATE OF ADOPTION
SELECT BOARD

TOWN OF NORFOLK, MASSACHUSETTS

A RESOLUTION ADOPTING THE
TOWN OF NORFOLK HAZARD MITIGATION PLAN 2023 UPDATE

WHEREAS, the Town of Norfolk established a Committee to prepare the *Town of Norfolk Hazard Mitigation Plan 2023 Update*; and

WHEREAS, the *Town of Norfolk Hazard Mitigation Plan 2023 Update* contains several potential future projects to mitigate potential impacts from natural hazards in the Town of Norfolk, and

WHEREAS, duly-noticed public meetings were held on December 15, 2022, and April TBD, 2023,

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

NOW, THEREFORE BE IT RESOLVED that the Town of Norfolk Select Board adopts the *Town of Norfolk Hazard Mitigation Plan 2023 Update*, in accordance with M.G.L. 40 §4 or the charter and bylaws of the Town of Norfolk.

ADOPTED AND SIGNED this Date. _____

Name _____

Title _____

Signature(s) _____