Newburyport Multi-Hazard Mitigation Plan November 2022

Prepared by:

Merrimack Valley Planning Commission

CITY OF NEWBURYPORT

IN CITY COUNCIL

ORDERED:

January 30, 2023

A RESOLUTION ADOPTING THE NEWBURYPORT MULTI-HAZARD MITIGATION PLAN FEBRUARY 2022

WHEREAS, the **City of Newburyport** established a local planning team to work with and assist the Merrimack Valley Planning Commission in the preparation of the ***Newburyport Multi Hazard Mitigation Plan Update 2022*** (hereinafter, "Newburyport HMP"); and

WHEREAS, the Newburyport HMP identifies potential future activities and projects aimed at mitigating potential adverse impacts from floods, winter storms, and other natural hazards in the City of Newburyport; and

WHEREAS, duly noticed workshops and public meetings were held by the City of Newburyport on August 18, 2021 (workshop) and on May 18, 2022 and February 13, 2023 (Listening Sessions) as part of the process of updating the Hazard Mitigation Plan; and

WHEREAS, the City of Newburyport, acting through its various municipal departments, boards, and commissions is committed to implementing these potential mitigation activities and projects as future City funding and personnel resources permit; and

WHEREAS, adoption of this Hazard Mitigation Plan makes the City of Newburyport eligible for funding to alleviate the impacts of future hazards.

NOW, THEREFORE BE IT RESOLVED by the Newburyport City Council adopts the ***Newburyport Multi-Hazard Mitigation Plan 2022*** in accordance with M.G.L. 40 §4 or the charter and ordinances of the City of Newburyport.

Councillor Edward C. Cameron Jr.

Councillor Mark R. Wright

In City Council January 30, 2023:
Councillor Wallace recused. Motion to refer to Planning & Development by Councillor McCauley, seconded by Councillor Cameron. Roll call vote. 11 yes. (1 remote, BL). Motion passes.

In City Council February 13, 2023:
Councillor Wallace recused. Motion to approve by Councillor Cameron, seconded by Councillor Vogel. Roll call vote. 10 yes, 1 recused (CW). Motion passes.

Approve: _____
Sean R. Reardon, Mayor

Attest: _____
Richard B. Jones, City Clerk

Date: 3/2/2023

TABLE OF CONTENTS

Table of Contents

Executive Summary

Local hazard mitigation planning is the process of organizing community resources, identifying, and assessing hazard risks, and determining how to best minimize or manage those risks. This process results in a Multi-Hazard Mitigation Plan (HMP) that identifies specific mitigation actions, each designed to achieve both short-term planning objectives and a long-term community vision. The Federal Disaster Mitigation Act of 2000 requires all municipalities to adopt a local HMP and update their plan every five years to be eligible for FEMA funding for hazard mitigation grants. Newburyport was previously included in the regional Merrimack Valley Multi-Hazard Mitigation Plan Update (2016), completed by the Merrimack Valley Planning Commission (MVPC). This plan expired in May of 2021.

The Massachusetts Executive Office of Energy and Environmental Affairs' Municipal Vulnerability Preparedness (MVP) grant program helps communities assess local vulnerabilities to climate change and to develop appropriate action-oriented response strategies. The program provides technical support, guidance, and financial incentives for cities and towns to undertake community vulnerability self-assessments and prioritize projects and actions that can make a community more resilient and better prepared to mitigate long-term risks and adapt to climate change impacts. This planning process is very similar to that which is required to complete a local hazard mitigation plan. Newburyport became a designated MVP community in 2018.

In October of 2020, the city released the Newburyport Climate Resiliency Plan. This plan focuses on Newburyport's short and long-term vulnerability to climate change. While it incorporates some of the risks identified in the Hazard Mitigation plan, it doesn't consider non-climate related risks such as terrorism and earthquake. This plan also does not replace current emergency response and evacuation plans, although information developed in this plan may contribute to both of those plans. This plan does consider and combine elements of previous risk and vulnerability studies and examines in greater detail the impacts of climate hazards on areas within the city to chart a course to meet Newburyport's climate related challenges.

By incorporating the city's MVP planning outcomes and the in-depth findings and adaptation strategies identified in the Climate Resiliency Plan, Newburyport has accomplished a foundation of planning to update their Multi-Hazard Mitigation Plan. By working with MVPC, the authors of the 2016 Regional HMP update, Newburyport will have the latest local and regional data to facilitate their HMP update process. MVPC with work with the city's Resiliency Committee to conduct an inclusive HMP update that will be a more comprehensive tool for addressing risk to human life and property associated with hazards that will be exacerbated by climate change.

SECTION 1. INTRODUCTION

This section provides a general introduction to the updated **Newburyport Multi-Hazard Mitigation Plan** (hereinafter "Newburyport HMP"). It consists of the following four subsections:

- Disaster Mitigation Act
- Background
- Plan Purpose
- Geographic Scope

Hazard Mitigation
Any sustained action taken to reduce or eliminate the long-term risk to human life and property from future disasters.

1.1 Disaster Mitigation Act

Congress enacted the Disaster Mitigation Act of 2000 (DMA 2000) on October 10, 2000. Also known as the Stafford Act Amendments, the bill was signed into law by President Clinton on October 30, 2000, creating Public Law 106-390. The law established a national program for pre-disaster mitigation and streamlined the federal administration of disaster relief. Specific rules on the implementation of DMA 2000 were published in the Federal Register in February 2002 and required that all communities have an approved Multiple Hazards Mitigation Plan in place to qualify for future federal disaster mitigation grants following a Presidential disaster declaration.

According to federal regulations, every five years regional and local jurisdictions must review and revise their plan to reflect changes in development, progress in mitigation efforts, and priority changes. The updated plan must be resubmitted to Massachusetts Emergency Management Agency (MEMA) and the Federal Emergency Management Agency (FEMA) for review and approval to continue to be eligible for mitigation project grant funding. Plan updates must demonstrate that progress has been made in the last five years through a comprehensive review of the previous plan.

The regional and local plans emphasize measures that can be taken to reduce or prevent future disaster damages caused by natural hazards. Mitigation, in the context of natural hazard planning, refers to any action that permanently reduces or eliminates long-term risks to human life and property. In 2006, FEMA performed a cost-benefit analysis based on a sampling of hazard mitigation grants and determined that every dollar spent on mitigation saved society an average of six dollars.[1]

A variety of mitigation actions are available to reduce the risk of losses from natural hazards. These activities, which can be implemented at the local and state levels, include

[1] Multi-Hazard Mitigation Council (2019). Natural Hazard *Mitigation Saves: 2019 Report.*

hazard mitigation planning, the adoption and enforcement of development codes and standards, the use of control structures such as floodwalls and culverts, and the protection of wetlands, floodplains, and open space. Many of the strategies identified in hazard mitigation planning are implemented through land use planning tools and development regulations that can prevent or limit development in hazard-prone areas. Where development has already occurred in hazard-prone areas, buildings can be retrofitted or modified to increase the chances of surviving a known hazard. Strict enforcement of the state building code is critically important to effectively minimize natural hazard losses.

In addition to addressing natural hazard mitigation, this updated hazard mitigation plan includes an overview of non-natural hazards and assesses the interrelationship of climate change and hazard mitigation.

1.2 Municipal Vulnerability Preparedness

Governor Baker in September 2016 issued Executive Order 569, directing the Secretary of the Energy and Environmental Affairs and the Secretary of Public Safety to coordinate efforts across the Commonwealth to strengthen the resilience of communities, prepare for the impacts of climate change and mitigate damage from extreme weather events. The State agencies were charged with establishing a framework that each city and town could use to assess local vulnerabilities to climate change and to develop appropriate action-oriented response strategies.

The Commonwealth's agency response is the Municipal Vulnerability Preparedness Grant Program (MVP) which provides support to Massachusetts communities to plan for resilience and implement key adaptation actions. The MVP framework, developed by The Nature Conservancy, employs a workshop-based model designed to help local stakeholders in:

- Characterizing climate-related and extreme weather hazards of highest concern to the community;
- Understanding the science of climate change and adaptation. EOEEA has established a website www.resilientma.org as a data clearinghouse for science and state-specific geographic data on climate change;
- Identifying existing and future vulnerabilities and asset strengths in areas of infrastructure and critical facilities, socio-economic characteristics, and environmental resources;
- Developing and prioritizing actions for community resilience based on identified opportunities for risk reduction and resilience building; and
- Implementing key actions through community partnerships.

With the completion of the resilience-building planning process, a city or town can become a formally designated MVP community, eligible for MVP action grants to undertake technical plans as well as design and construct priority resilience projects.

In 2018, the Commonwealth of Massachusetts adopted the **State Hazard Mitigation and Climate Adaptation Plan (SHMCAP)**. The plan was the first of its kind to comprehensively integrate climate change impacts and adaptation strategies with hazard mitigation planning

to comply with current federal requirements for state hazard mitigation plans under the Stafford Act. Following the State's example, cities and towns are eligible for additional funding to combine the MVP Planning process with hazard mitigation planning. Newburyport became an MVP designated community in 2018 and completed an all-inclusive Climate Resiliency Plan in 2020. The city will utilize these comprehensive planning processes and outcomes to integrate, as the state has done, climate change impacts and adaptation strategies into their HMP update.

1.3 Background

Natural hazards, such as floods, hurricanes, and severe winter storms, are a part of the world around us. Their occurrence is natural and inevitable, and our capacity to control their frequency, intensity, or duration is limited. Also, climate change is altering the frequency and intensity of these events requiring municipalities to examine climate projections as part of their planning. The Merrimack Valley region is vulnerable to a wide array of natural hazards, including ***floods***, ***hurricanes***, ***nor'easters***, ***snow and ice storms***, ***drought***, ***wildfires***, and even ***tornadoes*** and ***earthquakes***. These hazards threaten the safety of our residents and have the potential to damage or destroy public and private property, disrupt the local economy, and diminish the overall quality of life of those who live, work, and play in the region.

While we cannot eliminate natural hazards, there is much we can do to lessen their impacts on communities and citizens. By reducing a hazard's impact, we can decrease the likelihood that such an event will result in a disaster. The concept and practice of reducing risks to people and property from known hazards is generally referred to as ***hazard mitigation***. Also, by incorporating the best available scientific information on climate change, communities are better able to develop adaptation strategies to increase resilience.

Local hazard mitigation planning is the process of organizing community resources, identifying and assessing hazard risks, and determining how to best minimize or manage those risks. This process results in a Multi-Hazard Mitigation Plan that identifies specific mitigation actions, each designed to achieve both short-term planning objectives and a long-term community vision. To ensure the functionality of each action, responsibility is assigned to a specific individual, department, or board, along with a timeframe for its implementation. Plan maintenance procedures are established for the routine monitoring of implementation progress, as well as the evaluation and enhancement of the Mitigation Plan itself. These Plan maintenance procedures are intended to ensure that the Plan remains a current, dynamic, and effective planning document over time.

Mitigation planning has the potential to produce long-term, recurring benefits by breaking the repetitive cycle of disaster loss. A core assumption of hazard mitigation is that pre-disaster investments will significantly reduce the demands for post-disaster assistance by lessening the need for emergency response, repair, recovery, and reconstruction. Furthermore, mitigation practices will enable residents and businesses to re-establish themselves in the wake of a disaster, getting the community and its economy back on track sooner and with less disruption to lives and vital services.

The benefits of mitigation planning go beyond solely reducing hazard vulnerability. Measures such as the acquisition or regulation of land in known hazard areas can achieve multiple community goals, such as preserving open space, maintaining environmental health, and enhancing recreational opportunities. Thus, it is vitally important that any local mitigation planning process be properly integrated with other concurrent local planning efforts, such as the city's Master Plan or Open Space and Recreation Plan. Similarly, any proposed mitigation strategies and actions should take into account other community goals and initiatives that could complement (or possibly hinder) their future implementation.

1.4 Plan Purpose

The purpose of the Newburyport HMP is to identify and characterize hazards associated with natural disasters and climate change; determine specific locations, populations, and facilities that are vulnerable to these hazards; and formulate mitigation goals, strategies, and actions to reduce the risks and impacts associated with these hazards. By developing and implementing a hazard mitigation and vulnerability preparedness plan *before* disaster strikes, Newburyport will be better able to prevent or minimize loss of life and property. Anticipated Plan benefits include:

- A community that is a safer place to live, work, and visit;
- Speedier physical and economic recovery and redevelopment following disaster events;
- Compliance with state and federal regulatory requirements for natural hazard mitigation plans; and
- Qualification for local grant funding in the pre-disaster and post-disaster environments.

FEMA, within the Department of Homeland Security, is responsible for leading the country's efforts to prepare for, prevent, respond to, and recover from disasters. FEMA has made hazard mitigation a primary goal in its efforts to reduce the long-term effects of natural hazards. FEMA provides guidance to state, regional and local governments in developing their hazard mitigation plans, reviews and approves the plans, and administers several hazard mitigation grant programs to fund mitigation activities.

Some state and federal grant programs mandate that local governments develop and maintain up-to-date natural hazard mitigation plans. The Federal Disaster Mitigation Act of 2000 requires all communities to have such plans in place to be eligible for future

federal post-disaster mitigation funds under the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP). This Hazard Mitigation Plan is intended to assist the communities in complying with this requirement.

The mitigation planning process is also directed at ensuring that local mitigation strategies and implementation actions: 1) address the *priority* mitigation needs identified by each community, and 2) are properly coordinated among the region's communities to maximize limited resources, minimize inter-municipal conflicts, and avoid duplication of effort.

As stated previously, to remain current, hazard mitigation plans must be updated and resubmitted to FEMA for approval every five years. Plan updates must demonstrate that progress has been made in fulfilling the commitments made in the previous plan. This requires a review and update of each section of the plan and a discussion of the progress made over the past five-year period.

Newburyport was previously part of the regional Merrimack Valley Multi-Hazard Mitigation Plan which was approved in 2016. While the Merrimack Valley region has applied for Building Resilient Infrastructure Communities (BRIC) grant funding, the City of Newburyport needs an updated plan on a faster timeline. Having recently completed the Newburyport Climate Resiliency Plan (https://www.cityofnewburyport.com/recycling-energy-sustainability/resiliency-sustainability/links/newburyport-climate-resiliency-plan), the city is well prepared to incorporate this extensive work into the HMP update. The result is an HMP that describes occurrences of hazards included in the previous plan and assesses Newburyport's capacity to adapt to changing hazards and climate conditions in the future. The plan has also been updated to include changes in development patterns and changes in local and regional priorities. The goals contained in the MVP Summary of Findings and the Climate Resiliency Plan have been reviewed and reaffirmed and reflect new information, priorities, and a changing climate.

1.5 Planning Process and Vision Statement

Following extensive planning, education, and outreach to develop the Newburyport Climate Resiliency Plan, Newburyport seeks to use this information to update its Hazard Mitigation Plan. Working with Newburyport's Community Resiliency Committee, the city will:

1) update local and regional climate-related hazards;
2) update the city's strengths and vulnerabilities regarding each of these hazards, now and in the future;
3) update the city's prioritized action plan to improve the city's resilience to and preparedness for these hazards.

In developing this action plan, the following factors should be considered:

- Maintaining and improving quality of life in Newburyport;

- Maintaining fiscal balance and stability despite large and unforeseeable municipal expenses during and after events;
- Maintaining communication pathways, and information technology systems, during events (including power outages);
- Maintaining water quality and protecting our natural resources through changing conditions;
- Maintaining and replacing aging infrastructure to withstand current and future hazards;
- Protecting transportation systems against hazards, including public transportation reliability;
- Avoiding and mitigating damage to private and public property during events;
- Providing emergency shelter options to vulnerable populations during events;
- Avoiding poor air quality as temperatures rise, especially during heat waves;
- Accommodating increasing energy use and the resulting strain on the electrical grid during heat waves; and
- Managing insects, pests, wildlife, and invasive plant species with changes in precipitation patterns and increasing temperatures.

SECTION 2. PLANNING PROCESS & PUBLIC PARTICIPATION

This section describes the process undertaken to update the plan by the City of Newburyport and its Community Resiliency Committee and other stakeholders to develop the **Newburyport HMP update.**

2.1 Planning Process Summary

Prior to undertaking the HMP Update, the city completed four risk assessment studies, with the most recent going beyond just assessing storm and flood impacts, but also considering other impacts from climate change on Newburyport[2]:

Great Marsh Coastal Adaptation Plan[3] *– National Wildlife Federation (NWF), Final Report issued December 2017*

44 CFR Requirement

Part 201.6(c)(1): *The plan shall include documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.*

Following the devastation inflicted by Hurricane Sandy, the Federal Government made funds available to improve the resilience of coastal communities. In 2014, NWF was awarded $2.9 million dollars for the project titled "Community Risk Reduction through Comprehensive Coastal Resiliency Enhancement for the Great Marsh." This project offered a holistic and integrated approach to reducing the growing vulnerability of communities within the Great Marsh to coastal hazards by strengthening the resiliency of the ecological systems upon which those communities depend. Upon receipt of the award, this investment was leveraged by project partners to provide an additional $1.3 million dollars in research and conservation efforts in this priority coastal area.

Within the larger scope of this project, The NWF and Ipswich River Watershed Association (IRWA) led a community-driven process to assess community vulnerability and develop ecosystem-oriented adaptation strategies for the municipalities of Essex, Ipswich, Rowley, Salisbury, Newbury, and *Newburyport.* The planning process resulted in the development and engagement of cross-sector municipal resiliency task forces, six town-specific summary vulnerability assessments, community engagement workshops focused on community vulnerability and resiliency strategy planning and development, task force prioritization of near-term and long-term risk-reduction strategies, and ultimately the development of the Great Marsh Coastal Adaptation Plan.

[2] Newburyport Climate Resiliency Plan: https://www.cityofnewburyport.com/sites/g/files/vyhlif7106/f/uploads/newburyport_climate_resiliency_plan_10-08-2020_final.pdf

[3] National Wildlife Federation. 2017. Great Marsh Coastal Adaptation Plan. https://www.nwf.org/-/media/Documents/PDFs/NWF-Reports/NWF-Report_Great-Marsh-Coastal-Adaptation-Plan_2017.ashx

This effort, along with what had been completed via the EPA grant set the stage for the NRC to start formulating Newburyport's own Climate Change Resiliency Plan.

Newburyport Municipal Vulnerability Preparedness Workshop

Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA), Final Report Issued May 2018

The Commonwealth of Massachusetts observed that while some coastal communities were attempting to develop risk assessments and resiliency plans, their focus narrowly considered only sea level rise and coastal flooding impacts. Furthermore, the processes being employed were not uniform. Climate change was having far reaching effects and would be affecting all municipalities, both coastal and non-coastal. Hence the Massachusetts Executive Office of Energy and Environmental Affairs developed the Municipal Vulnerability Preparedness (MVP) program as a means for Communities to consider all the potential climate change impacts, not just sea level rise and coastal storms. The standardized process served to level the field, allowing communities to become MVP certified and apply for grants to mitigate the risks identified via the MVP program. In early 2017, Newburyport sought, and was awarded, a grant from EOEEA to become an MVP certified community. The goal of the program was to not only identify community vulnerability imposed by climate change, but to also involve community residents, business owners and other stakeholders in the process.

On April 7, 2018, Newburyport held a Municipal Vulnerabilities Preparedness (MVP) workshop. The workshop's goal was to identify hazards Newburyport faced that were being exacerbated by climate change, and to prioritize actions the city could take to prepare for identified hazards. This workshop, planned by a core team of the NRC and the Horsley Witten Group, Inc. was a step towards MVP certification, which allowed certified communities access to additional state grants for projects related to climate change resiliency. Thirty-eight community members attended the workshop, representing a wide cross section of city officials, response partners, and other interested parties.

During discussion, participants concluded that the most relevant hazards to Newburyport were storms including nor'easters, winter storms, and hurricanes; bipolar weather including extreme cold, extreme heat, and drought; inland flooding; and sea level rise. In four small groups, participants listed features of Newburyport that may be impacted by climate change or may help the community cope with climate related hazards. Small groups then listed actions that could be taken to protect or utilize features to mitigate the impact of prioritized hazards. Following small and large group discussion and voting, participants prioritized seven action items.

The complete Newburyport Municipal Vulnerability Preparedness Workshop Report can be found here:
https://www.cityofnewburyport.com/recycling-energy-resiliency-sustainability/resiliency-sustainability

Wastewater treatment facility Climate Change Resiliency, Climate Change Vulnerability Report

As a result of participation in the Massachusetts MVP Program (discussed above), the city was awarded an MVP Action Grant in fiscal year 2018 to develop a Resiliency Plan for the Wastewater Treatment Facility (WWTF). The Plan was completed in June 2019 and assessed the vulnerabilities of the facility and provided measures and strategies to make the plant resilient to climate change impacts.

Newburyport Climate Resiliency Plan October 2020

This Resiliency Plan's focus is on Newburyport's short and long-term vulnerability to climate change. Its chapters address Newburyport-specific climate change hazards and vulnerabilities and recommends adaptation strategies to ensure that Newburyport remains a resilient community in the face of global warming, sea level rise, and climate change implications. These strategies include infrastructure installations and improvements, regulatory and administrative approaches, community communication and education, and mitigation through "carbon footprint" reductions. The Plan was published in October of 2020 and was followed by a public presentation of the Plan in February of 2021. Residents, business, and other local stakeholders were invited and encouraged to participate in the process.

Newburyport's Resiliency Committee meets 6-8 times per year in open meetings with published agendas and meeting minutes. The Resiliency Committee served as the Core Team for updating the city's HMP.

In the spring of 2021, the City of Newburyport requested that the Merrimack Valley Planning Commission (MVPC), coordinators and authors of the Merrimack Valley Multi-Hazard Mitigation Plan Update 2016-2021, assist the city in an individual HMP update. MVPC recently completed individual plan updates for nearby Merrimac and North Andover and was able to begin work with Newburyport in the summer of 2021. Given the extensive amount of recent climate resiliency planning and community outreach undertaken in Newburyport, the city had already done much of the work needed for the HMP update.

Newburyport's Resiliency Committee includes the following representation:

*David	Chatfield	Chairman
Donna	Holaday	Mayor
Barry	Connell	City Council President
*Andy	Port	Planning Director
*Christopher	LeClaire	Fire Chief
*Jon-Eric	White	City Engineer
*Molly	Ettenborough	Sustainability Manager
*Julia	Godtfredsen	Conservation Administrator
Joe	Teixeira	Conservation Commission Chair
Rishi	Nandi	Resident
*Jane	Healey	Resident

Janet	Daisley	Resident
Bret	LeFebvre	Resident
Heather	Lipp	Resident
Sarah	Tappan	Resident

* Participated in as part of Core HMP Planning Team

The full Newburyport Climate Resiliency Plan can be found here:

https://www.cityofnewburyport.com/recycling-energy-sustainability/resiliency-sustainability/links/newburyport-climate-resiliency-plan

Merrimack Valley Multi-Hazard Mitigation Plan 2016

In 2008, MVPC completed the Merrimack Valley region's initial HMP. In 2015/16 MVPC completed the first update of that Plan. This plan update builds upon that planning initiative with Newburyport as the sole planning area focus. Updated data regarding natural hazard events, demographics, non-natural hazards, and critical infrastructure have been incorporated into the document as well as the outcomes of the Newburyport's Municipal Vulnerability Preparedness Planning (2018) and Climate Resiliency Planning (2020) efforts which further incorporate climate change into the existing plan. New information regarding changes in development patterns, progress in local mitigation efforts, and changes in local and regional priorities have been incorporated into this update as well.

During the prior plan development of the Merrimack Valley Multi-Hazard Mitigation Plan, MVPC and local staff took numerous steps to coordinate all aspects of emergency management planning. Each municipality had a Comprehensive Emergency Management Plan (CEMP), and a Regional Homeland Security Plan in place. Accordingly, Newburyport's Hazard Mitigation Plan update includes goals and objectives that meet local needs and complement local and regional goals established in the CEMPs and Homeland Security Plan.

2.2 Preparing for Plan Updating Process

Since completing the Regional Multi-Hazard Mitigation Plan update, MVPC staff attended FEMA- and MEMA-sponsored hazard mitigation planning conferences including a one-day Local Mitigation Planning Workshop that included a Planning for a Resilient Community module. MVPC also reviewed state and federal guidance documents on the development of an updated and combined Hazard Mitigation and Climate Adaptation Plan. MVPC utilized the instructional manual, "Natural Hazards Mitigation Planning: A Community Guide" (January 2003), prepared jointly by the Massachusetts Department of Environmental Management (now the Department of Conservation and Recreation), the Massachusetts Emergency Management Agency, and the Massachusetts Hazard Mitigation Team. Special attention was given to the planning requirements described in FEMA's updated guidance document, "Local Mitigation Plan Review Guide" (October 1, 2011) *Planning Handbook (2013)*. Appendix A of that document, titled "A *Local* a detailed summary of FEMA's current minimum standards of acceptability for an updated plan's compliance with the Disaster Mitigation Act of 2000.

MVPC is a certified MVP provider and staff leading the HMP update planning process are trained in workshops to provide technical assistance to communities in completing the assessment and resiliency plan using the CommunityResilienceBuildingFramework (CRB). Certified staff is well versed in relevant resources including climate change projections for the Commonwealth and the region, found at the Climate Change Clearinghouse (resilientma.org). MVPC staff is also knowledgeable on how to incorporate nature-based solutions into the planning process, and how to integrate the MVP process with creating and/or updating a local Hazard Mitigation Plan.

Newburyport's Hazard Mitigation plan update included a review of City and regional planning documents including those listed above and the 2019 Regional Housing Production Plan, Newburyport Master Plan (2017), and the Newburyport Open Space and Recreation Plan (2020) as well as meetings with key staff within the City.

Comprehensive hazard maps were developed using the best available data with input from the City's Emergency Management staff and Department of Public Services. The maps depict the locations of natural hazard areas such as flood zones, as well as critical facilities and infrastructure. They also depict the location of residences and other buildings within the flood zones and form the basis for estimating the probable losses from potential natural disasters, such as severe flooding. These maps can be found in Appendix A.

The hazard identification and assessment process also included compiling information on the region's high-risk dams and structurally deficient bridges. This information was culled from several state data sources, including the DCR Office of Dam Safety and the Massachusetts Highway Department, and, where possible, was updated through input from knowledgeable local officials.

2.3 Hazard Mitigation Plan Core Team and Stakeholders

Project Announcement. The Merrimack Valley Regional Multi-Hazard Mitigation Plan expired in May of 2021. To maintain its eligibility for upcoming FEMA grant funding, Newburyport is required to have a current Hazard Mitigation Plan. Newburyport engaged MVPC to assist with the plan update in the summer of 2021. MVPC met with a core group of the Climate Resiliency Committee (see members marked with an asterisk above) on July 13, 2021.

Core Team Meeting. The city identified its Resiliency Committee as possessing the integral group of community representatives to lead the HMP update. This Committee meets an average of six times per year and has the following mission statement:

The committee will analyze, coordinate, and develop a plan in conjunction with regional planning to impacts of climate change including sea level rise, storm surge, flooding and extreme weather events throughout the city. Further, the committee will advocate for and oversee implementation of the plan's recommendations.

The Core team reviewed natural hazards of greatest concern, existing inventories including those of critical facilities and infrastructure, dams, bridges, and flood-prone areas, as well

as new developments and changes in land use. The resulting information was then used to compile the "Existing Protections Matrix" element of the Plan (see Section 5). Core Team members also provided valuable information to identify mitigation projects that have been completed or initiated since the prior Multi-Hazard Mitigation Plan was approved in 2016.

At their first meeting in July and their second on August 5, 2021, the Core Team reviewed the priority actions from both the MVP Final Report, the Climate Resiliency Plan, and the prior 2016 Hazard Mitigation Priority Action Plan to identify the full range of actions to be considered for the plan update.

A virtual meeting of the full Resiliency Committee and a group of community and regional stakeholders was set for August 18, 2021.

Stakeholders and HMP Planning Workshops. The Core Team engaged with stakeholders from its prior planning processes (MVP and Resiliency Plan) including a broad representation of community groups, board and commission members, and city staff with subject matter expertise from public services, building, planning, conservation, the council on aging, veterans, and other departments. The stakeholder list also included local elected officials and managers from neighboring communities as well as representatives from the business community, and nonprofit and environmental organizations. This broad representation of local and regional entities ensures the HMP update aligns with the policies, planning, and hazard mitigation strategies at different levels of government.

The invited Stakeholder representatives included:

Stakeholders

- Kassandra Gove, Mayor, Amesbury
- Tracy Blais, Town Manager, Newbury
- Angus Jennings, Town Manager, West Newbury
- Neil Harrington, Town Manager, Salisbury
- Christine Berry, Dept. of Conservation and Recreation (DCR)
- Noah Berger, Executive Director, MVRTA, Haverhill
- Diana DiZoglio, State Senator, First Essex District
- James Kelcourse, State Representative, First Essex District
- Joy Duperault, State NFIP Coordinator, DCR
- Vanessa Johnson-Hall, Essex County Greenbelt, Essex
- Wayne Castonguay, Executive Director, Ipswich River Watershed Association

- Matthew Thorne, Executive Director, Merrimack River Watershed Council
- Frank Giacalone, Director of Public Health
- Mark Murray, City Marshal, Police Department
- Paula Burke, Executive Director, Council on Aging
- Greg Earles, Building Inspector, Building Department
- Sean Gallagher, Superintendent, Newburyport Public Schools
- Tracy Watson, Executive Director, Newburyport Housing Authority
- Paul Hogg, Harbormaster
- Kevin Hung, Director, Veterans Services
- Joseph Muraco, National Grid
- Thomas Cusick, Water Treatment Superintendent, DPS Water Division
- Charles Tontar, Councilor At-Large, City Council
- Afroz Khan, Councilor At-Large, City Council
- Joseph Devlin, Councilor At-Large, City Council
- Sharif Zeid, Ward 1 Councilor, City Council
- Bruce Vogel, Councilor At-Large, City Council
- Jared Eigerman, Council President, Ward 2 Councilor
- Heather Shand, Ward 3 Councilor, City Council
- Christine Wallace, Ward 4 Councilor, City Council
- Jim McCauley, Ward 5 Councilor, City Council
- Byron Lane, Ward 6 Councilor, City Council
- Nancy Pau, Parker River National Wildlife Refuge
- Bonnie Sontag, Chair, Planning Board
- Joe Teixeira, Chair, Conservation Commission

2.4 Prior Planning Process and Outcomes

As discussed previously, Newburyport has conducted extensive prior planning regarding natural hazards and the associated actions to promote resiliency. During the MVP planning process, participants prioritized seven action items. The City's Municipal Vulnerability Preparedness Plan details the action items developed from the MVP process.

Newburyport Municipal Vulnerability Preparedness Workshop

Summary of Findings (May 31, 2018)

On April 7, 2018, Newburyport held a Municipal Vulnerabilities Preparedness (MVP) workshop. The workshop's goal was to identify hazards Newburyport faces that are being exacerbated by climate change, and to prioritize actions the city can take to prepare for identified hazards. This workshop, planned by a core team of organizers and the Horsley Witten Group, Inc. was a step towards MVP certification, which allows certified communities access to additional state grants for projects related to climate change resiliency. Thirty-eight community members attended the workshop, representing a wide cross section of city officials, response partners, and other interested parties.

During discussion, participants concluded that the most relevant hazards to Newburyport were storms including nor'easters, winter storms, and hurricanes; bipolar weather including extreme cold, extreme heat, and drought; inland flooding; and sea level rise. In four small groups, participants listed features of Newburyport that may be impacted by climate change or may help the community cope with climate related hazards. Small groups then listed actions that could be taken to protect or utilize features to mitigate the impact of prioritized hazards. Following small and large group discussion and voting, participants prioritized the following seven action items:

- Enhance the resilience of the Wastewater treatment facility. Specifically, in the short term, protect and flood proof the Wastewater treatment facility, and in the long term (estimated 40-50 years, at the close of the useful lifespan of the current facility), relocate the wastewater treatment facility.
- Create a short term and long-term plan for the city's management of Plum Island, including discussion of access via the Plum Island turnpike, dune and floodplain management and potential retreat from current residential areas.
- Enhance emergency preparedness and response procedures. Specifically, improve participation in and use of the community's Code Red system, and enact an educational program to help residents improve their family's emergency preparedness.
- Develop a resiliency study of the Lower Artichoke Reservoir Dam to improve protection of the public water supply.
- Improve flood protection of utilities (water, sewer, electric, and gas). Specifically, require an annual accountability report from all utilities in the community.
- Create an inventory of coastal infrastructure (e.g., seawalls, boat ramps, bulkheads, and jetty) and conduct an assessment evaluating the efficacy of each component.
- Evaluate and plan for raising roadways and modifying culverts in areas of the city where it may be needed due to current or potential inundation risks (e.g., Water Street, Business Park, and Malcolm Hoyt Drive).

The City of Newburyport expanded upon these initial findings in its 2020 Climate Resiliency Plan. This plan discussed in greater detail the following Climate Hazards:

1. Sea Level Rise

2. Coastal Storms - Extra Tropical, Tropical, and Hybrid Cyclones
3. Heavy Precipitation Events
4. Flooding
5. Wind
6. Tornados
7. Weather Extremes – Drought, Heat Waves, Winters and Cold Snaps, Persistent Precipitation
8. Insect Disease Vectors - Tick and Mosquito related illness
9. Combined Sewer Overflows (CSOs)

The plan further identified strategies to mitigate risk exposure including a mixture of protection, adaptation, and retreat with suggested timelines of immediate, short term (current day to 2030), and long term (2030 -2070). The strategies fall into four main strategic areas:

- Infrastructure Installations/Improvements
- Regulatory and Administrative Approaches
- Community Communication and Education
- Mitigation through Carbon Footprint Reductions

The following is a summary of the more than 150 recommendations developed by the Resiliency Committee:

Resiliency Plan Summary Recommendations:

Infrastructure installations/improvements

- Immediately deploy methods to protect vulnerable Critical Assets from inundation.
  - Water Supply
  - Wastewater Treatment Facility
  - National Grid Substation
- Develop, evaluate, and implement plans for permanent protection of the water supply
- Develop and evaluate plans for protecting low lying sanitary sewer lift stations and in the long-term the future relocation of the WWTF and National Grid facilities.
- For the areas surrounding and including Cashman Park and Waterfront Park, perform a design, cost and feasibility analysis that considers elevating or protecting these properties to preserve their amenities vs. adapting and transitioning the assets to alternate uses in a rising sea and surge scenario.
- Strengthen the electrical grid by reducing conflicts with trees, burying utilities and evaluating micro grids.

Regulatory and Administrative Approaches

- As some shoreline areas will become uninhabitable sooner than others, use sea level rise (SLR) and inundation projections to prepare an inundation timeline for neighborhoods along the river and Plum Island.
- Review, evaluate, and revise zoning and building regulations to improve resilience, water conservation, energy efficiency and discourage development in the FEMA high hazard flood zones.
    - o Develop and adopt a design flood elevation for all new and proposed renovations of properties in the FEMA high hazard flood zones.
    - o Continue to enforce existing Wetlands Protection act regulations.
- Develop and implement a task force to develop with Newbury and implement a long-term, sustainable, science-based plan to address the multifaceted challenges facing Plum Island. Continue to work with the Merrimack River Beach Alliance, the Plum Island Foundation, the U.S. Army Corp of Engineers, Legislators and State Agencies in this process.
- Evaluate alternative access options to Plum Island.
- Develop and implement an automated water quality monitoring and warning system to protect residents from the health risks associated with combined sewer overflows (CSOs). Continue to work with legislators to support efforts to upgrade upriver wastewater treatment facilities to reduce CSOs.
- Implement a storm water/impervious surfaces management program in compliance with EPA MS4 permit. Impervious surfaces contribute to flooding, raise summer temperatures citywide through heat island effects, and increase the cost of snow removal.
- Develop alternative revenue streams to fund the city's budget and pay for resiliency and emergency response activities. As future sea level rise and inundations begin to claim shoreline properties, resiliency costs will increase, and current sources of real estate tax revenues would decline.
    - o Design and implement a storm water utility
    - o Evaluate a differential tax rate for properties located within the FEMA high hazard flood zones.
    - o Evaluate additional use tax strategies

Community Communication and Education

- Develop recommendations for personal resilience to assist and educate residents to make their households resilient to climate hazards.
- Develop a property owner's flood resiliency guide and educate property owners of acceptable methods to flood proof their properties.
- Engage with the community to determine under what circumstances and resources, that a managed retreat from shoreline areas would be acceptable.
- Educate and alert residents to emerging public health impacts related to heat, air and water quality, residents of the need to evaluate and strengthen their own personal resilience to climate hazards.

- Develop a public outreach and education program to educate residents about this resiliency plan. Specifically: promote personal preparedness, community resiliency, natural hazard mitigation, public health impacts, CPR, First Aid training and managing carbon footprints. Create school-based programs to educate future generations about climate change impacts and resiliency.

Mitigation through Carbon Footprint Reductions

- To mitigate climate change and temper hazards for future generations, Newburyport and each of its residents must do their part to achieve communitywide net-zero emissions by 2050. To that end, track the current municipal carbon footprint and implement a program to quantify and track the impact of residential households. Implement an annual program of residential carbon footprint reporting.
- Increase the use of renewable energy versus fossil fuel energy citywide.

Having undertaken this extensive planning work related to hazard mitigation, the City of Newburyport utilized the August 18, 2021, stakeholder meeting to affirm and prioritize actions to mitigate hazards related to key vulnerabilities in the city. The virtual meeting was hosted on zoom and the outcomes of online polling completed using PollEverywhere can be found in Appendix B. This meeting served to inform the Mitigation Action Plan presented in Chapter 9.

2.5 Listening Sessions, Other Public Forums and Opportunities for Community Involvement

Efforts to adopt new mitigation activities can be constrained by the general public's lack of awareness and understanding of natural hazards and their risks. Collaboration aimed at clarifying goals, priorities, and desired outcomes is essential to an effective hazard mitigation planning process. Accordingly, a public involvement process was utilized to encourage governmental entities, adjacent communities, residents, businesses, and nonprofit organizations to participate in the planning process.

In addition to including these public entities in the stakeholder groups, Newburyport held two listening sessions; one to review the outcomes of the HMP Planning process and draft plan and the second to review the final HMP Plan before adoption by the City Council.

The first session was held virtually on May 18th 2022. The public meeting was advertised on the Public Meetings Calendar on the city website and was also promoted on the city's social media accounts. All Core Team members and Stakeholders were invited via email. The meeting was held virtually with over 20 participants. In conjunction with MVPC, the City of Newburyport presented the priority actions identified during the planning process and facilitated discussion with attendees.

The second listening session will be held once comments from MEMA and FEMA have been received and the plan is ready for presentation to the Board of Selectmen. Agendas for all meetings can be found in Appendix C. A summary of all public meetings is presented in the following table:

Meeting	Date	Attendees
Project Kick-off Meeting	July 13, 2021	Core Team
Core Team Meeting	August 5, 2021	Core Team
HMP Planning Meeting	August 18, 2021	Core Team & Stakeholders
Additional Planning Meetings	September 2, November 23, and December 21, 2021	Core Team
Listening Session 1	May 18, 2022	Core Team, Stakeholders, Public
Listening Session 2		Core Team, Stakeholders, City Council, Public

2.6 Continuing Public Outreach

Following MEMA and FEMA approval of Newburyport's Multi-Hazard Mitigation Plan, the city's Resiliency Committee will regularly review the plan and include accomplishments as achieved. Also, the Committee will meet annually to evaluate the effectiveness of the mitigation and risk reduction strategy and update as needed. All plan revisions/additions will include public participation and meetings will be publicly noticed per city and state open meeting laws.

SECTION 3. COMMUNITY PROFILE

This section of the Plan provides an overview of Newburyport and includes updated information on the city's population and economy, land use, transportation network, water resources, protected open space, and historic/cultural resources. It is intended to provide context for the natural hazard characterizations, assessments, and mitigation actions that follow later in the Plan.

The Historic Seaport City of Newburyport is located on the Northeast coast of Massachusetts, along the southern bank of the Merrimack River. The city's easterly extent touches the Atlantic Ocean along the northern shores of Plum Island. There, Newburyport shares the Merrimack River inlet with the town of Salisbury located across the river to the north. In addition to Salisbury, three other towns share Newburyport's border: West Newbury along the river to the west, Amesbury across the river to the northwest, and Newbury (including much of populated Plum Island), to the south.

The city has a total area of 10.6 square miles, of which 22.5% is wetlands or open water. The city's northern border is the MerrimackRiver. The Artichoke Reservoir, shared with the Town of West Newbury, is at the western border of Newburyport.

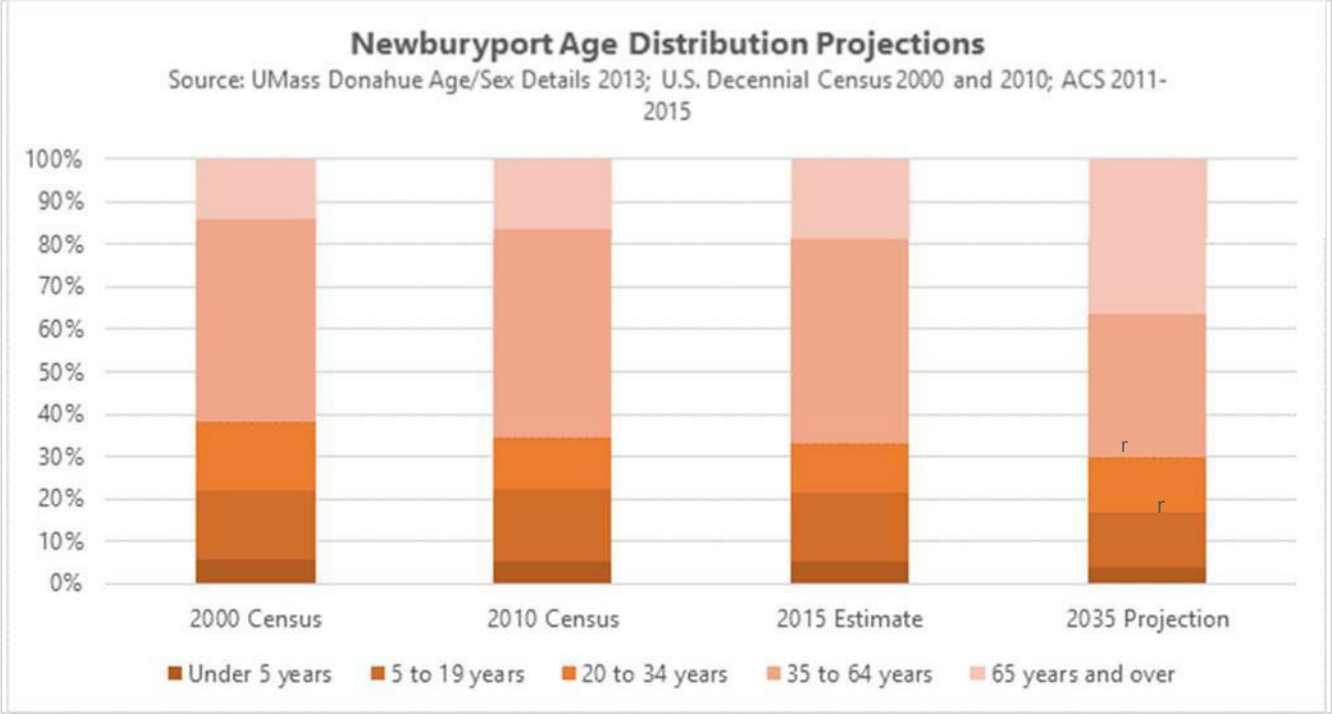
3.1 Current Population, Housing, and Employment

***Population*.** Newburyport's population, as reported by the U.S. Census Bureau's 2020 dataset, is 18,289 people – an increase of 5 percent from 2010. The population of Massachusetts (state) and Essex County (county) increased about 7.4 percent and 8.9 percent respectively between 2010 and 2020.[4] The estimated population of the region increased 10.8 percent in the same period.

Per the UMass Donahue projections, the age composition of Newburyport's population is anticipated to change with a 118 percent increase in the number of older adults (age 65 years and over), a 25 percent decrease in the number of school age children, and a 32 percent decrease in the number of adults aged 35 to 64. The median age in Newburyport was estimated to be 46.97 years in 2019, which is higher than the county's median age of 40.11 years and the state's median age of 39.33 years.[5]

[4] https://data.census.gov/

[5] City of Newburyport Housing Production Plan 2018-2022 prepared by Merrimack Valley Planning Commission with JM Goldson community preservation & planning. https://mvpc.org/demographics/



The U.S. Census Bureau, per the ACS, defines disability as including go-outside-home, employment, mental, physical, self-care, and sensory.[6] Newburyport's estimated disability rate (9 percent of total non-institutionalized population)[7] is slightly lower than the region (11 percent), county (12 percent), and state (12 percent). The estimated percentage of children under 18 years with a disability in Newburyport (4 percent) is slightly lower than the region (5 percent), county (6 percent), and state (5 percent), and the estimated percentage of adults ages 18 to 64 years with a disability is slightly lower in Newburyport as well (6 percent) than the estimated 9 percent of population in this age cohort in the region, county, and state.

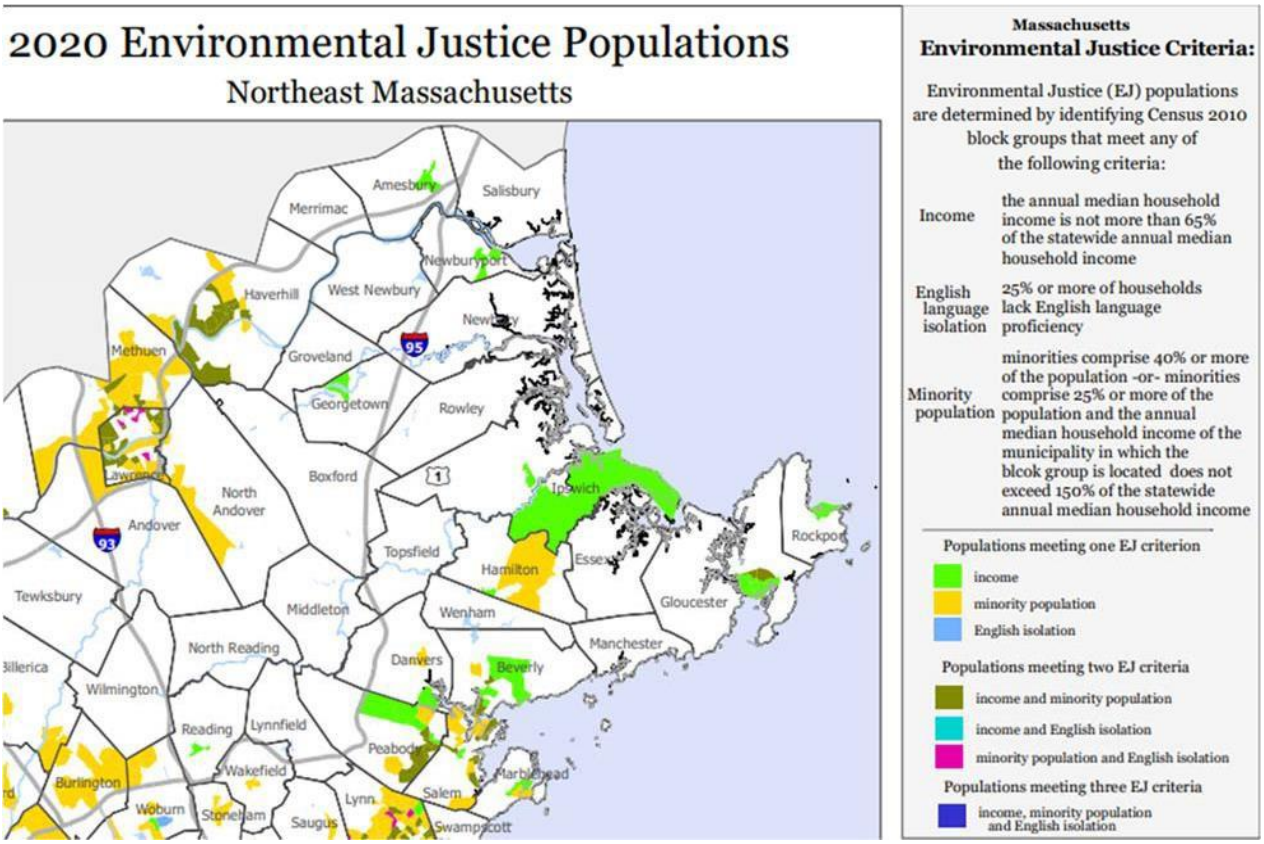
However, there is still an estimated 24 percent of older adults age 65 years and over with disabilities. Newburyport stakeholders identified senior populations and individuals with disabilities as more vulnerable to climate change and emergencies and disasters overall.

Environmental Justice. Since 2002, the Massachusetts Executive Office of Energy and Environmental Affairs has been implementing an Environmental Justice (EJ) Policy to help ensure that all Massachusetts residents experience equal protection and meaningful involvement concerning development, implementation, and enforcement of

[6] U.S. Census Bureau, American Community Survey definition of disability: https://www.census.gov/people/disability/methodology/acs.html

[7] The U.S. Census Bureau defines non-institutionalized population as all people living in housing units, including non-institutional group quarters, such as college dormitories, military barracks, group homes, missions, or shelters. Whereas, institutionalized population includes people living in correctional facilities, nursing homes, or mental hospitals. https://www.census.gov/topics/income-poverty/poverty/guidance/group-quarters.html

environmental laws, regulations, and policies, and the equitable distribution of environmental benefits. Historically, land-use decisions in Massachusetts caused lower-income people and communities of color to experience a disproportionate share of environmental burdens and often lacked environmental assets in their neighborhoods.[8] The state has identified Environmental Justice (EJ) neighborhoods that are comprised of EJ populations.[9] Vulnerable populations such as EJ neighborhoods should be given special consideration when planning for current and future hazards. Newburyport has two environmental justice block groups as defined by the Commonwealth.



[8] Source: MA Executive Office of Energy and Environmental Affairs

[9] Environmental Justice (EJ) Populations are those segments of the population that the Massachusetts Executive Office of Energy and Environmental Affairs has determined to be most at risk of being unaware of or unable to participate in environmental decision-making or to gain access to state environmental resources. They are defined as neighborhoods (U.S. Census Bureau census block groups) that meet one or more of the following criteria: 1) The median annual household income is at or below 65 percent of the statewide median income for Massachusetts; or 2) 25% of the residents are minority; or 3) 25% of the residents are foreign born, or 4) 25% of the residents are lacking English language proficiency. https://www.mass.gov/doc/environmental-justice-policy6242021- update/download

Race and ethnicity. Per the 2020 Census, Newburyport's population continues to racially identify primarily as white alone, with an estimated 91 percent; this is a slight decrease from 2010 when 96 percent of the population identified as white alone. In the region, about 73 percent of the population identified as white alone in 2019, down from 77 percent in 2015. The region is becoming more racially diverse, while Newburyport remains primarily white. About 2.5 percent of Newburyport's population (of any race) identifies as having Hispanic/Latino ethnicity, whereas 27 percent of the region's population identifies as having Hispanic/Latino ethnicity. Despite lower reported ethnic diversity, language barriers need consideration during the hazard mitigation planning process and actions to increase communication in multiple languages is recommended.

Economic. Roughly 48 percent of Newburyport's total labor force is employed in the industries of management, business, science and arts. About 18.5 percent is employed in sales or office occupations, and about 17 percent is employed in the service industry according to the 2019 ACS. The remaining employed population works in the fields of natural resources, construction, and maintenance and production, transportation, and material moving. In March of 2020, the COVID-19 pandemic shuttered many businesses, with the greatest losses seen in the leisure and hospitality industries. At that time, the unemployment rate in Newburyport was reported at 2.5 percent with the Lower Merrimack Valley being reported at 3.3 percent. In January of 2021, the Newburyport rate was reported at 6 percent with the Lower Merrimack Valley Region at 7.9 percent. As vaccination rates increased, unemployment dropped and in June of 2021, Newburyport's rate was 3.5 percent with the Lower Merrimack Valley at 5.4 percent. [10]

Per the 2015 to 2019 ACS estimates, about 50 percent of Newburyport households have a 31-minute mean travel time to work. This is higher than the average in the county (30.4 minutes), and state (30.2 minutes). About 14 percent of Newburyport households commute over an hour, which is similar to the region, county, and state.

In 2019, the MVPC Data Portal reports that there were 1,528 business establishments in Newburyport. The number of establishments compared to the number of jobs in the city reveals that most local businesses are small employers or self-employed individuals. The sectors with the most employees in 2019 were Health and Medical Services, Professional Services, and Real-Estate. Newburyport is a regional hub for employment, as well as a regional destination for culture, entertainment, commerce, and recreation. Newburyport also draws visitors from farther afield, providing opportunities for history and architecture buffs, birders, boaters, beachgoers, trail-users, and others who enjoy the attractive downtown's festivals, shops, and restaurants.[11] The largest employer is the City of Newburyport is Anna Jaques Hospital with 694 employees according to the MVPC Data Portal.

[10] Labor Market Information | Mass.gov
[11] Newburyport Open Space & Recreation Plan, 2020

Roughly 73 percent of Newburyport's occupied housing units were owner occupied and 27 percent renter occupied, which is a lower proportion of renter housing than in the region. In comparison, the region, county, and state had a greater percentage of renter-occupied units (37, 37, and 38 percent, respectively).

Although the rate of single-family residential growth has fluctuated with economic cycles, single-family development has generally been consistent over the past 30 years. More recently there has been an increase throughout Newburyport in housing density resulting from infill and redevelopment of existing smaller house lots. This is particularly true on Plum Island, which is particularly sensitive to development and the adverse effects from rising sea levels and severe storm events. During the period between 2012 and the present, Newburyport has issued 337 building permits for new housing construction. In a community as densely developed as Newburyport, where housing costs remain high, demand for housing can sometimes present a challenge for open space protection efforts.

Consistent with state and national trends, Newburyport home sales prices have continued to rise over the past eight years. And while market demand remains strong, land available for new housing development is limited. From a natural disaster (especially *flooding*) perspective, the sprawl pattern of development has undesirable consequences, not the least of which are an accelerated loss of open space and natural flood storage capacity, increased impervious surface cover, and increased stormwater runoff. The 2017 Newburyport Master Plan notes that, "based on existing zoning, the city's residential districts could accommodate up to 128 new units of single-family housing. The Master Plan suggests the Central Waterfront will likely be redeveloped into parkland; restricting further subdivision of land along scenic High Street and ridgeline; and restricting development on Plum Island.[12] Development in flood-prone areas exacerbated by severe storms and sea level rise is a particular concern.

3.2 Land Use Characteristics and Trend

Newburyport is one of the smallest cities in the state and is defined by the watershed of the Merrimack River, which serves as the northern border of the city. Newburyport's character is shaped by its physical location along the south side of the Merrimack, where its historic harbor reaches the Atlantic at the northern point of Plum Island. The Artichoke river, which flows into the Merrimack River, forms part of the city's western boundary. The location and extent of these

[12] Newburyport Open Space and Recreation Plan 2020

resource areas have little relationship to the political boundaries that separate Newburyport from adjacent communities or the Commonwealth of Massachusetts.

As mentioned in previous sections, the greatest development pressures come from infill development and redevelopment of existing housing with larger homes. Plum Island is an area particularly sensitive to this development as it a barrier island threatened by sea level rise and erosion from wave action.

Table 3.2.1 presents the most recent (FY2020) land use information available for Newburyport. The information was developed based on assessment data/parcel land use codes. The table shows total acreage within each category as well as the percent cover of each category within the city. Also included is the percentage of land within the Zone A and Zone X Flood Areas per the FEMA Flood insurance rate maps. These areas are further defined in Chapter 4 (Natural Hazards section) of the plan.

Table 3.2.1 Newburyport Land Use FY21

	Acres	Rounded Percent	Acres in Zone A	% in Zone A	Acres in Zone X	% in Zone X
Agriculture	362.86	5.2	0.0093	0	52.58	0.75
Commercial	211.01	3	28.3088	0.41	4.2	0.06
Industrial	362.68	5.2	22.044	0.32	0.451	0.01
Institutional	836.43	12	141.35	2.03	8.88	0.13
Mixed Use	2.18	0	0.1175	0	0.1494	0
Multi Family	376.29	5.4	28.41	0.41	4.54	0.07
Open Space	956.15	13.7	201.42	2.89	0.3874	0.01
Single Family	1273.77	18.3	111.124	1.6	10.66	0.15
Vacant Commercial	7.56	0.1	0.8744	0.01	0.75	0.01
Vacant Industrial	98.84	1.4	9.405	0.14	0.1065	0
Vacant Residential	184.09	2.6	19.319	0.28	0.26	0
Water	1563.52	22.5	915.305	13.14	0.14	0
ROWs & Rail ROWs	724.20	10.4	35.107	0.5	10.56	0.15
Unknown Parcels	4.72	0.1	4.3	0.06	0	0
Total	**6964.28**	**99.9**	**1517.094**	**21.79**	**93.6643**	**1.34**

The largest category of developed land use in the Merrimack Valley region is residential. This includes all residential dwelling types, from large lot, single-family homes to multi-family apartments and condominiums. In Newburyport, assessment data shows that, with "water" removed, approximately 76% of city land currently supports development. Land that supports agriculture, open space, and recreation is approximately 24%.

Of the undeveloped Open Space and Recreation Plan notes that "negative impacts of new development can be profound if they are not guided with appropriate policies and land

use regulations designed to protect natural resources, preserve historic features, and retain desired community character." Newburyport has sought to guide future development and protect essential resources by undertaking different strategic planning efforts, recognizing the need to adjust land use planning to direct growth to appropriate areas and to preserve the conservation values of critical open space. Approximately 19 acres of residential land lies within a floodplain area. Development in floodplain areas is regulated by the Newburyport Zoning Ordinance and the Newburyport Conservation Commission.

The City of Newburyport Planning Board is the primary agency responsible for regulating development. The Newburyport Planning Board, through its staff, provided feedback during the local hazard planning team meetings. In addition, Merrimack Valley Planning Commission, the city's regional planning authority, works with all agencies that regulate development in its region, including the municipalities and state agencies, such as Department of Conservation and Recreation and MassDOT. This continued involvement ensured that during the development of the City of Newburyport Hazard Mitigation Plan, the operational policies and any mitigation strategies or identified hazards from these entities were incorporated.

A buildout analysis is an estimate of the maximum amount of development that can theoretically occur under the existing zoning regulations. By itself, the buildout analysis is not a prediction of the amount of development that will occur; but an estimate of the level and types of development that Newburyport could see as a function of existing zoning bylaws and regulations. Build-out potential is important in understanding development pressure on Newburyport's natural resources. The 2017 Newburyport Master Plan notes that, "based on existing zoning, the city's residential districts could accommodate up to 128 new units of single-family housing. The Master Plan suggests the Central Waterfront will likely be redeveloped into parkland; restricting further subdivision of land along scenic High Street and ridgeline; and restricting development on Plum Island.[13]

Newburyport has one of the highest commercial/industrial sectors among Merrimack Valley communities. The Business Park located roughly between Hale Street, Low Street, Route 1, and the Newbury border, is home to approximately 60 large-scale industrial businesses. Several manufacturing businesses are located outside of the business park. A stated goal of the of Newburyport's 2017 Master Plan is to "enable new and expanded commercial and industrial use at the Business Park to generate at least 15% of the city's property tax revenues."

The busy Storey Avenue area located near the intersection of I-95 and Route 113 is home to several banks, three gasoline pumping stations, two major supermarkets with adjoining strip mall businesses, fast food franchises, office buildings and apartment/condo complexes along with their associated impermeable parking lots. As more land is developed, additional impervious surface is created, thereby decreasing the area available for flood storage and increasing the flood risk, a concern cited in Newburyport's MVP and

[13] City of Newburyport Massachusetts Master Plan 2017

Climate Resiliency Plans. As population and housing density increase, the potential for property damage and economic loss as a result of a natural disaster also increases.

3.3 Transportation Network

Newburyport has an increasingly robust transportation network that includes local roadways, major highways, bike lanes, sidewalks, multi-use trails and public transportation.

Roadways
Newburyport is accessed by a network of local roadways and highways, including State Routes 1, 1A and 113, as well as I-95, with close connections to I-495 in Amesbury. Virtually all of the roads in the Merrimack Valley region are administered by either the Massachusetts Department of Transportation (MassDOT) or the municipality in which the road is located. While individual communities often make minor improvements to the federal-aid roadway network in the region, the federal government and/or MassDOT fund almost all major highway improvements.

Publicly available electric vehicle charging stations are located at the Harris/State Streets parking lot as well as at the parking garage on Merrimac Street.

Active Transportation
The City of Newburyport has been developing a network of multi-use trails and connecting corridors that not only provide safer and better access within Newburyport, but also connect to Salisbury, Amesbury and Newbury as part of the Coastal Trails Network. The city has developed a looped rail-trail that connects to the Commuter Rail Station, providing additional multi-modal connections. Bicycle parking has increased throughout the downtown area.

The City of Newburyport has a network of sidewalks as well as two bike lanes -- one on High Street and one on water Street/Plum Island Turnpike. The city adopted a Complete Streets policy and received its first grant from MassDOT for infrastructure implementation. The city has participated in MassDOT's Safe Routes to School program resulting in safer pedestrian access.

***Transit*.** Newburyport Route 54, which connects directly to Amesbury, Newburyport, and Salisbury and has connections to the fixed route to the City of Haverhill. Route 57 was created as downtown Newburyport Shuttle. In addition, the MVRTA provides on-demand service to people with disabilities and those who are ages 60+. The Council on Aging van provides additional local transportation services for seniors.

The Massachusetts Bay Transportation Authority (MBTA), based in Boston, supplements the MVRTA bus system by providing commuter rail services to Newburyport. The train station can be accessed via car, bus, biking and walking. Private carrier, C&J Trailways provides commuter bus service to the area from Seabrook, NH.

Air, Water and Other Transportation.

The closest airports are in Manchester, NH and Boston. The small, historic Plum Island airfield allows arrivals and departures by small aircraft. Access by air year-round is also possible via the Helipad Located at Anna Jaques Hospital, though its intended use is for emergency medical evacuations. Active marinas and docks also allow boaters to use the Merrimack River as an access point to the city. As there are no ferry services, marine access is via pleasure and charter craft. Taxis, seasonal pedi-cabs and ride-hailing services such as Uber and Lyft (also known as Transportation Network Companies or TNC) serve residents and visitors. According to Massachusetts Department of Public Utilities, in 2019 over 55,000 TNC trips originated in Newburyport (https://tnc.sites.digital.mass.gov/).

Plum Island Airport - Newbury

3.4 Water Resources and Public Water Supplies

Water Resources. The communities in the region share many resources. The most significant is the 180-mile Merrimack River and its watershed. The Merrimack River watershed is New England's fourth largest, covering 5,010 square miles and including more than 200 cities and towns. More than 600,000 people use surface water from the Merrimack River for drinking water including the environmental justice communities of Lowell and Lawrence, Methuen, Tewksbury, and other towns. Other communities in the region rely on the Merrimack's groundwater resources. There are unconsolidated sand and gravel aquifers along the Merrimack River and its major tributaries that can sustain well yields of more than 300 gallons per minute (gpm). Newburyport and Salisbury together are the most downstream communities within the Merrimack River's

Watershed. They are the last municipalities through which the river flows before it empties into the Atlantic Ocean.

In addition to the Merrimack, headwaters of the Little River begin west of I-95 near the intersection of Storey Avenue and Turkey Hill Road and meanders along the abandoned I-95 roadway. Its main eastern tributary begins near the shopping centers behind Storey Avenue. The Little River then flows along the southwestern and then southern edge of the business park, ultimately emptying into the Parker River. The Parker flows through the Great Marsh and into Plum Island Sound with the waters ultimately emptying into the Atlantic Ocean in Ipswich Bay. The Little River drains the area along I-95, Storey Ave, and much of Newburyport that slopes toward Low Street.

Finally, overflow from Newburyport's Artichoke drinking water Reservoir passes over the Lower Artichoke dam located along State Road 113 into a small tributary called the Artichoke River which borders West Newbury. This sometimes tidally influenced tributary slowly meanders for ¾ of a mile and empties directly into the Merrimack River.

Public Water Supply Newburyport's drinking water comes from both surface water and groundwater supplies. Four surface water reservoirs, which represent 80% of the city's drinking water supply, include the Indian Hill Reservoir in West Newbury, the Upper and Lower Artichoke Reservoirs in both West Newbury and Newburyport, and the Bartlett Spring Pond in Newburyport. These surface reservoirs supply 780 million gallons of water primarily to Newburyport and some also to the towns of Newbury and West Newbury.

Lower Artichoke Reservoir and Artichoke River

The watersheds for the city's reservoirs are primarily a mixture of residential, agricultural, recreational and forestland. Most of the land abutting the surface reservoirs lies in West Newbury and is privately owned. Groundwater, which accounts for 20% of the drinking water, is supplied by two gravel-packed wells located on Old Ferry Road (Well #1) and Ferry Road (Well#2). A drinking water treatment plant (WTP) located on Spring Lane near Well #1 treats the surface water supplies and the water from Well #1. Groundwater from Well #2 is minimally treated at the well and is directly connected to the city's water distribution system. The Plant is permitted to treat and deliver 2.5 million gallons per day (MG/D), but on average treats 1.6 MG/D. A chlorine booster station is located next to the Plum Island drawbridge to inject chlorine into the water distribution system.

The Newburyport Open Space Committee continues to work with the city's Water Division to protect other lands important to the drinking water supply and quality, consistent with the 2002 Water Works Master Plan, which recommends that the "city should protect

sensitive parcels of land through purchase, easement, conservation restrictions and other protective mechanisms." Moreover, a water supply yield/estimate performed in 2017 showed adequate water supply for anticipated needs through 2040.

Upper Artichoke Spillway

Water supply was a top concern of Newburyport stakeholders as future sea level rise and more intense storms increase the vulnerability of these resources. The public water supply is vulnerable and requires action to avoid being compromised by river flooding or an extreme weather event. The Lower Artichoke dam's spillway currently sits approximately 3 feet lower than FEMA's 100-year flood elevation. Thus, a lesser storm could overtop the spillway with CSO tainted Merrimack River waters thereby cutting off access to 75% of the city's water supply.

3.5 Protected Open Space and Prime Farmland

Newburyport is blessed with an abundance of ecologically rich and visually stunning open space resources. This range includes approximately 2,913* acres of open space. It is home to 37 municipal and private parks, 6 public and private cemeteries, and an array of non-profit land and private open spaces protected by conservation restrictions. Together this mix of open space helps to define the character of Newburyport, playing a vital role in fostering civic pride, public health and wellbeing, biodiversity and economic development.[14]


Maudslay State

Together, these rich resources provide outstanding and diverse:

- **habitat and migration corridors** for numerous wildlife species, birds, fish, and plants;
- **surface and groundwater source protection** for the public drinking water supply as well as private drinking water wells;
- **productive soils** for agriculture, horticulture, and farming; and
- **natural buffers** for protection against flooding.

They also serve as a draw for recreational hikers and other outdoor enthusiasts and naturalists. Newburyport's prime open space resources are critically important to

[14] Newburyport Climate Resiliency Plan, 2020

* Open space land use is calculated by assessor code which yields different acreage than a parcel inventory

the overall character, economic vitality, and quality of life, and as such warrant ongoing maintenance and sustainable use.

Prime Farmland

Historic agricultural vestiges such as outbuildings, barns, silos, stone walls and tilled fields reinforce a Community's sense of place, as do its open spaces and scenic landscapes. Newburyport has several landscapes that retain their agricultural character and naturally

scenic qualities. Several farms are listed in Newburyport's open space inventory the historic Arrowhead Farm (28 acres), a portion of which has been protected since 1993 by a conservation restriction held by the state Department of Conservation and Recreation. Located near Maudslay State Park, Arrowhead Farm grows vegetables and some fruit (and raises livestock). Another is Ferry Landing Farm (25 acres) which is covered by an early version of an agricultural preservation restriction, held by the state Department of Agricultural Resources. The Open Space Committee is interested in strategies that would strengthen protections for this parcel.[15] Hayfields dominate fields in privately owned farms – Sweeney Farm and Turkey Hill Farm – in the Newburyport section of the Common Pasture.

Undeveloped land provides many benefits to the community including clean water, wildlife habitat, rural character, wood products, food, livestock grazing, and outdoor recreation. Chapter 61, 61A and 61B provides a tax incentive to property owners who maintain their properties in a natural state. Chapter 61 applies to forest lands used for growing products such as wood and timber. Chapter 61A is intended for land kept in active agricultural use. Chapter 61B is for land kept in its natural state, or for certain recreational purposes. Currently, there are 16 parcels totaling about 369 acres temporarily protected in the Chapter 61A program in Newburyport.

Open, productive farm tracts are typically the most easily developed land because their deeper soils make excavation easier, their drainage is good, and they lack wooded cover. As a result, they are ideal for most commercial and residential development projects and can often command top dollar. In the face of this constant development pressure, local farmers are finding it increasingly difficult to hold on to their coveted lands indefinitely. Newburyport stakeholders recognized the vulnerability of the critical natural resource functions open lands provide, including infiltration and flood protection, and recommended a collaborative effort to implement strategies that both strengthen the economic viability of farming and protect farmland in perpetuity.

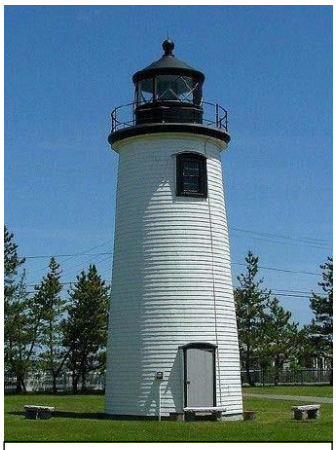
[15] Newburyport Open Space & Recreation Plan, 2020

3.6 Historic and Cultural Resources

The preservation of historic and cultural resources must be carefully considered to protect the character of the Merrimack Valley region's city, town, and village centers. Many colonial-era residences, mill structures, and village greens are already protected to some extent through the establishment of historic districts. However, additional consideration should be given to protecting such resources from potential natural hazards. Historic inventories and plans are essential in guiding historic preservation initiatives, and such plans should consider hazard mitigation. Effective preservation of these resources requires active stewardship and support of the community as a whole.

The community's treasured heritage landscapes include Newburyport's historic Merrimack River harbor, identified for more than two centuries with shipbuilding; Newburyport's extensive colonial and federal-era streetscapes (part of a very large National Historic Register District); its timeless marshes and beaches; Maudslay State Park (the former Moseley Estate); and the Common Pasture. Other cultural heritage sites include an early 19th century powder house, an 18th century grist mill operated on the Artichoke River, and a Merrimack ferry crossing. (President George Washington crossed the river at the site.)

Later years in Newburyport's history added mills and shoe factories – distinctive brick structures now converted into homes and offices – as well as rail lines, one segment of which has been converted into a rail trail. Salt-hay heiress Anna Jaques made donations to fund a hospital (since relocated and rebuilt within Newburyport). Historic lighthouses, specially aligned to assure safe navigation to and from the Atlantic, enrich Newburyport's character and help convey its importance as the birthplace of the U.S. Coast Guard. Plum Island served as both a staging area for rescues of sailors and ships, and as a relatively sedate resort destination. Many of Newburyport's historic cemeteries date from the colonial and revolutionary eras, and several parks and schools date from the 19th century.



Plum Island Lighthouse

A centrally located Frog Pond and its surroundings, used in colonial days for grazing, and later for training local militias, became the grand Victorian- era Bartlet Mall, with formal walkways and stately elms. Brown Square, dignified by a statue of Newburyport's famed abolitionist, William Lloyd Garrison, has long been a site of outdoor civic events.[16]

COSTEP-MA (Coordinated Statewide Emergency Preparedness in Massachusetts https://mblc.state.ma.us/costepma/) is a collaborative of representatives of cultural and historical institutions and agencies as well as first responder and emergency management professionals from federal, state, and municipal governments. COSTEP- MA promotes

[16] Newburyport Open Space and Recreation Plan 2020

proactive steps to reduce losses from natural hazards, especially flooding or water damage following fires, through cooperative, team-building activities in communities through educational activities within the cultural heritage and emergency management communities. COSTEP-MA has worked to develop an Annex to the state's CEMP and to promote education and cooperation in communities to enhance the protection of cultural resources from natural disasters.

3.7 Demographic Trends and Projections

In considering exposure to natural hazards, it is important to assess population and development trends. As more land is developed, the additional impervious surface increases the flood risk and decreases available flood storage area.

In the 2018 City of Newburyport Housing Production Plan, the UMass Donahue Institute projected that between 2020 and 2030, Newburyport's population would decline by 2.6 percent, from 17,934 to 17,462, and would continue declining after that. However, it is important to remember that because many factors affect population change, it cannot always be accurately predicted. The 2020 Census in fact showed that between 2010 and 2020, Newburyport grew 5 percent. With associated household growth and high demand for housing in the region, development is likely to continue. Major development activity completed, in construction or planning since the 2016 plan update includes:

Table 3.7.1 Major Developments

Project Name/Location	Project Type	Status	Total Housing Units/Sq.Ft.
1 Boston Way (40R)	76 units / multi-family / live-work	Constructed	84 units / live-work
100 Hale Street	Industrial expansion	Constructed	87,956 sq.ft.
146-148 Merrimac Street	Multi-family residential	Constructed	4 units
151 High Street	Multi-family residential	Constructed	10 units
17 Malcolm Hoyt Road	Industrial Expansion	Constructed	19,087 sq.ft.
18 Boyd Drive and 5 Brown Avenue (OSRD)	OSRD Subdivision	Constructed	38 units
Low Street at Colby Farm Lane (OSRD)	OSRD Subdivision	Constructed	15 units
2 Parker Street and 151-155 State Street	Multi-family residential	Partially Constructed	23 units
23 Hale Street	Industrial Space	Constructed	11,700 sq.ft.
25 Highland Avenue	Hospital Expansion	Under Construction	11000 sq.ft.
2-6 Market Street	Multi-family / mixed use	Under Construction	5 units /8,000 sq.ft.
3 Boston Way (40R)	84 units / multi-family / live-work	Under Construction	84 units / live-work

3 Perkins Way	Industrial Expansion	Under Construction	40,000 sq.ft.
3 Stanley Tucker Drive	Industrial Expansion	Complete	9,688 sq.ft.
Hillside Ave. and Cottage Court ("Hillside")	Multi-family residential	Partially Constructed	48 units
6 Perkins Way	Industrial space	Under Construction	30,000 sq.ft.
75 Parker Street	Industrial Expansion	Permitted	8,300 sq.ft.
77-79 Parker Street	Mixed use / office / event space	Permitted	23,400 sq.ft.
77R, 85 & 85R Storey Avenue	Assisted living / 49 new rooms	Constructed	49 rooms / assisted living
Colby Farm Lane (OSRD)	OSRD Subdivision	Under Construction	10 units
83 Merrimac (Parking Garage)	Public parking garage	Constructed	27,400 sq.ft.
20 Henry Graf Jr. Road	New medical office building	Constructed	20,000 sq.ft.

To characterize any change in Newburyport's vulnerability associated with new developments as shown above, a GIS mapping analysis was conducted which overlaid the development sites with the FEMA Flood Insurance Rate Map. All new development, except for 77-79 Parker Street (industrial expansion) is located outside of the FEMA designated 100-year and 500-year floodplains. All structures on the Parker Street industrial property are outside the flood hazard area. However, as noted in Section 4 of this plan, Newburyport's Business Park (west of Route 1 and south of Low Street) is in a low-lying area of the Parker River watershed and drainage issues and extreme precipitation have caused flooding beyond the FEMA flood zones. This increased vulnerability will be addressed in the upcoming sections of this plan.

In addition, continued improvements and expansion of structures on Plum Island are of particular concern to the city due to the barrier island's vulnerability to current and future natural and climate related hazards. Considering current climate projections, Newburyport's Climate Resiliency Plan identifies a need to review, evaluate, and revise Plum Island zoning and regulations to guide development such that it promotes barrier island stability thereby delaying barrier island migration and protecting the Plum Island beach resource. These vulnerabilities and actions will be discussed in the upcoming sections of this plan.

Overall, future development in Newburyport requires guidance relative to the risk of developing in, or near, a floodplain. While many parts of the city are vulnerable to flooding

due to river influences, sea level rise, and storm surge, the areas differ enough from one another such that the three variables contributing to flooding will not contribute equally within each neighborhood. With proper precaution and guidance regarding flood risk during development, vulnerability is not likely to increase drastically. Given that the majority of Newburyport's planned future development lies outside of the floodplain, and those which do, namely the business park, are receiving special attention relative to flood prevention, these precautionary measures are being taken and will in turn mitigate new development's impact on the City's vulnerability.

3.8 Critical Infrastructure

In preparing for the workshops, the Newburyport Core Team reviewed and updated a database of the community's critical facilities and infrastructure. These facilities are vital to the delivery of key government services and may significantly impact the public during a time of emergency or while recovering from an emergency. The primary sources of information relative to the critical facilities were Newburyport Emergency Management, Fire, Police, and Public Services personnel on the Core Team. Some of these facilities have emergency backup generators and might be logical choices for emergency shelter locations. However, in the two schools with backup generators, Knock Middle School and Bresnahan Elementary School, the generators only power a portion of the buildings and therefore aren't sufficient for these buildings to be used for sheltering capacity. The only facility adequate for emergency shelter, the Salvation Army building, is not owned by the city. Additional facilities with backup generators are identified on the table below. Critical infrastructure located in a flood hazard area, as determined by review of the most recent FEMA Flood Insurance Rate Maps, is also identified.

Table 3.8.1 Newburyport Critical Infrastructure

Name	Type	FEMA Flood Zone (100/500)	Facility has Backup Generator
Newburyport Post Office	POST OFFICE	N	*
Newburyport Superior Court	COURT	N	*
MBTA Newburyport Commuter Rail	TRANSPORTATION HUB	N	*
Newburyport Society for Aged Men	NURSING HOME	N	*
Port Healthcare Center	NURSING HOME	N	Y
Brigham Manor and Rehab Center	NURSING HOME	N	Y
Country Rehabilitation and Nursing Ctr	NURSING HOME	N	Y

Atria Merrimack Place	ASSISTED LIVING FACILITY	N	*
Anna Jaques Hospital	HOSPITAL	N	Y
Newburyport City Hall	CITY/TOWN OFFICES	N	N
Newburyport High School	SCHOOL	N	Y
Rupert A. Nock Middle School	SCHOOL	N	Y
Kelley School Youth Center	YOUTH CENTER	N	N
Edward G. Molin Elementary	SCHOOL	N	Y
Francis T. Bresnahan Elementary	SCHOOL	N	Y
River Valley Charter School	SCHOOL	N	N
Newburyport Montessori	SCHOOL	N	N
Immaculate Conception	SCHOOL	N	N
Newburyport Senior Center	SENIOR CENTER	N	Y**
Newburyport Police Department	POLICE STATION	N	Y
Public Safety Building Plum Island	POLICE STATION	Y	N
Harbormaster/Visitor Boating Facility	HARBORMASTER	N	N
US Coast Guard Station		Y	Y
Historical Society of Old Newbury Library	LIBRARY	N	N
Newburyport Public Library	LIBRARY	N	N
Rogers Medical Library	LIBRARY	N	*
South End Library	LIBRARY	N	N
Newburyport District Court	COURT	N	*
Newburyport Juvenile Court	COURT	N	*
Newburyport Fire Department Headquarters	FIRE STATION	N	Y
West End Fire Station	FIRE STATION	N	Y
Emergency Management Headquarters 1 – DPS Admin. Bldg, Perry Way	EMERGENCY OPERATIONS CENTER	N	Y

Emergency Management Headquarters 2 – NFD Greenleaf Street	EMERGENCY OPERATIONS CENTER	N	Y
Salvation Army	EMERGENCY SHELTER	N	Y
Graf Ice Rink	EMERGENCY MORGUE	N	*
National Guard Armory	EMERGENCY OPERATIONS	N	Y
Public Works Facility	CITY/TOWN OFFICES	N	Y
DPS Administration Building	CITY/TOWN OFFICES	N	Y
Recycling Facility and DPW Storage	PUBLIC SERVICES	N	N
Wastewater Treatment Plant	WASTEWATER TREATMENT	Y	Y* **
Plum Island Vacuum Pump Station	SEWAGE LIFT STATION	Y	Y
Duffy Drive Pump Station	SEWAGE LIFT STATION	N	Y
Coke Plant Pump Station	SEWAGE LIFT STATION	N	Y
Crow Lane Pump Station	SEWAGE LIFT STATION	N	Y
Garrison Ave Pump Station	SEWAGE LIFT STATION	N	Y
Gould Pump Station	SEWAGE LIFT STATION	N	Y
Graf Road Pump Station	SEWAGE LIFT STATION	N	Y
Hale Street Pump Station	SEWAGE LIFT STATION	N	Y
Hiltons Lift Station	SEWAGE LIFT STATION	Y	N* ***
Laurel Road Station	SEWAGE LIFT STATION	N	Y
Lower Artichoke Reservoir	WATER	Y	N A
Upper Artichoke Reservoir	WATER	Y	N A
Indian Hill Reservoir	WATER	N	N A
Bartlett Pond Reservoir	WATER	N	Y

Water Filtration Plant	WATER	N	Y
Artichoke Reservoir Pump Station	WATER	N	Y
Marches Hill Water Tank	WATER STORAGE	N	N A
Rawson Hill Water Tank	WATER STORAGE	N	N A
Oleo Woods Pump Station	SEWAGE LIFT STATION	N	Y
Savory Street Pump Station	SEWAGE LIFT STATION	N	N* ***
Scotland Road Pump Station	SEWAGE LIFT STATION	N	Y
Storey Avenue Pump Station	SEWAGE LIFT STATION	N	Y
Water Street Pump Station	SEWAGE LIFT STATION	Y	Y
Whites Court Pump Station	SEWAGE LIFT STATION	Y	N* ***
#1 Well	WELL FIELDS	N	Y
#2 Well	WELL FIELDS	N	Y
National Grid Substation	UTILITY	N	N
Kindercare Learning Center #658	DAY CARE FACILITIES	N	*
Knoll Edge Nursery School	DAY CARE FACILITIES	N	N
Newburyport Montessori School Inc.	DAY CARE FACILITIES	N	N
Community Action, Inc. Headstart At Newburyport	DAY CARE FACILITIES	N	Y
Knoll-Edge Preschool	DAY CARE FACILITIES	N	N
Mulberry Child Care and Preschool	DAY CARE FACILITIES	N	*
Children's House Bright Horizons	DAY CARE FACILITIES	N	*
School’s Out Program/YWCA	DAY CARE FACILITIES/SCHOOL	N	*
Powder House	HISTORIC SITE	N	*
Custom House Maritime Museum	HISTORIC SITE	N	*

Custom House Museum Property	HISTORIC SITE	Y	*

* Unknown

** Senior Center has a generator on-site ready to be installed. It is not hooked up yet.

*** WWTF generator has recently failed. A new one is on order ready to be delivered this fall. We have a portable generator on-site now until the permanent one is hooked up.

**** Pump station does not have a permanent backup generator but is wired to easily hookup a portable generator.

SECTION 4. NATURAL HAZARDS IDENTIFICATION

A. Natural Hazards Inventory

This section of the Hazard Mitigation Plan identifies and describes natural hazards that are likely to occur in the Merrimack Valley Region of Massachusetts and Merrimac in particular. A natural "hazard" is defined as "an event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, and agricultural loss, damage to the environment, interruption of business or other types of harm and loss". Natural hazards are inevitable, but the impacts of natural hazards can, at a minimum, be mitigated or, in some instances, prevented entirely. However, natural hazard impacts can also be exacerbated by societal behavior and practices, such as building in a floodplain or on a barrier beach.

Hazard identification details the geographic extent, the significance, and the probability of a particular natural hazard affecting a region, based on historical records and other information available from local, state, and federal sources. The identification includes an assessment of risks, to provide communities with information needed to prioritize mitigation strategies.

The State Hazard Mitigation and Climate Adaptation Plan identifies 11 natural hazards that are likely to affect the Commonwealth. These include:

Coastal Erosion Landslide Dam Failure Nor'easter Earthquake Severe Weather Fire Severe Winter Flood Tsunami Hurricane

Natural hazards that are likely to occur in the Merrimack Valley region, and documented in the 2016 Merrimack Valley Regional Multi-Hazard Mitigation Plan Update, were grouped – in order of frequency – in the following seven categories:

- **Flood-related hazards**
- **Wind-related hazards**
- **Winter-related hazards**
- **Fire-related hazards**
- **Geologic hazards**
- **Heatwaves/extreme heat**
- **Climate change/sea level rise**

44 CFR Requirement

Part 201.6(c)(2)(i): *The risk assessment shall include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future occurrences.*

It is important to note that the above hazard categories are not always mutually exclusive. Indeed, they are often interrelated. For example, flooding can be the result of a hurricane, a nor'easter, a thunderstorm, or a winter storm. Similarly, tornadoes can be spawned by, and accompany hurricanes. Also, the geographic extent and the impacts of the hazards can vary widely. Some hazards, such as severe winter storms, may impact a large area

yet cause little damage, while other hazards, such as tornadoes, may impact a small area yet cause catastrophic damage.

During Newburyport's MVP Planning process, workshop participants came to consensus that the following climate-change related hazards were the highest priority for Newburyport: Storms including nor'easters, winter storms, and hurricanes (wind, snow, rain, storm surge) Bipolar Weather (including extreme cold, extreme heat, drought, and extreme fluctuations) Inland Flooding (precipitation) Sea Level Rise.

The following discussion describes the natural hazards that affect the Merrimack Valley region and the City of Newburyport, including their historical presence and probability of recurrence incorporating the likely impacts of climate change on each hazard.

4.1 Flood-Related Hazards

As is the case nationally and throughout New England, floods are the Merrimack Valley region's most frequent and costly natural disaster in terms of human hardship and economic loss. Flooding is generally the direct result of moderate to severe weather events such as coastal storms ("nor'easters"), heavy rainstorms, and hurricanes. Total annual precipitation at the century's end is projected to increase by as much as 18% above the 1971-2000 baseline of 45", with most high precipitation events concentrated in the winter and spring months. Increased frequency of high-intensity events, the Northeast experiencing a 71% increase in precipitation during storms.[17] With extreme rainfall events becoming more frequent, the severe impacts from flooding are also likely to increase.

Flooding poses a significant, and recurring, risk to life and property in the Valley region. Three types of flooding typically affect the region: *riverine* flooding, *coastal* flooding, and *urban* (stormwater) flooding. Also, there are scattered low-lying wetland areas that have the potential to flood. According to the National Climatic Data Center, sixty-seven (67) flood events were reported in Essex County from January 1, 1950, to April 30, 2020. While the Merrimack River is generally prone to minor flooding, on May 15, 2006, rainfall raised the river to more than 8 feet (2.4 m) above flood stage, forcing evacuations and damaging property. Reports of total rainfall vary, but most areas appear to have received around a foot of rain, with some areas, in the Merrimack Valley, receiving as much as 17 inches. According to the Boston Globe, around 1,500 people evacuated their homes to escape the flood.

The most significant flood in the recorded history of the Merrimack River was in March 1936, when rain, melting snow and ice swelled the Merrimack in Lowell to 68.4 feet (20.8 m), 10 feet (3 m) higher than the 2006 flood. Upstream in Methuen, Lawrence, North Andover, Haverhill, and other riverfront communities, densely developed downtown centers and riverfront neighborhoods were devastated by the floodwaters. In addition to the 1936 flood, the 1852 flood, the Mother's Day Flood of 2006, the New England

[17] University of Massachusetts Amherst. 2018. National Climate Science Center Climate Change Projections http://www.resilientma.org/resources/resource::2152

Hurricane of 1938, and the Patriots Day Flood of April 2007 are among the region's most serious flood events. Most recently, from March 14 through 21, 2010, a major rain event caused several local rivers and streams to reach or exceed flood stage. Table 4.1.1 below lists all flood events in Essex County between 1958 and 2019.

Table 4.1.1 Merrimack Valley Flood Events 1998 - 2020

Location	County/Zone	Date	Deaths	Injuries	Property Damage
Totals:			2	3	20.712M
WESTERN ESSEX (ZONE)	WESTERN ESSEX (ZONE)	06/17/1998	0	0	0.00K
WESTERN ESSEX (ZONE)	WESTERN ESSEX (ZONE)	06/18/1998	0	0	0.00K
EASTERN ESSEX (ZONE)	EASTERN ESSEX (ZONE)	03/05/2001	0	0	0.00K
WESTERN ESSEX (ZONE)	WESTERN ESSEX (ZONE)	04/03/2004	0	0	0.00K
WESTERN ESSEX (ZONE)	WESTERN ESSEX (ZONE)	04/03/2004	0	0	0.00K
EASTERN ESSEX (ZONE)	EASTERN ESSEX (ZONE)	10/15/2005	0	0	50.00K
EASTERN ESSEX (ZONE)	EASTERN ESSEX (ZONE)	10/25/2005	0	0	45.00K
COUNTYWIDE	ESSEX CO.	05/13/2006	2	0	7.000M
COUNTYWIDE	ESSEX CO.	05/13/2006	0	0	0.00K
LYNN PEABODY	ESSEX CO.	07/11/2006	0	0	10.00K
PEABODY	ESSEX CO.	07/28/2006	0	0	20.00K
HAVERHILL	ESSEX CO.	03/02/2007	0	0	20.00K
HAVERHILL	ESSEX CO.	04/16/2007	0	0	45.00K
LITTLE NAHANT	ESSEX CO.	02/13/2008	0	0	30.00K
SALEM	ESSEX CO.	03/08/2008	0	0	0.00K
TAPLEYVILLE	ESSEX CO.	08/08/2008	0	0	25.00K
SOUTH ESSEX	ESSEX CO.	09/06/2008	0	0	5.00K
NEWBURY	ESSEX CO.	03/14/2010	0	1	9.800M
NEWBURY	ESSEX CO.	03/30/2010	0	2	3.270M
LYNN	ESSEX CO.	04/01/2010	0	0	0.00K
SALEM MARITIME NHS	ESSEX CO.	08/05/2010	0	0	7.00K
HAWTHORNE	ESSEX CO.	08/25/2010	0	0	0.00K
SOUTH LAWRENCE	ESSEX CO.	10/04/2011	0	0	0.00K
TOPSFIELD	ESSEX CO.	10/04/2011	0	0	5.00K
PEABODY	ESSEX CO.	10/04/2011	0	0	300.00K
SOUTH LYNNFIELD	ESSEX CO.	06/23/2012	0	0	0.00K
LYNN	ESSEX CO.	06/23/2012	0	0	0.00K
NORTH SAUGUS	ESSEX CO.	08/10/2012	0	0	0.00K
MARSH CORNER	ESSEX CO.	06/24/2013	0	0	5.00K
SALEM MARITIME NHS	ESSEX CO.	07/01/2013	0	0	0.00K
	ESSEX CO.	07/01/2013	0	0	0.00K

RIVERVIEW	ESSEX CO.	07/01/2013	0	0	0.00K
SALEM MARITIME NHS	ESSEX CO.	07/27/2014	0	0	0.00K
LYNN COMMON	ESSEX CO.	10/23/2014	0	0	30.00K
METHUEN	ESSEX CO.	10/23/2014	0	0	0.00K
(BVY)BEVERLY MUNI AR	ESSEX CO.	10/23/2014	0	0	0.00K
PEABODY	ESSEX CO.	12/09/2014	0	0	0.00K
SOUTH MIDDLETON	ESSEX CO.	12/09/2014	0	0	0.00K
ROOTY PLAIN	ESSEX CO.	12/09/2014	0	0	0.00K
SALEM MARITIME NHS	ESSEX CO.	12/09/2014	0	0	0.00K
TOZIER CORNER	ESSEX CO.	08/18/2015	0	0	0.00K
EAST SAUGUS	ESSEX CO.	08/18/2015	0	0	0.00K
CARLETONVILLE	ESSEX CO.	09/30/2015	0	0	0.00K
DEVEREUX	ESSEX CO.	06/29/2016	0	0	0.00K
WEST ANDOVER	ESSEX CO.	04/06/2017	0	0	0.00K
LYNNFIELD	ESSEX CO.	06/27/2017	0	0	1.00K
SOUTH MIDDLETON	ESSEX CO.	06/27/2017	0	0	1.00K
HAWTHORNE	ESSEX CO.	07/08/2017	0	0	0.00K
SOUTH GROVELAND	ESSEX CO.	07/18/2017	0	0	0.00K
LAWRENCE	ESSEX CO.	09/06/2017	0	0	0.00K
LAWRENCE	ESSEX CO.	09/06/2017	0	0	0.00K
SOUTH LAWRENCE	ESSEX CO.	09/15/2017	0	0	10.00K
CARLETONVILLE	ESSEX CO.	09/30/2017	0	0	4.00K
TAPLEYVILLE	ESSEX CO.	10/25/2017	0	0	0.00K
RIVERVIEW	ESSEX CO.	10/25/2017	0	0	0.00K
DANVERS	ESSEX CO.	01/13/2018	0	0	5.00K
LAWRENCE	ESSEX CO.	08/11/2018	0	0	10.00K
DEVEREUX	ESSEX CO.	08/12/2018	0	0	0.00K
MIDDLETON	ESSEX CO.	11/03/2018	0	0	0.00K
SOUTH LAWRENCE	ESSEX CO.	11/03/2018	0	0	0.00K
WEST ANDOVER	ESSEX CO.	04/15/2019	0	0	0.00K
EAST SAUGUS	ESSEX CO.	07/31/2019	0	0	3.00K
LYNN	ESSEX CO.	07/31/2019	0	0	0.00K
EAST LYNN	ESSEX CO.	09/02/2019	0	0	10.00K
COMMON PLUM	ESSEX CO.	09/02/2019	0	0	0.50K
IS ARPT	ESSEX CO.	07/13/2020	0	0	0.00K
GEORGETOWN	ESSEX CO.	07/23/2020	0	0	0.00K
NEWBURYPORT PLUM ARP	ESSEX CO.	07/23/2020	0	0	0.00K

BEVERLY	ESSEX CO.	07/23/2020	0	0	1.00K
BALLARDVALE	ESSEX CO.	07/23/2020	0	0	0.00k
WEST GLOUCESTER	ESSEX CO.	07/23/2020	0	0	0.00k
MIDDLETON	ESSEX CO.	09/10/2020	0	0	0.00k
BEVERLY	ESSEX CO.	09/10/2020	0	0	1.00k

Riverine floods are most likely to occur in Spring. They result from the "overbanking" of swollen rivers and streams and are typically caused by a large-scale weather event that generates an unusual amount of precipitation or by rapid snowmelt. *Coastal floods* commonly occur during the winter months and are the result of storm surges spawned by northeast coastal storms (Nor'easters). Packing sustained wind speeds of up to 40 miles per hour and wind gusts of up to 70 mph, these storms cause repeated wave and erosion-induced damage to structures and natural resources, such as beaches and dunes. In the Merrimack Valley region, the barrier beaches of Salisbury Beach and Plum Island are especially vulnerable to coastal storms, and sustain frequent wind, wave, and flood damage. *Urban (stormwater) floods* may occur year-round and are caused by inadequate stormwater drainage in areas with a high percentage of impervious surface (rooftops, roads, parking lots, etc.) that prevents groundwater infiltration. Flooded roadways and basements often result from this type of flood event.

Floodwaters can be extremely dangerous, as the force of six inches of rapidly moving water can knock people off their feet. Flash flood waters move very quickly and often happen unexpectedly. Flash floods usually result from an intense storm, typically a thunderstorm, that dumps a large amount of rainfall over a short period. Flash floods can destroy buildings and obliterate bridges. Around the country, most flood deaths are due to flash floods, and nearly half of all flash flood deaths are auto related.

Methodology

Flood hazard identification is the first phase of flood hazard assessment. Identification is the process of estimating the geographic extent of the floodplain. The intensity of flooding that can be expected in specific locations, and the probability of occurrence of flood events.

The methodology for assessing the hazard presented by flooding involved mapping the FEMA Flood Insurance Rate Maps as an overlay to Newburyport's critical infrastructure. Additionally, repetitive loss structures were identified based on records from the National Flood Insurance Program (NFIP). Vulnerable critical facilities and infrastructure, including dams and bridges, were then mapped in relation to their proximity to rivers, streams, and flood-prone areas. Definitions of the various flood hazard areas/zones for Newburyport are as follows:

Zone A - Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply. Some A Zones in coastal areas are likely to be subject to moving water, overwash, breaking waves (with heights less than 3 feet), storm surge, and wave runup (with depths less than 3 feet)—all of which may cause erosion and scour.

Zone AE - Areas subject to inundation by the 1-percent-annual chance-flood event determined by detailed methods. Base Flood Elevations are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

AO-Zones are those portions of Land Subject to Coastal Storm Flowage (LSCSF) which are subject to inundation by moving water (usually sheet flow on sloping terrain) where average depths are between one and three feet. In Massachusetts, coastal AO-zones are commonly associated with 'overwash' and generally border on the landward side of V-zones.

Zone X - An area of moderate flood hazard that is determined to be outside the Special Flood Hazard Area between the limits of the base flood and the 0.2-percent-annual-chance (or 500-year) flood.

Velocity Zones (including V-, VE-, and Va-30) – Those portions LSCSF of which are coastal high hazard areas or areas of special flood hazard extending from the mean low water line to the inland limit within the 100-year floodplain that have been determined by FEMA to wave run heights in excess of three feet or subject to high-velocity wave run-up or wave-induced erosion

National Flood Insurance Program

The National Flood Insurance Program (NFIP) is a federal program, administered by FEMA. The NFIP provides subsidized flood insurance within communities that agree to adopt corrective and preventative floodplain management regulations that will reduce future flood damages. Congress created the NFIP in 1968, with the passing of the National Flood Insurance Act. The Act was passed to benefit homeowners whose insurance does not cover flood damage. In general, flood insurance from private companies is either not available or extremely expensive. NFIP flood insurance is available anywhere within a participating community, regardless of the flood zone in which a property is located. Federal law requires that flood insurance be purchased as a condition of federally insured financing used for the purchase of buildings in the Special Flood Hazard Area (SFHA).

FEMA produces Flood Insurance Rate Maps, commonly known as FIRMs, to support the National Flood Insurance Program. The FIRMs depict SFHAs, including the areas subject to inundation from the 1% annual chance flood (also known as the Base Flood or the

100-Year Flood). The SFHA determines where flood insurance is required as a condition of a federally insured loan through the NFIP mandatory purchase requirement. This requirement is intended to shift flood damage and recovery costs away from the general taxpayer and on to those who live in floodplains. The risk zones and flood elevations shown on the FIRMs within the SFHA are used to determine flood insurance rates.

The SFHA also determines where NFIP floodplain management requirements must be enforced by communities that participate in the program. These include land use and building code standards. In addition to the NFIP, the FIRMs are also used within FEMA's Individual and Public Disaster Assistance programs and FEMA's Mitigation Grant Programs, in emergency management, and they are also used to identify areas where certain State Building Code and Wetland Protection regulations must be enforced. Massachusetts State Building Code covers the entire state, applies to both public and private construction, and is administered through the local building inspectors with state oversight. Section 3107 of the State Building Code contains most of the construction requirements related to buildings or structures.

In 2010, and again in 2012, 2014, and 2018 new FEMA floodplain maps were released for the communities located in the Merrimack Valley region. The most current FIRM maps for Newburyport are dated July 19, 2018.

It is important to note that the term "100-year flood" is misleading. It is not a flood that will occur only once every 100 years. Rather, it is a flood that has a one percent chance of being equaled or exceeded each year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The 100-year flood, which is the standard used by most federal and state agencies, is used by the National Flood Insurance Program (NFIP) as the standard for floodplain management and to determine the need for flood insurance. A structure located within a Special Flood Hazard Area (SFHA) shown on an NFIP map has a 26 percent chance of suffering flood damage during the term of a 30- year mortgage.

Community Rating System

The Community Rating System (CRS) is part of the NFIP. The CRS program encourages communities to reduce their flood risk by engaging in floodplain management activities. CRS provides discounts on flood insurance for communities that establish floodplain management programs that go beyond the minimum requirements of the NFIP. Depending on the level of activities that communities undertake in four areas – public information, mapping, and regulatory activities, flood damage reduction, and flood preparedness - communities are categorized into 1 to 10 CRS classes. A Class 1 rating provides the largest flood insurance premium reduction, while a community with a Class 10 rating receives no insurance.

Although communities are not required to participate in CRS to receive approval of a hazard mitigation plan, FEMA encourages jurisdictions to integrate the CRS planning steps in their multi-hazard mitigation plans.

NFIP and Repetitive Loss Structures

Newburyport participates in the National Flood Insurance Program (NFIP). This Federal program, administered by FEMA, allows property owners in participating communities to obtain flood insurance to protect against flood losses and recover more quickly following an event. To participate, communities must adopt and enforce floodplain management regulations to mitigate future flood damage.

According to the most recent data provided by the Massachusetts Flood Hazard Management Program (FHMP), Newburyport has 530 policies in force, insuring over $154 million in buildings and contents. Over the years, flood damage to these structures has resulted in the payment of nearly $2.9 million in insurance claims under the National Flood Insurance Program (NFIP).

According to FEMA and the NFIP, Repetitive Loss Properties are properties that have received flood insurance claim payments greater than $1,000 twice in any 10-year period years since 1978. There are currently 19 repetitive loss properties in Newburyport. Seventeen (17) of them are single-family residences. One is identified as a non- residential business and another as “other” non-residential. For these 19 properties, there have been a total of 49 losses totaling $745,009.27 in payments.

Table 4.1.2 Summary of Repetitive Loss Properties Newburyport

	Total
RL Properties (Total)	19
RL Properties (Insured)	7
RL Losses (Total)	49
RL Losses (Insured)	20
RL Payments (Total)	$745,009.27
Building	$636,733.99
Contents	$108,275.28
RL Payments (Insured)	$511,758.04
Building	$47,196.17
Contents	$40,562.87

Source: MA Department of Conservation and Recreation, data as of 01/28/2020

Newburyport is located at the mouth of the Merrimack River at its confluence with the Atlantic Ocean and includes a portion of a barrier island, Plum Island. This geography coupled with sea level rise, climate enhanced storm activity, and more frequent heavy precipitation events, makes flooding the most recognized hazard in the community. According to the State Hazard Mitigation and Climate Adaptation Plan, the

Commonwealth experiences a substantial flood event once every three years. For Newburyport flooding is very much a short and long-term hazard.

Flood Prone Areas

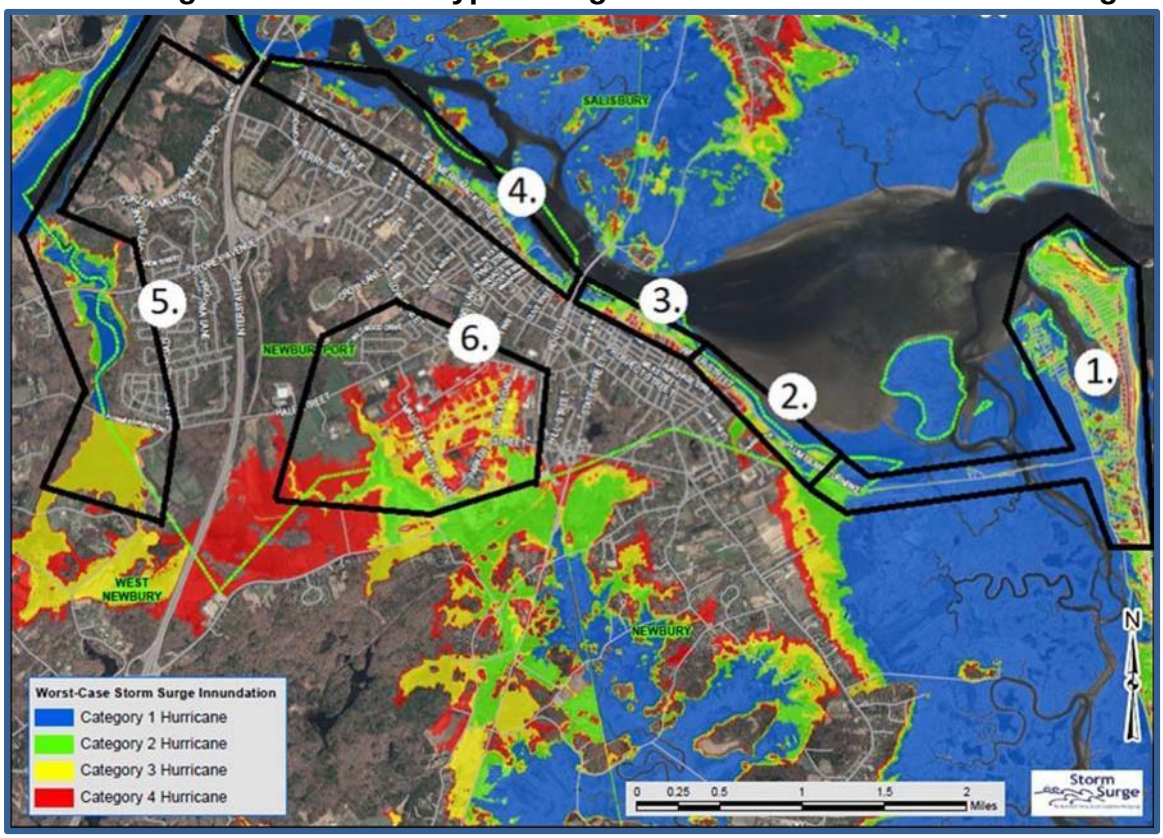
Newburyport is a city of three watersheds: the Merrimack, the Little River and the Artichoke. The Merrimack River flows alongside Newburyport downtown before draining into the Atlantic. As the Merrimack approaches the western boundary of the City, it meets the Artichoke River, source of public drinking water supply for Newburyport and West Newbury. The headwaters of the Little River are by Route 95 north of Hale Street. The main branch meanders along the Old Route 95 roadbed. The western tributaries include streams that originate behind the shopping centers on Storey Avenue. The Little River flows south through Newbury and enters the Parker River, which along with the Ipswich and Rowley rivers are freshwater sources entering into Plum Island Sound, part of the Great Marsh ecosystem designated an Area of Critical Environmental Concern (ACEC).

Because Newburyport is both a water-rich and a low-lying coastal community, significant portions of it are located in flood hazard zones and thus are susceptible to flooding. This is especially the case when high river flows from heavy rains coincide with high ocean tides. When high winds from the northeast and east are added to this mix, the effects can be truly devastating. Nowhere has this been more evident than on Plum Island, where storm surges have eroded large swaths of beach frontage and seriously damaged or destroyed a number of ocean-side structures.

Significant parts of Newburyport lie within the floodplains of the Merrimack, Little, and Artichoke Rivers. A GIS analysis of the city's FIRM flood hazard areas by MVPC has determined that a total of 1,517 acres (2.37 sq. mi.) of land area in Newburyport is located within the 100-Year floodplain and thus is vulnerable to flooding. An additional 93.7 acres (0.15 sq. mi.) lies within the 500-Year floodplain. Together, these two flood zones constitute 24% of the total area of the community which is a large proportion of land in Newburyport located in a flood hazard area.

Newburyport's Climate Resiliency Plan stresses that neighborhoods within the city are vulnerable to flooding due to a variety of influences, including river, sea level rise, and storm surge. Dividing the city into regions of vulnerability subject to the types of flooding they experience allows City officials to fine tune risk, adaptation strategies, and zoning efforts that will guide the mitigation process. The following figure is taken from the Climate Resiliency Plan:

Figure 4.1.1 Newburyport Neighborhoods Vulnerable to flooding



1. Plum Island and the Plum Island Turnpike
2. Joppa to the National Grid Substation
3. The National Grid Substation to the Route 1 Bridge – Downtown and Waterfront
4. The Route 1 Gillis Bridge to the I-95 Bridge – Cashman Park and Merrimac St.
5. The Surface Water Reservoirs (Critical Asset already discussed)
6. The Little River Watershed including the Business Park

The prior MVHMP identified several areas of special concern. The following list from the 2016 MVHMP has remained the same. Additional details have been added to highlight more specific issues of the more vulnerable areas.

SPECIAL FLOOD HAZARD CONCERNS

1. Plum Island & Beach – erosion
2. Plum Island Turnpike – roadway flooding, ice cakes, high winds, zero visibility
3. Plum Island Center – overtopping, flooding
4. Newburyport Turnpike – flooding north of Ould Newbury Golf Course during astronomical high tide and hurricane storm surge
5. Cashman Park, Downtown Waterfront,–high tide flooding and storm surge
6. Hale Street – Flooding/Inadequate infrastructure
7. Fox Run Road – Localized Flooding/inadequate infrastructure
8. Henry Graf Road – Flooding
9. Business Park at Malcolm Hoyt Road – Flooding and inadequate infrastructure
10. Merrimac Street – Localized Flooding
11. Ocean Avenue – High Tide Flooding and storm surge
12. Parker Street at Scotland Road – Flooding/inadequate infrastructure
13. Quail Run Hollow – Localized flooding
14. Downtown State Street/Market Square – Major flooding, aged infrastructure.

First on this list is Plum Island. Plum Island is an 11-mile barrier beach, most of which falls outside the city's boundaries. However, the far northern tip of the island is in Newburyport and is densely populated with vacation homes and year-round residences. This portion of Newburyport has extremely high exposure to coastal flooding and erosion. Beginning on March 3rd, 2018, the region was impacted by the first of four significant storm systems that rode in atop of a nearly 10-foot tide. Adding in a 2-3-foot storm surge resulted in a 12-13 foot storm tide (7.6- 8.6 feet NAVD88). Aside from flooding the Plum Island turnpike, Old Point Road, and Sunset Boulevard, the combined level of the sea to the east and the river to the west, forced the water table under Plum Island to the surface to form ponds between dunes, streets and homes. This ponding was not the result of rainfall.

Water Table Ponding March 2018 – Source: Climate Resiliencv Plan 2020

Plum Island Turnpike – March 2018

Aside from travel by boat, there is only one way to and from Plum Island which is via the roughly 2-mile-long, two lane, flat and exposed Plum Island turnpike, and its Bascule draw bridge over the Plum Island River. In 2016, on average some 11,846 vehicles traversed the turnpike bridge daily (Source: MassDOT). The turnpike has historically flooded during storms and was impassable during and after the Blizzard of '78 as it had been flooded and littered with giant ice cakes. When the draw bridge was constructed in 1973, the causeway's approach to the bridge was elevated to accommodate the structure's height, but the balance of the roadway is low and increasingly today

becoming impassable during significant storm events due to flooding, river ice intrusion and blowing and drifting snow. Though infrequent and more often a vulnerability during the boating season, the draw bridge has broken down in its raised position cutting off access to the island for upwards of 6 hours.

Another area of flooding concern is the 550-acre Business Park area, built on low-lying former farmland within the Parker River watershed. Several of the sixty industrial and manufacturing facilities there have hazardous materials on site and are vulnerable to flooding. During the May 2006 flood, all six entrances into the Business Park area were inaccessible, not only creating private business losses, but also shutting down critical routes of egress and emergency vehicle access.

Business Park Flooding 2006- MVPC Photo

In 2020, the City redesigned Malcolm Hoyt Drive in order to raise it and install a larger cross-culvert in order to improve runoff from larger storm events. However, bids for the project came in too high, and the city could not fund the entire amount. The city repaved the road and raised it slightly to be less prone to flooding. However, funding did not allow replace the culvert. As seas continue to rise, this and a few other roads will need to be raised again and culverts replaced with larger structures.

The *Newburyport Climate Resiliency Plan* details the different flooding influences in each area shown in Figure 4.1.1 and outlines vulnerable structures and identifies current as well as future flood risk. This information guided the Newburyport Resiliency Committee in choosing the priority actions to mitigate hazards and improve resiliency found in Section 8.

Coastal Erosion/Shoreline Change

Coastal shoreline change is a natural and anticipated phenomenon. Numerous factors such as wind, waves, storms, sea level, seasonal and climatic cycles, and anthropogenic activity may all influence shifts in coastal shorelines. Patterns of erosion and accretion can be expected and tracked, such as loss during winter months due to sediment removal by high-energy waves and gain during summer months due to low energy wave deposits. Outside of these normal fluctuations, more extreme shoreline change can occur due to the convergence of natural factors (i.e. storm events), human intervention (i.e. coastal armoring), or a combination of both.

Coastal erosion is defined as the loss or displacement of land or sediment along a coastline and is frequently reported as an average annual erosion rate (loss in feet or meters per year). The 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan identifies a number of factors that determine location-specific erosion/accretion rates:

- Frequency and severity of high-energy storms
- Surrounding sediment size and composition
- Local bathymetry
- Variations in alongshore wave energy and local sediment transport rates
- Sea-level rise levels
- Exposure to significant storm waves
- Anthropogenic intervention/structural development

Figure 4.1.2 Coastal Erosion in Newburyport. Photo credit: Sandy Tilton, Great Marsh Coastal Adaptation Plan (2017).

Hazard Location: Sections of Newburyport along the barrier beach system of Plum Island have and continue to experience significant shoreline change and coastal erosion. Patterns of erosion and accretion have been noted since the 1800s by the US Army Corps of Engineers, with in-depth morphological studies beginning in the 1940s, and more regular monitoring starting with the emergence of remote sensing and other surveying techniques in the 1990s.[18] Historically, the shoreline along Plum Island beach has remained relatively stable, with long-term erosion rates averaging 0.3 +/-2.0 ft/year; however cycles of acute and intense erosion and accretion have been observed and recorded since the 1960s.[19] Since recorded observations began, shoreline change has occurred across the barrier

[18] MA Department of Conservation & Recreation (2021). Upper North Shore Regional Sediment Management Study.
[19] MA Department of Conservation & Recreation (2021). Upper North Shore Regional Sediment Management Study.

beach system from Newburyport to Ipswich, with different locations experiencing acute erosion/accretion depending on the given dynamics in a particular year (such as Reservation Terrace and the Center Island Groin). Because Plum Island acts as the first line of defense against storm surges and sea level rise, understanding patterns of shoreline change and protecting natural barrier beach systems that act as buffers for coastal communities is critically important. Beachfront ownership across Plum Island ranges from private to public with parcels owned at the town, state, and federal level. The Merrimack River inlet at the North of Plum Island is federally maintained and repaired periodically by the US Army Corps of Engineers (USACE). Due to the broad range of stakeholders involved and invested in Plum Island, monitoring and management of this system must be a collaborative process.

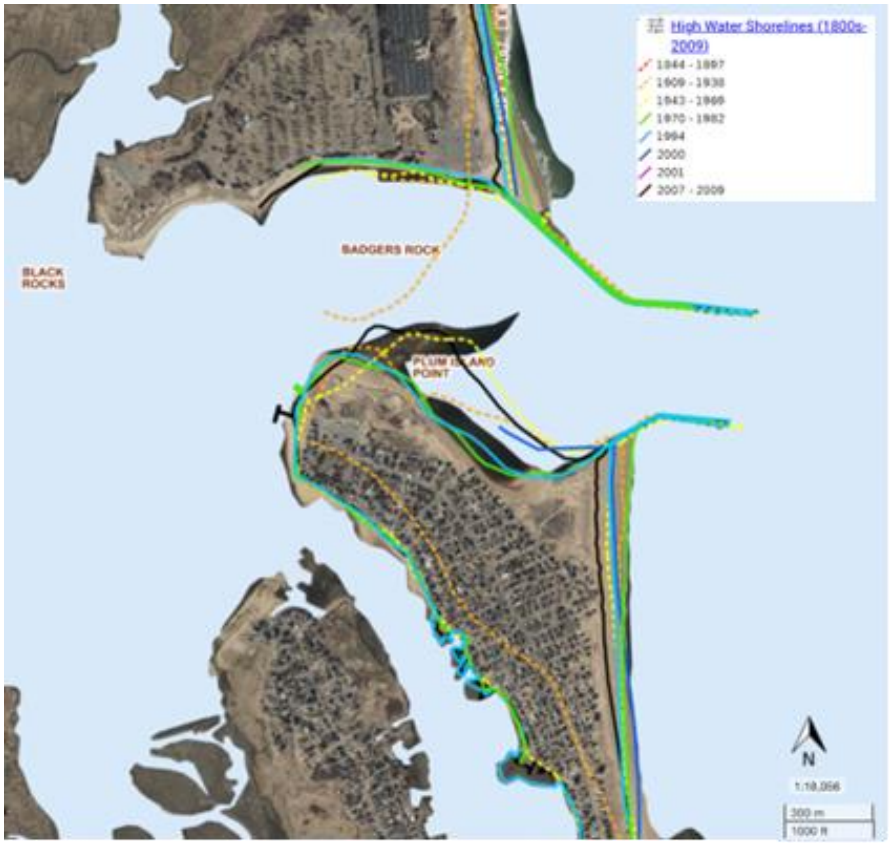


Figure 4.1.3 Map of the north and south jetties at the mouth of the Merrimack River with historic coastal edge data from 1909-2009. Source: Coastal Zone Management Massachusetts Shoreline Change Project.

Previous Occurrences and Severity: Human-constructed features across Plum Island have been found to influence patterns of accretion and erosion along the barrier beach system. Recently, acute erosion has been noted along the northern edge of Plum Island, at Reservation Terrace. Due to the concern around loss at this location, a focus is given to address current conditions and efforts being made along Reservation Terrace, however it should be noted that this is not the only location along Plum Island that has historically experienced acute loss. Originally constructed in 1914 to improve the navigability of the channel, the Merrimack River Inlet jetties have been rehabilitated numerus times, only to

degrade as storms erode sediment along the toe of the structure.[20] Most recently, work to repair the jetties was undertaken in 2012 following a breach of the system. The South jetty repair in Newburyport was completed in 2014 and the North jetty on the Salisbury side of the channel was completed in 2015. This was the ninth time repairs had been made to the jetty system.[20] Since the most recent repair, residents have noticed a significant increase in erosion along the northern tip of Plum Island at the Reservation Terrace and Old Point neighborhoods, estimated by the Army Corps of Engineers at 53 feet of loss per year.[21]

Erosion of this magnitude poses a significant threat to residents on Plum Island and further degrades the capacity of dunes and beaches to protect properties from natural events and the impacts of climate change (storms, tidal surge, sea level rise, etc.). Over the past several decades, significant nor'easters and other storm events have caused acute beach erosion, prompting emergency shoreline protection and response efforts (rock barriers, coir bags, beach nourishment, emergency road maintenance, water/sewer repair) from the City and local residents to protect dwellings, buildings and other infrastructure along Plum Island. While the efforts have provided some short-term protection to adjacent properties, they do not offer lasting protection and require regular maintenance. Therefore, understanding the dynamics of the hazard and developing long-term collaborative planning efforts are necessary to respond to ongoing shoreline change and erosion along the Plum Island system.

The extreme shoreline change observed by residents since the most recent jetty rehabilitation at the norther tip of Plum Island along Reservation Terrace is in line with historical trends observed at this location. Beach sediment along Reservation Terrace has alternated between accretional and erosive periods since the jetty was installed in the early 1900s and is largely caused by the jetty altering the Merrimack River's natural hydraulic flow.[20] Initially, as water moves into the river basin during a flood tide, the jetty restricts the flow, causing a circulation gyre to form within the inlet along Reservation Terrace (Figure 4.1.3). The currents created from the gyre are able to mobilize and transport sediment away from the shoreline. Once inside, the constricted river mouth acts as a funnel to hold the water within the river basin and marsh. During heavy storm events, precipitation and runoff coming down river overwhelms the system, and the river is unable to efficiently discharge the significant volume of water. The trapped water causes floods, which rise along the rear of the barrier beaches and along Newburyport's waterfront, where they exert substantial hydraulic pressure, pulling the suspended sand and sediment with it when water retreats.[22]

While the construction and repair of the jetties was aimed at maintaining a navigable channel by managing the flow of water and sand out of the river, their presence has altered the distribution of sand moved by hydraulic forces. When historic aerial imagery and

[20] MA Department of Conservation & Recreation (2021). Upper North Shore Regional Sediment Management Study.
[21] Army Corps of Engineers (2021). Section 204 Beneficial Use of Dredged Material FROM Federal Navigation Project Maintenance Detailed Project Report and Environmental Assessment.
[22] National Wildlife Federation (2017). Great Marsh Coastal Adaptation Plan. https://www.nwf.org/-/media/Documents/PDFs/NWF-Reports/NWF-Report_Great-Marsh-Coastal-Adaptation-Plan_2017.ashx

shoreline change data is paired with a record of jetty repairs, a connection between beach erosion and the condition of the jetty can be made.[23]

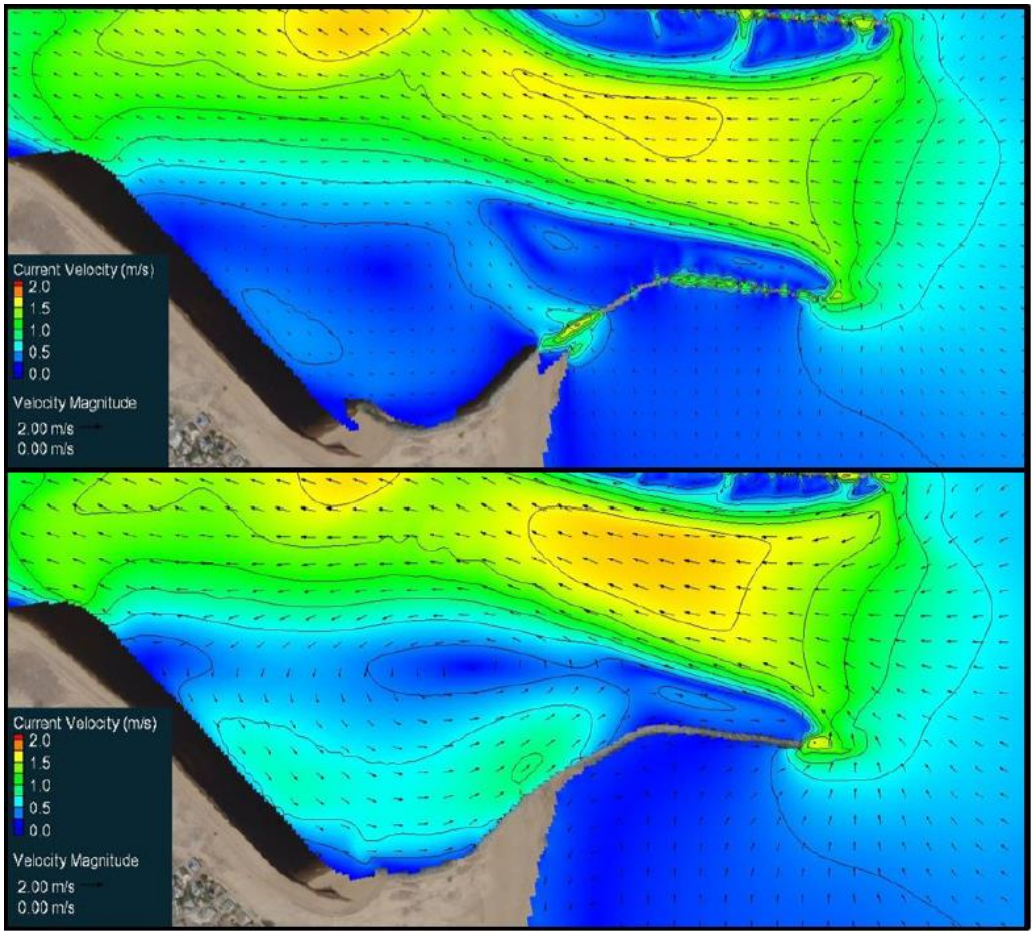


Figure 4.1.4 Coastal Modeling System Flow Results illustrating impact of jetty condition on flow within river basin. Top model represents flow when jetties are in disrepair vs. bottom model which represent flow when jetty system is repaired (source: DCR Upper North Shore Regional Sediment Management Study, 2021).

During periods of disrepair, Newburyport's coastal beach eroded while the beach on Plum Island Point, within the river, accreted. During periods of repair, the coastal beach accreted, while Plum Island Point eroded. This phenomenon can be explained by the movement of sand from the coastal beach into the river when the jetty is in disrepair, and conversely, the lack of available supply from the coastal beach when the jetty is repaired. During periods of jetty repair, the change in available sediment supply paired with the development of a circulation gyre leads to acute and significant coastal erosion and shoreline change. While the jetties have been found to significantly alter erosion and accretion rates, it should be noted that some portion of shoreline change at Plum Island Point and across the barrier beach system is due to factors outside of direct human

[23] Hein, C.J. et al. (2019). Shoreline Dynamics Along a Developed River Mouth Barrier Island: Multi-Decadal Cycles of Erosion and Event-Driven Mitigation. Frontiers 7:103

activities such as high wave energy and longshore currents which naturally shape barrier beach systems.[24]

The use of gray infrastructure (such as jetties and seawalls) to combat coastal erosion is not unique to Newburyport. The 2015 Massachusetts Coastal Erosion Commission report found that 46% of the exposed coastline along the North Shore of Massachusetts is armored by some form of coastal engineered structure.[25] Armoring can successfully protect adjacent structures but can also lead to unintended long-term consequences due to the disturbance of natural systems, as experienced at Plum Island Point.

Due to the drastic erosion occurring along Plum Island, the city and the USACE have taken follow-up steps to conduct an additional assessment of the jetty design and impact, as well as dredging and remediation to key sites. The USACE 2021 detailed project report and environment assessment expands on this work. In the fall of 2022, an estimated 250,000 cubic yards of sand will be dredged from the channel to allow for safe navigation. Dredged material will be placed on the most severely eroded section of dune and beach at Plum Island Point, adjacent to Reservation Terrace. Historically, dredging was conducted by the USACE every 3-5 years from 1961-1999, but the frequency has decreased to every 10 years since that point.[26] Despite this effort, the USACE acknowledges in their assessment that benefits of the beachfill at Plum Island Point will only offer a temporary solution, with the lifespan of the beachfill estimated at 3-4 years at Plum Island Point. Further, the study states that "if more effective protective measures are not implemented, it is anticipated that long term erosion will continue at the current rate and continue to threaten the shorefront structures along Northern Boulevard and the sewer and water system under the road."[27] The Department of Conservation and Recreation's 2021 Regional Sediment Management study emphasizes this point, acknowledging that while beach nourishment is a short-term solution "unless steps are taken to disrupt the erosive forces on the shoreline (i.e., structural improvements), the shoreline is likely to continue to erode at a rate of 30-70 feet per year." The study further notes that while the unraveling of the south jetty would reduce erosive pressure on Reservation Terrace, it would likely result in increased erosion to the east facing coastal beach, as was experienced during the last period of jetty disrepair prior to 2013.[26] To combat this, the study recommends creating a weir (20-30 meters in length) by lowering a portion of the southern jetty to allow flow to pass over in a controlled manner. To further reduce the chance of unintended erosion along the coastal beach, it is recommended that stone removed from the formation of the weir could be used as a jetty spur to better control the passage of water and sand.[26] As Newburyport is one of the communities (along with Salisbury, and Newbury) that is directly influenced by the jetty along the Merrimack River, the DCR report anticipates that these communities along with the USACE will be involved in efforts to develop a long-term solutions to sediment loss and

[24] Army Corps of Engineers (2021). Section 204 Beneficial Use of Dredged Material FROM Federal Navigation Project Maintenance Detailed Project Report and Environmental Assessment.
[25] Massachusetts Coastal Erosion Commission (2015). Volume 1: Findings and Recommendations. https://www.mass.gov/files/documents/2016/12/sd/cec-final-report-dec2015-complete.pdf
[26] MA Department of Conservation & Recreation (2021). Upper North Shore Regional Sediment Management Study.
[27] Army Corps of Engineers (2021). Section 204 Beneficial Use of Dredged Material FROM Federal Navigation Project Maintenance Detailed Project Report and Environmental Assessment.

stabilization of the barrier beach system.[28] To act on this expectation, funding and support will likely be needed to develop and implement a comprehensive and dynamic remediate plan for this site.

Climate Change: Newburyport is already experiencing coastal erosion, which is likely to accelerate with climate change. With heightened sea levels and more intense and frequent storms, the barrier beach of plum island is likely to experience increased wave action and tidal inundation of coastal areas (marsh, beach and dunes) that currently help to reduce storm surge and erosion. This will cause landward retreat of these natural systems, which reduces the natural buffer they provide to existing development. These conditions will cause further risk for populations and structures in the densely populated areas of Plum Island.

Land Use

With a growing population and continued pressure for additional housing, vacant land is scarce in Newburyport. Vacant residential parcels make up just 2.6% of land in Newburyport. As discussed above, nearly 1/4 of that land lies within a designated FEMA Flood Hazard Area (100 or 500-year floodplain). Of vacant commercial and industrial land, less than 2% is within a Flood Hazard Area. Newburyport regulates development in the Floodplain through the Newburyport Zoning Ordinance which creates a Floodplain Overlay District and associated Regulations (Section XIII) requiring compliance with the following regulations:

The Floodplain District is established as an overlay district to all other districts. All development in the district, including structural and nonstructural activities, whether permitted by right or by special permit, must comply with MGL c. 131, § 40 (The Wetlands Protection Act) and with the following:

a) Massachusetts General Laws (M.G.L.), Chapter 131, Section 40 (The Wetlands Protection Act)
b) Sections of the Massachusetts State Building Code which address floodplain and coastal high hazard areas (currently 780 CMR including but not limited to Section 2102.0 entitled "Floodplain Resistant Construction");
c) Wetlands Protection Regulations, Department of Environmental Protection (DEP) (currently 310 CMR 10.00);
d) Inlands Wetlands Restrictions, DEP (currently 310 CMR 13.00);
e) Coastal Wetlands Restrictions, DEP (currently 310 CMR 12.00);
f) Minimum Requirements for the Subsurface Disposal of Sanitary Sewage, DEP (currently 310 CMR 15, Title 5);

Any variances from the provisions and requirements of the above-referenced State regulations may only be granted per their required variance procedures. In addition to the

[28] MA Department of Conservation & Recreation (2021). Upper North Shore Regional Sediment Management Study.

resource areas protected by the Massachusetts Wetland Protection Act (Chapter 131, Section 40), Newburyport's Wetland Ordinance protects "Lands subject to flooding or inundation by groundwater or surface water and lands subject to tidal action, coastal storm flowage, or flooding" and the associated Regulations identify performance standards for that resource. The Regulations also require the consideration of Sea Level Rise Projections based on data from Boston.[29] Specifically, the Regulations state:

"*At a minimum, for activities proposed in A and V-Zones, a rate of relative sea level rise in Massachusetts of 40 inches by the year 2070 shall be incorporated into the project design and construction. (40 inches of SLR by 2070 was selected because it is consistent with both the National Oceanic and Atmospheric Administration's (NOAA's) and the BRAG Report's likely SLR scenarios, is the basis for the City of Boston's neighborhood coastal resilience plans and was adopted by the Boston Planning and Development Agency as part of their "Coastal Flood Resilience Design Guidelines" in 2019);*"

Additional regulations specific to Land Subject to Coastal Storm Flowage can be found in the Newburyport Wetlands Regulations (last revised 12/5/2019).

Further analysis of vacant residential parcels (Land Use Codes 130 Developable land and 131 Potentially developable lands) shows that over 184 acres contain land in some portion of the floodplain as shown on FIRM maps. As the frequency and intensity of rainfall events increases, flooding is likely to increase. Sea level rise and storm surge will also challenge residents in coastal areas. Development of residential structures and redevelopment should be prioritized outside of designated Flood Hazard Areas to protect Newburyport residents. This is highlighted Newburyport's MVP actions where stakeholders recommended stricter zoning for FEMA flood zones and requirements to design new development to incorporate sea level rise projections. Limits on new development, especially on Plum Island, were also included in the proposed actions.

Commercial and Industrial properties are also vulnerable to flooding. Commercial and industrial properties are not only subject to possible loss of property and revenue during flood events but also the valuable services, products, and jobs they provide to the community and region. Approximately 5.5% of existing commercial and industrial property in Newburyport is within a Flood Hazard Area with an additional 1.5% of vacant commercial and industrial land in these zones.

[29] The Boston Research Advisor Group. 2016. Climate Ready Boston, Climate Change and Sea Level Rise Projections for Boston.

Flooding and Critical Infrastructure

Table 4.1.3 Newburyport Critical Facilities in Flood Hazard Areas		
Facilities in *100-Year* Floodplain		
Facility Name	**Parcel ID / Street Location**	**2020 Buildings Valuation**
Wastewater Treatment Plant	23-11	$12,699,400.00
US Coast Guard Station – Merrimack River	17-10	$2,744,300.00
Custom House Museum	12-10	$1,440,000.00
Plum Island Public Safety Building	77-125-A	$88,400
National Grid Substation	20-1	$1,296,800.00
Hilton's Lift Station	48-23	$500,000.00*
Water Street Pump Station	31-7	$500,000.00*
Whites Court Pump Station	52-83	$500,000.00*
Plum Island Vacuum Pump Station	U02-0-171**	**In Town of Newbury

Critical Infrastructure identified by the Newburyport Core Team was identified on maps used in the workshop process. These mapped facilities were overlaid with the FEMA Flood Insurance Rate maps to identify what critical infrastructure might be vulnerable to flood events. Of over 75 facilities, only the following are in a Flood Hazard Area.

Facilities in 500-*Year* Floodplain		
Facility Name	**Parcel ID / Street Location**	**2020 Buildings Valuation**
None		

* Pump station estimated value, not assessed value of land

MVPC also examined *non*-critical facilities in the 100-year floodplain areas. This analysis revealed the presence of 968 residential, commercial, industrial, and institutional structures in the 100-year floodplain. Based on current (2021) Assessor records, these structures collectively are valued at over $200 million. Residential structures account for $160.6 million (80.2%) of the total valuation, followed in turn by commercial at $19 million (9.4%), institutional at $11.8 million (5.9%), and industrial at $8.9 million (4.5%).

Table 4.1.4 Assessed Value of Buildings in the 100-Year Floodplain						
City/Town	**Number of Buildings**	**Assessed Building Value by Land Use Type**				**Total Assessed Value in 100-Yr**
		Residential	**Commercial**	**Industrial**	**Institutional**	
Newburyport	968	$160,636,100	$19,006,500	$8,929,300	$11,792,300	$200,364,100.00

The total assessed value of all buildings in Newburyport is $3,450,859,500 to provide

context for the above. While the table figures provide an estimate of the building values, they do not include the estimated cost of replacing building contents. It is also important to note that loss of property does not reflect the entire cost of a region-wide flood event. There may also be added personnel (overtime) costs, rescue and evacuation costs, infrastructure repair/replacement costs, sediment and debris cleanup costs, and economic costs related to business closures.

In addition to threatening homes and other building structures, flood events pose risks to critical infrastructure, such as bridges and dams. The ability of these structures to withstand flood events depends in part on their current maintenance and repair status. Dam failure during a flood event can pose a serious threat to downstream properties by releasing a surge of water that was stored behind the dam before its failure.

Bridges

Bridges in Massachusetts are rated in accordance with standards set by the American Association of State Highway and Transportation Officials (AASHTO). AASHTO standards rate bridges on a scale of 1 to 100, with one being the least compliant with the ideal and 100 being the most compliant. Bridges with an AASHTO rating lower than 50 are considered in need of improvement and are placed on a state bridge repair list. In some cases, a bridge may have an AASHTO rating greater than 50 but is considered deficient due to a specific key structural problem with a particular component. A bridge may also be considered functionally obsolete, meaning that the roadway carried by the bridge does not meet current design standards for features such as roadway width. For flood-related hazards, the designation of structurally deficient is the most critical.

Currently, the seven of the nine federally inspected MassDOT highway bridges in Newburyport have AASHTO ratings ranging between 69.6 and 94 and are not considered structurally deficient. Two bridges on Route 1, over Merrimac Street and the Merrimack River are rated below 50 (46 and 48.5) and are listed as structurally deficient though both are listed as open with no restrictions.

Locally, the bridge on Plummer Spring Road, shared with the Town of West Newbury, is listed as structurally deficient and is currently closed. Several additional structures on Newburyport's inventory of bridges are listed as closed, abandoned, or removed and include a cattle crossing, a railroad bridge, and a foot bridge.

Dams

A *dam* is an artificial barrier that can impound water, wastewater, or any liquid for the purpose of storage or control. Dam failure can be defined as a catastrophic failure characterized by the sudden, rapid, and uncontrolled release of impounded water. Dams can fail for several reasons:

- Overtopping caused by floods that exceed the capacity of the dam

- Deliberate acts of sabotage
- Structural failure of materials used in dam construction
- Movement and/or failure of the foundation supporting the dam
- Settlement and cracking of concrete or embankment dams
- Piping and internal erosion of soil in embankment dams
- Inadequate maintenance and upkeep

Dam failures are potentially the worst of flood events. Typically, a dam failure is the result of neglect, poor design, or structural damage caused by a major event such as an earthquake. When a dam fails, huge volumes of water are often released, causing widespread destruction and potential loss of life. Although infrequent, floods due to dam failures have occurred in New England in the past. On May 16,1874, in Williamsburg, Massachusetts, a landslide destroyed a 43-foot dam on Mill Creek, a tributary of the Connecticut River, resulting in the deaths of 144 people.

Dams are classified by the Massachusetts Department of Conservation and Recreation's Office of Dam Safety according to their "hazard potential." Dams are classified as *High Hazard* (Class I), *Significant Hazard* (Class II), and *Low Hazard* (Class III). Each level of classification has an associated hazard potential. Class I dams are located in areas where "failure or misoperation will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s), or railroad(s)". Class II dams are located in areas "where failure or misoperation 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." Class III dams are located in areas "where failure or misoperation may cause minimal property damage to others." Loss of life is not expected from the failure of Low Hazard dams.

It is important to note that a dam's hazard classification is not an assessment of its potential for failure. For example, a Class I – High Hazard Dam does not have a higher potential for failure than a Class III – Low Hazard Dam. The hazard classification identifies the potential damage that would be caused if failure were to occur. However, because of the greater risk posed by higher hazard dams, the state requires more frequent inspections of such dams. The higher the hazard classification, the more frequently dam inspections must be performed. Low Hazard dams must be inspected at least once every ten years. Significant Hazard dams must be inspected at least once every five years, while High Hazard Dams must be inspected once every two years.

In addition to the requirement that high hazard dams be inspected every two years, owners are also required to develop Emergency Action Plans (EAPs) that outline the activities that would occur if the dam failed or appeared to be failing. This plan should include a notification flow chart, a list of response personnel and their responsibilities, a map of the inundation area that would be impacted, and a procedure to warn and evacuate residents in the inundation area. The EAP must be filed with local and state emergency agencies.

According to DCR Office of Dam safety records, as of May 2020, there are five Newburyport-owned dams on the statewide dam classification inventory. A table showing all of the Newburyport-owned dams and their current status per the Office of Dam safety can be found in **Table 4.1.3** below.

Table 4.1.5 Newburyport Dams

Dam Name	Impoundment Name	Hazard Classification	Date of Most Recent Inspection
Lower Artichoke River Dam	Artichoke River	Low Hazard	Not required
Lower Artichoke Reservoir Dam	Lower Artichoke Reservoir	Low Hazard	Not required
Upper Artichoke Reservoir Dam	Upper Artichoke Reservoir	Low Hazard	Not required
Fred Maudslay Dam	Flowering Pond	Low Hazard	Not required
Indian Hill Reservoir Dam (located in West Newbury but owned by Newburyport)	Upper Artichoke Reservoir	Low Hazard	Not Required

While none of Newburyport's dams are classified by DCR as either a "high hazard" or a "significant hazard" dam, local officials in recent years have taken action to address conditions at the Upper Artichoke Reservoir Dam, built in 1915. During inspection in 2012 and 2013, it was discovered that the dam, inlet pipes and gatehouse were deteriorating and required major repairs. Improvements completed in Fall 2014 by the City have restored the dam and provided the Newburyport Water Department with updated technology to control basic dam functions.

Newburyport's Climate Resiliency Plan identifies that the Lower Artichoke Reservoir Dam will require improvements in order to protect it from sea level rise and storm surge. The Lower Artichoke dam's spillway currently sits approximately 3 feet lower than FEMA's 100-year flood elevation. Thus, a less than 100-year storm event could overtop the spillway with CSO tainted Merrimack River waters thereby cutting off access to 75% of the city's water supply. Action items to address this vulnerability are identified in Section 8: Mitigation Action Plan and much greater detail can be found in the *Resiliency Plan*.

4.2 Wind-Related Hazards

High winds pose a risk to the communities of the Merrimack Valley region. As wind speed increases, pressure against an object increases at a disproportionate rate. For example, a 25 mile per hour wind causes about 1.6 pounds of pressure per square inch. When the wind speed increases to 75 mph, the force on that same object increases to 450 pounds

per square inch. At a wind speed of 125 mph, the force increases to 1,250 pounds per square inch. High winds can cause considerable damage to structures, infrastructure, and trees. Winds sustained at 31 to 39 mph for at least one hour, or any gusts of 46 to 57 mph, cause the National Weather Service to issue a Wind Advisory. While winds 58 mph or higher would lead to the issuance of a High Wind Warning.

Located on the coastal plain, Newburyport is exposed to the open Atlantic and can be susceptible to high wind events associated with coastal storms, storm systems traversing the Ohio River Valley to our West (such as the Mother's Day Storm of 2006), as well as passing frontal systems. As climate enhanced storm activity increases, so will damage from wind. Wind coupled with heavy precipitation, especially in the form of snow and ice, is most damaging. Newburyport's tree lined streets are interlaced with power lines and are particularly susceptible. In addition, many of Newburyport's buildings, especially its historic homes, are not built to withstand Hurricane force winds.[30]

The region is susceptible to high wind from several types of weather events: before and after frontal systems, hurricanes and tropical storms, severe thunderstorms, and Nor'easters. The State Building Code incorporates engineering standards for wind loads. Calculating wind load is important in the design of the wind force-resisting systems (including structural members, components, and cladding) to ensure against shear, sliding, overturning, and uplift actions. The three major wind-related hazards that can occur in the region are hurricanes, tornadoes, and coastal storms (Nor'easters). While less frequent than coastal storms, hurricanes and tornadoes have the greatest potential to cause massive, widespread damage and loss of life in Newburyport. Unlike flooding, where historical river flow records allow the potential extent of flooding to be delineated with some accuracy within each community, delineating the exact area where a hurricane or tornado will strike is not possible. A brief description of hurricanes and tornadoes, along with the general risks associated with each for this region, follows.

Hurricanes

A hurricane is a type of tropical cyclone, an organized rotating weather system, that develops in the tropics. Tropical cyclones are classified as follows:

Tropical depression: An organized system of persistent clouds and thunderstorms with a low-level circulation and maximum sustained winds of 38 mph or less.

Tropical storm: An organized system of strong thunderstorms with a well-defined circulation and maximum sustained winds of 39-73 mph.

[30] Newburyport Climate Resiliency Plan, 2020

Hurricane: An intense tropical weather system with a well-defined circulation and maximum sustained winds of 74 mph or higher.

The typical hurricane moves at an average speed of approximately 12 miles per hour. While in the lower latitudes, hurricanes tend to move from east to west. However, when a storm drifts further north, the westerly flow at the mid-latitudes tends to cause the storms to curve toward the north and east. When this occurs, the storm may accelerate its forward speed. This explains why some of the strongest hurricanes have reached New England.

Tropical depressions and tropical storms, while generally less dangerous than hurricanes, can be deadly. The winds of tropical depressions and tropical storms are usually not the greatest threat. Heavy rains, flooding, and severe weather such as tornadoes, create the greatest problems associated with tropical storms and depressions. Serious power outages can be associated with hurricanes and other tropical storms. After Hurricane Gloria in 1985, some area residents were without power for many days. Although not considered a Hurricane in eastern Massachusetts, storms associated with Hurricane Sandy in 2012 also left Newburyport residents in some parts of the city without power for several days. Hurricanes can occur along the East Coast of the United States anytime in the period between June and November. Based on the number and intensity of previous storms, mid-August through mid-October is defined as the peak hurricane season. Hurricane intensity and the potential property damage posed by a hurricane are rated from 1 to 5 according to the Saffir-Simpson Hurricane Scale. Hurricanes reaching Category 3 and higher are considered major hurricanes given the potential for loss of life and property damage. The wind intensity and potential damage of each category are summarized in **Table 4.2.1** below.

Figure 4.2.1 Hurricane Categories

Category 1 – Winds 74 to 95 miles per hour (mph). Damage potential to unanchored mobile homes, trees, shrubbery, and poorly constructed signs.

Category 2 – Winds 96 to 110 mph. Damage to roofing material, doors, and windows. Considerable damage to mobile homes and poorly constructed signs. Significant damage to trees and shrubs, with some trees blown down.

Category 3 – Winds 111 to 130 mph. Small residences and buildings may experience some structural damage. Minor curtainwall* failure possible. Destruction of mobile homes and poorly constructed signs. Foliage is blown off trees and trees may be blown down.

Category 4 – Winds 131 to 155 mph. Small residences may experience complete roof structure failures. Mobile homes completely destroyed. All signs, trees, and shrubs blown down. Doors and windows extensively damaged.

Category 5 – Winds greater than 155 mph. Many residences and industrial buildings experience complete roof failure. Complete building failures possible. Small utility buildings blown over or away. All signs, trees, and shrubs blown down. Mobile homes completely destroyed. Windows and doors severely and extensively damaged.

Hurricane-force winds can destroy buildings and mobile homes. Debris, such as signs, roofing materials, siding, and lawn furniture can become missiles. Tree branches and even entire trees are downed and with them the telephone and power lines. Hurricanes can also spawn tornadoes. Tornadoes generally occur in thunderstorms embedded in rain bands well away from the center of the hurricane. They can also occur near the eyewall. Usually, tornadoes produced by tropical cyclones are relatively weak and short-lived.

A hurricane watch is issued when a hurricane or hurricane conditions pose a threat to an area in the next 36 hours. A hurricane warning is issued when hurricane winds of 74 mph or higher are expected in the next 24 hours. If a hurricane's path is erratic or unusual, the warning may be issued only a few hours before the beginning of hurricane conditions.

While there have been relatively few direct hits from hurricanes in New England, peripheral effects from offshore hurricanes and tropical storms that track inland are not uncommon. In the period of time that records have been kept for hurricanes, Massachusetts has experienced 45 wind-related occurrences associated with hurricanes. Of those, six have had a direct impact and 39 have had an indirect impact. The most recent hurricane to affect the region was Hurricane Bob, which passed through in 1991. **Table 4.2.1** provides a summary of hurricanes that have affected New England since 1938.

Source: National Climatic Data Center, NOAA, U.S. Dept. of Commerce

Table 4.2.1 New England Hurricanes and Tropical Storms (1938-Present)

Date	Storm Event	Description	Deaths	Injuries	Property Damage
9/21/1938	New England Hurricane	Highest sustained winds-121 mph. Forward motion in excess of 50 mph. 17 inches of rain; extensive flooding.	564	1700+	9,000 homes and businesses destroyed, 15,000 damaged.
9/15/1944	Great Atlantic Hurricane	Forward motion in excess of 40 mph.	390	NA	$925 million
9/12/1950	Hurricane Dog	Center passed offshore Cape Cod. 4.42 inches of rain in 24 hours.	0	0	$2 million
9/07/1953	Hurricane Carol	Moved through the Bay of Fundy with only minor damage.	0	0	
8/31/1954	Hurricane Carol	First of three devastating hurricanes of 1954. Forward motion in excess of 50 mph. Category 3. Extensive flooding and damage.	60	NA	$438 million
9/11/1954	Hurricane Edna	Over 7 inches of rainfall. Extensive flooding.	29	NA	$40.5 million
10/15/1954	Hurricane Hazel	Forward motion over 50 mph.	600	NA	$350 million
8/00/1955	Hurricane Connie	Extensive flooding with 4-6 inches of rainfall	43	NA	$40 million
8/18/1955	Tropical Storm Diane	20 inches of rainfall caused devastating floods	184	NA	$832 million
8/29/1958	Hurricane Daisy	New England felt only periphery gales.	0	0	NA
9/12/1960	Hurricane Donna	Category 2. Forward motion of 39 mph.	133	NA	$387 million
9/21-25/1961	Hurricane Esther	Did unusual loop-de-loop southeast of Cape Cod. 7-8 inches of rainfall. Forward motion slowed approaching New England.	0	NA	NA
10/10/1961	Hurricane Frances	Category 3 storm, 110 mph winds. Some wind damage in New England	NA	NA	NA
8/29/1962	Hurricane Alma	Minor damage only.	NA	NA	NA
10/6-7/1962	Hurricane Daisy	14.25 inches of rainfall over 48 hours in Wakefield, MA. Significant flooding occurred throughout New England. Set record for 24-hour precipitation which remained unbroken until Hurricane Bob in 1991.	24	NA	NA
10/29/1963	Hurricane Ginny	Famous snow hurricane in Maine with up to 18 inches falling in the mountains.	0	0	$300,000
9/14/1964	Hurricane Dora	Moderate rainfall.	3	NA	$200 million
9/24/1964	Hurricane Gladys	Moderate to heavy precipitation.	2	NA	$6.7 million
6/13/1966	Hurricane Alma	Minor damage.	5	NA	$1.5 million
9/9/1969	Hurricane Gerda	Center passed directly over Nantucket with gusts up to 140 mph.	NA	NA	NA
8/28/1971	Tropical Storm Doria	Wind gusts up to 80 mph. Heavy rains, flooding.	3	NA	NA

Table 4.2.1 New England Hurricanes and Tropical Storms (1938-Present)

Date	Storm Event	Description	Deaths	Injuries	Property Damage
9/14/1971	Tropical Storm Heidi	Moderate rainfall, little damage.	0	0	NA
9/3-4/1972	Tropical Storm Carrie	Hurricane-force wind gusts. Heavy rainfall	1	NA	$1.2 million
7/27/1975	Hurricane Blanche	Most heavy weather remained offshore	0	NA	NA
8/9-10/1976	Hurricane Belle	Category 1. Forward motion 32 mph. Heavy rainfall causes some flooding.	3	3	NA
9/6/1979	Tropical Storm David	Minor effects	1,100 virgin Islands	NA	$60 million
9/25/1985	Tropical Storm Henri	Minor effects	0	0	NA
9/27/1985	Hurricane Gloria	Category 2. Forward motion of 72 mph. Gusts to 80 mph.	NA	3	$1 billion
8/7/1988	Tropical Storm Alberto	Winds of 50 mph.	31	NA	$500 million
8/19/1991	Hurricane Bob	Category 2. Forward motion of 51 mph. Wind speeds of up to 60 mph. Set new 24- hour precipitation record. Major flooding and power outages.	18	NA	$1.5 billion
10/30-11/01/1991	Unnamed "Halloween"	Huge storm surge caused extensive damage along the coast.	12	NA	$210 million
7/13/1996	Hurricane Bertha	Forward motion of 48 mph. Very heavy rainfall and strong gusty winds. Spawned one tornado in Massachusetts.	12	NA	$275 million
9/02/1996	Hurricane Edouard	Left 40,000 residents without power, 3 inches of rain fell.	0	0	$3.5 million
7/25/1997	Tropical Storm Danny	Dropped 3-5 inches of rain.	0	0	
9/16-17/1999	Tropical	Forward motion of 56 mph. No significant damage in Massachusetts.	0	0	$4.5 billion
9/03/2010	Hurricane Earl	Tropical Storm passed 98 miles east of New England with winds of 40+ mph producing high surf, heavy rain, and coastal flooding.	1	0	NA
8/21/2011	Tropical Storm Irene	Hurricane Irene became a tropical storm as it moved inland over NY, CT, MA, NH and ME	42	NA	$7-10 billion (est.)
10/29-30/2012	Hurricane Sandy	Category 1. Schools and public transportation closed in many communities.	285		$75 billion (est.)
9/20/2017	Tropical Storm Jose	Hurricane Jose became a tropical storm as it stalled off the coast of Nantucket.	0	0	$10K
9/7/2019	Hurricane Dorian	Passed about 140 miles southeast of Nantucket with some minor wind damage in southeastern Massachusetts.	0	0	$0.50K
8/4/2020	Tropical Storm Isaias	Tropical Storm Isais moved from coastal Virginia to the NYC area, causing widespread wind damage across southern	0	0	0

The National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center provides a searchable database that allows one to query hurricane records dating back to as early as 1851. Query results show historical storm tracks by storm intensity within a specified radius of a site. Query results for this region for hurricanes of Category 1 or above, passing within a 75-mile radius, show eight Category 1-5 hurricanes, as depicted in **Figure 4.2.2** According to NOAA's Historical Hurricane Tracker, 39 hurricane or tropical storm events have occurred in the vicinity of Massachusetts between 1842 and 2019. Within this period the Commonwealth was not impacted by any Category 4 or 5 hurricanes, however, the state was impacted by three Category 3 hurricanes, four Category 2 hurricanes, ten Category 1 hurricanes, and 25 tropical storms. Also, within this time a total of 31 tropical depressions and extratropical events impacted the Commonwealth.[31]

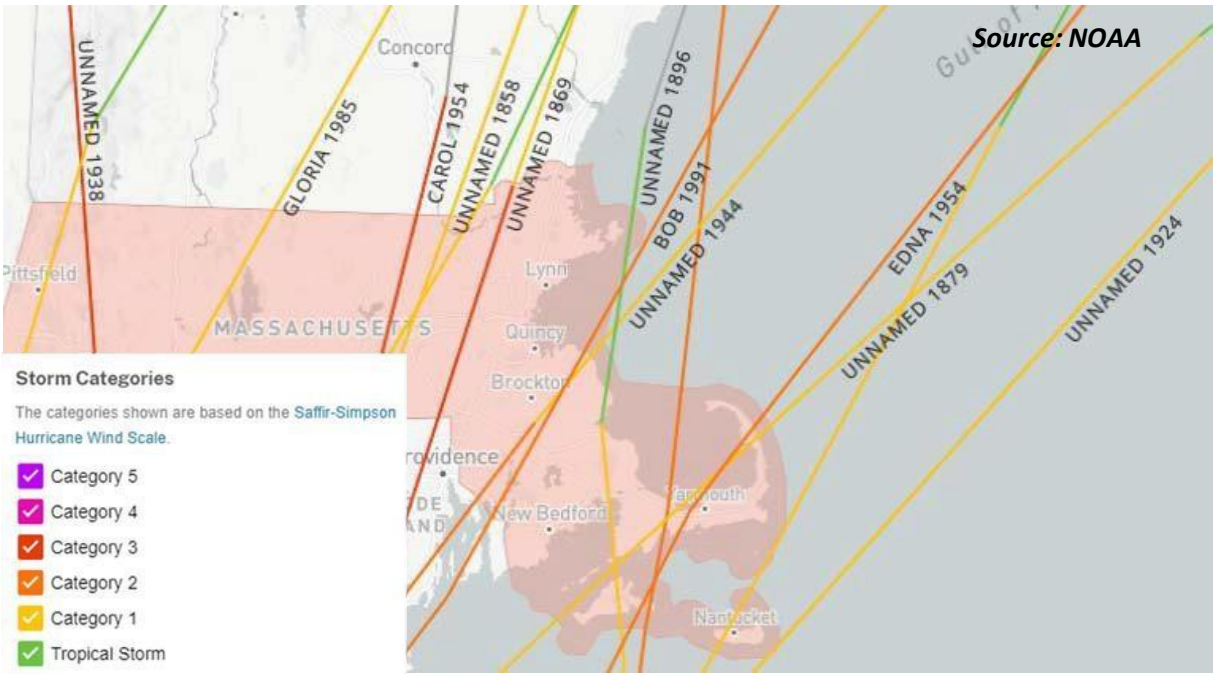


Figure 4.2.2 Historical Hurricane Tracks over Massachusetts

[31] Commonwealth of Massachusetts Tropical Cyclone Profile, July 2020

As noted above, however, a hurricane's wind intensity alone does not speak to the threat posed by intense rains that can cause serious inland flooding. Less intense hurricanes, or tropical storms, can carry higher rainfall amounts independent of wind speed. **Figure 4.2.3** on the following page shows all Tropical Storms whose centers have passed within 10 nautical miles of the Massachusetts state boundary from 1851 to 2020.

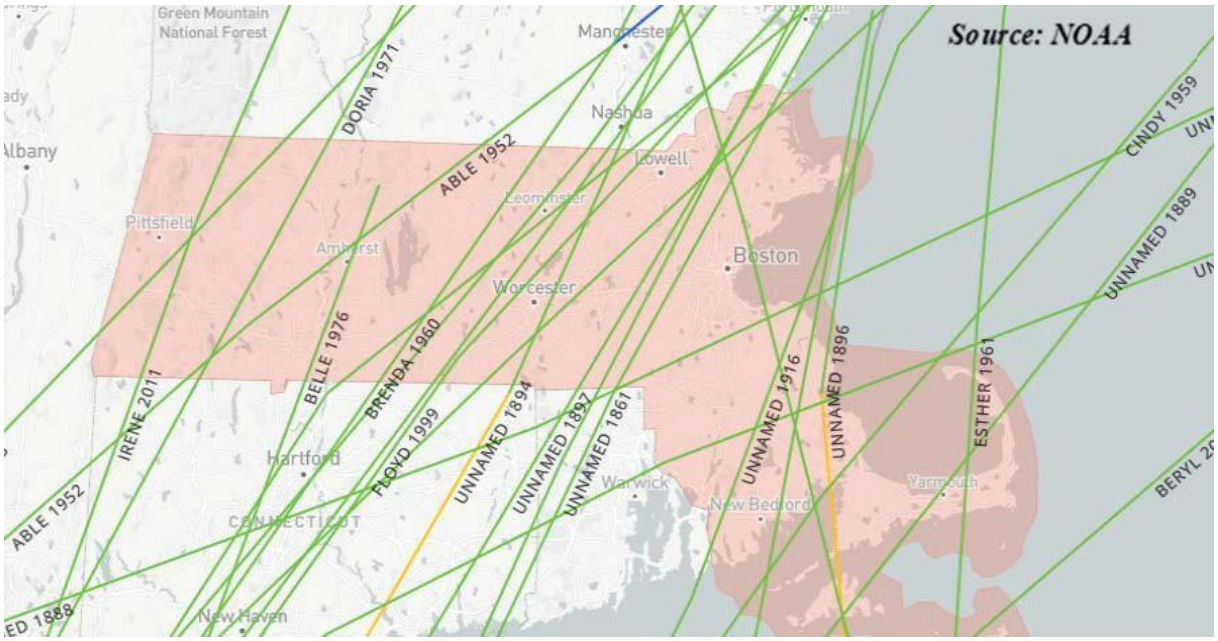


Figure 4.2.3 Tropical Storm Tracks over Massachusetts (1851-2020)

In the Merrimack Valley region's coastal area, including Newburyport, rapidly rising **storm surge** is the hurricane's primary threat to public safety, especially if timely notification and evacuations are not undertaken. Storm surge is a dome of water that moves ashore to the right of the hurricane eyewall. It packs a tremendous force, and places people and property in its path at grave risk. For this reason, it is imperative that residents and visitors alike be alerted to remain well above surge elevations until all threats have passed.

In the case of Plum Island, storm surge can scour and erode large swaths of beach and dunes, significantly altering the configuration of the shoreline. The extent of surge damage depends on the hurricane's intensity, size, and direction of movement. Storm surges cause flooding that can quickly render evacuation routes impassable, cripple communications, cause sewers and stormwater systems to back up, and contaminate local drinking water supplies. Storm surge flooding can wash out roads and parking areas, leaving behind mounds of sand and debris and rendering streets impassable long after surge waters have receded.

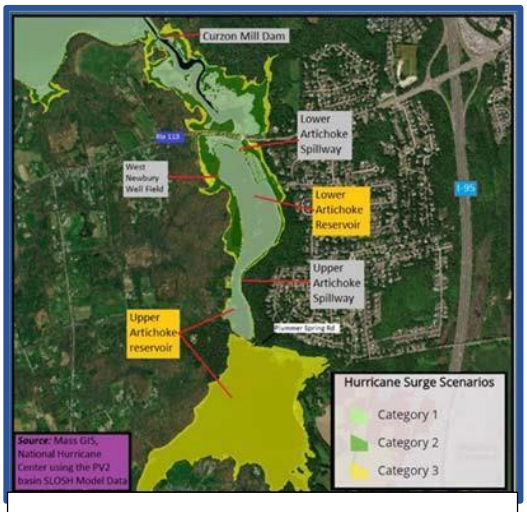


Figure 4.2.4 Hurricane Storm Surge Inundation – Lower and Upper Artichoke Reservoirs

The Worst-Case Hurricane Surge Inundation water levels are derived from the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) computerized weather model. SLOSH was developed by the National Weather Service (NWS) to estimate storm surge (the rise of water generated by a storm, over and above the predicted astronomical tides) resulting from historical, hypothetical, and predicted hurricanes. The SLOSH model computes storm surge heights from tropical cyclones using pressure, size, forward speed, and track data to create a model of the wind field which pushes the water around thereby calculating a potential "worst-case" surge based on the results from thousands of combinations of hurricane category, forward speed, pressure, pre-landfall location, direction, and local topography. The SLOSH model does not include rainfall amounts, river flow, or wind-driven waves riding in atop of a storm surge. The Resiliency Plan goes into further detail outlining the vulnerability of the various critical assets and neighborhoods under current and future Worst-Case Hurricane Storm Surge Inundations (example scenario in Figure 4.2.4 above).[32]

Hurricanes in Newburyport are considered a medium frequency event. As defined by the 2018 Massachusetts State Hazard Mitigation and Adaptation Plan, this hazard occurs more frequently than once in 5 years (a greater than 20% chance per year). Hurricanes and tropical storms will impact the planning area equally although it was noted by Newburyport stakeholders that some critical assets and identified neighborhoods, are at greater risk for these events. Vulnerable assets include the public water supply, Wastewater Treatment Facility, and the National Grid substation on Water Street. Vulnerable neighborhoods include Plum Island and the Plum Island Turnpike, Joppa/Water Street, Downtown Waterfront, Cashman Park/Merrimac Street, and the Business Park. Residents of these areas may be left without access to vital services during these outages.

Tornadoes

According to the American Meteorological Society's Glossary of Meteorology, a tornado is "a violently rotating column of air, pendant from a cumuliform cloud or underneath a cumuliform cloud, and often (but not always) visible as a funnel cloud." The most deadly and destructive tornado forms from a supercell, which is a rotating thunderstorm with a well-defined circulation called a mesocyclone. Normally a tornado will stay on the ground no longer than twenty minutes.

[32] Newburyport Climate Resiliency Plan 2020

Tornadoes can appear from any direction, but most move from southwest to northeast, or west to east. Tornadoes can last from several seconds to more than an hour. Most last less than ten minutes. Over 80% of tornadoes strike between noon and midnight. “Tornado season” is generally from March through August, although a tornado may occur any time of the year. 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 (i.e., from the southeast at the surface to west aloft);
- Increasing wind speed 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; and
- A forcing mechanism, such as a cold front or leftover weather boundary from a prior shower or thunderstorm activity.

The most devastating tornado to occur in New England was the Worcester tornado of July 9, 1953, killing 96 people and injuring over 1,300. On average, six tornadoes per year touch down somewhere in New England. Those most at risk include people in automobiles, anyone not in a secure structure, and residents of mobile homes. Since 1951, there have been 166 tornadoes in Massachusetts, which resulted in 109 fatalities and 1,562 personal injuries. Within the Merrimack Valley region, there have been seven tornadoes since 1951, as shown in **Table 4.2.2** below.

Table 4.2.2 Tornadoes in the Merrimack Valley Region (1951- Present)

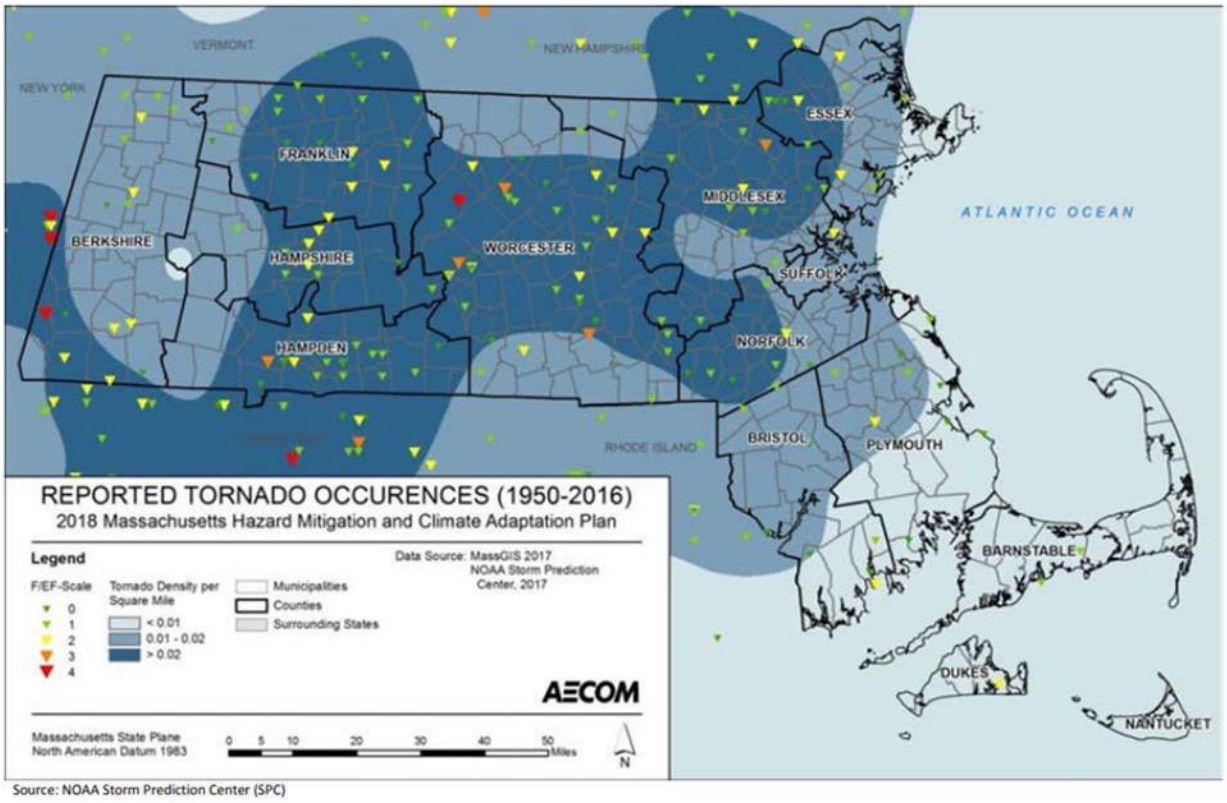
Year	Date	Tornadoes	Category	Injuries	Fatalities
1951	8-21-51	1	F2	0	0
1956	6-13-56	1	F1	0	0
1956	11-21-56	1	F2	0	0
1960	7-13-60	1	F0	0	0
1964	5-19-64	1	F0	0	0
1971	7-1-71	1	F1	1	0
1991	8-15-91	1	F1	0	0

Source: www.tornadohistoryproject.com

According to the Commonwealth’s 2018 on all-time initial touchdown locations across

the Commonwealth as documented in the NOAA NCDC Storm Events Database.[33] The following Figure 4.2.5 shows the area of the state at greatest risk runs from central to northeastern Massachusetts including a portion of the Merrimack Valley region.

Figure 4.2.5 Tornado Density per Square Mile



Source: NOAA Storm Prediction Center (SPC)

The National Weather Service (NWS) issues tornado forecasts through each local NWS office. In predicting severe weather, meteorologists look for the development of instability, lift and wind shear for tornadic thunderstorms. Real-time weather observations from satellites, weather stations, weather balloons, and radar become highly important as a storm approaches. A tornado watch defines an area where tornadoes and other types of severe weather are possible in the next several hours. A tornado warning means that a tornado has been spotted, or that Doppler radar indicates a thunderstorm with a circulation that can spawn a tornado.

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 2007, the National Weather Service began rating tornados using the Enhanced Fujita-scale (EF-scale). It is considerably more complicated than the original F-scale, and it allows surveyors to create more precise assessments of tornado severity. **Tables 4.2.3** and **4.2.4** illustrate the EF-scale and the damage indicators. Its uses three-second gusts

[33] Massachusetts SHMCAP, September 2018

estimated at the point of damage as judged by eight levels of damage to the 28 indicators listed in Table 4.2.3. These estimates vary with height and exposure.

Table 4.2.3 The Enhanced F-Scale

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

Source: www.noaa.gov

Table 4.2.4 Enhanced F-Scale Damage Indicators		
Number	**Damage Indicator**	**Abbreviation**
1	Small barns, frames outbuildings	SBO
2	One or two-family residences	FR12
3	Single-wide mobile home	MHSW
4	Double-wide mobile home	MHDW
5	Apt, Condo, townhouse (3 stories or less)	ACT
6	Motel	M
7	Masonry Apt. or motel	MAM
8	Small retail building (fast food)	SRB
9	Small professional (Doctor office, Bank)	SPB
10	Strip Mall	SM
11	Large shopping mall	LSM
12	Large, isolated (big box) retail building	LIRB
13	Automobile showroom	ARS
14	Automobile service building	ASB
15	School – 1-story elementary (interior or exterior halls)	ES
16	School – jr. or sr. high school	JHSH
17	Low-rise (1-4 story) building	LRB
18	Mid-rise (5-20) building	MRB
19	High-rise (over 20 stories	HRB
20	Institutional bldg. (hospital, govt. or university)	IB
21	Metal building system	MBS
22	Service station canopy	SSC
23	Warehouse (tilt-up walls or heavy timber)	WHB
24	Transmission line tower	TLT
25	Free-standing tower	FST
26	Free-standing pole (light, flag, luminary)	FSP
27	Tree - hardwood	TH
28	Tree - softwood	TS

Source: www.noaa.gov

The Disaster Center evaluated tornado statistics from 1950-1995 by state. When compared with other states across the country, Massachusetts ranked 35th in frequency, 16th in the number of tornado-related deaths, 21st in the number of injuries, and 12th for the cost of tornado-related damages. In terms of tornado frequency per square mile, Massachusetts ranked 14th in overall frequency, and first in terms of fatalities, injuries, and cost per area.

On June 9, 1953, one of the most powerful tornadoes ever recorded struck Worcester, Massachusetts, killing 96 people. The damage caused by this one event, relative to the State's small size, accounts for the statistical rankings previously cited.

In Essex County, 12 tornadoes were recorded from 1950 to 2021 (source: NOAA National Climatic Data Center). Of these, all fell within the lower F0 to F2 windspeed and damage categories. Since 1991, no tornadoes have been recorded for Essex County according to the NOAA database. On July 27th-28th, 2014, however, four tornado strikes occurred in New England, the closest taking place in the North Shore community of Revere, MA just south of the Merrimack Valley region. The EF2 force tornado of 120 mph winds accompanied by torrential rain lasted about four minutes and cut a swath of destruction two miles long and 3/8-mile-wide through the coastal community of Revere. According to the City Fire Department, 65 buildings were substantially damaged including 13 homes left uninhabitable.

Tornado events in Newburyport are considered a low frequency event. As defined by the 2018 Massachusetts State Hazard Mitigation and Adaptation Plan, this hazard may occur from once in 50 years to once in 100 years (a 1% to 2% chance per year).

Severe Thunderstorms

The National Weather Service considers a thunderstorm to be severe if it produces hail at least ¾ inch in diameter, has winds of 58 mph or higher, or has the potential to produce a tornado. Lightning accompanies all thunderstorms and can cause death, injury, and property damage. Straight-line winds can exceed 100 mph and are responsible for most thunderstorm wind damage. A downburst, a small area of rapidly descending air beneath a thunderstorm, can reach speeds equal to that of a strong tornado.

Three basic ingredients are required for a thunderstorm to form: moisture, rising unstable air (air that keeps rising when given a nudge), and a lifting mechanism to provide the impetus. The sun heats the surface of the earth, which warms the air above it. When this warm surface air begins to rise, such as in areas with hills or mountains, or areas where warm/cold or wet/dry air bump together, it will continue to rise as long as it weighs less and stays warmer than the air around it. As the air rises, it transfers heat from the surface of the earth to the upper levels of the atmosphere (a process known as convection). The water vapor in the air begins to cool, releases heat, and condenses into a cloud. The cloud eventually expands upward into areas where the temperature is below freezing. Some of the water vapor turns to ice, and some of it turns into water droplets. Both ice particles and water droplets have

electrical charges. Ice particles usually have positive charges, and rain droplets usually have negative charges. When the charges build up, they are eventually discharged in a bolt of lightning, which causes the sound waves we hear as thunder.

An average thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. *Severe* thunderstorms can be much larger and last much longer. Southern New England typically experiences about 10-15 days per year in which there are *severe* thunderstorms. It is not unusual for the Merrimack Valley region to experience a few moderate-to-severe thunderstorms throughout the spring and summer. The greatest hazard caused by this type of storm is flash flooding. Additionally, hail can cause substantial damage to property and crops. Large hailstones can fall faster than 100 mph and be very costly in terms of economic losses.

Every thunderstorm has an updraft (rising air) and a downdraft (sinking air, usually with the rain). However, sometimes, there are extremely strong downdrafts, known as downbursts, which can cause tremendous straight-line wind damage at the ground, similar to that of a tornado. A small (< 2.5-mile path) downburst is known as a "microburst" and a larger downburst is called a "macroburst." An organized, fast-moving line of an embedded microburst that travels across large portions of a state is known as a "derecho" and this can occasionally occur in Massachusetts. The strongest downburst ever recorded was 175 mph, near Morehead City, North Carolina. Winds exceeding 100 mph have been measured in Massachusetts from downbursts.

There have been several damaging thunderstorms in Massachusetts. In June of 1998, a very slow-moving and complex storm system moved through southeast New England. The combination of its slow movement and presence of tropical moisture across the region produced rainfall of 6 to 12 inches over much of eastern Massachusetts. This led to widespread urban, small stream, and river flooding. As a result, the counties of Bristol, Essex, Middlesex, Norfolk, and Suffolk received a Presidential Disaster Declaration for the Individual Household Program (Individual Assistance) on June 23, 1998.

According to the NOAA Storm Events Database Essex County experienced 30 days of Thunderstorm Wind events causing nearly $770 thousand in property damage since 2015. This includes 3 events reported in Newburyport the most recent of which occurred on August 21, 2019. The NOAA event database describes the event as "a warm front moved across southern New England and a moist southerly low-level jet at 850 mb developed. This set the stage for scattered severe thunderstorms, some prompting Tornado Warnings, but the strong rotation remained aloft. In Newburyport, due to thunderstorm winds, wires were down across a span of three houses on Harrison Street." Highest winds were reported at 57 mph.

Severe thunderstorms are considered high frequency events in Newburyport. As defined by the 2018 Massachusetts State Hazard Mitigation and Adaptation Plan, this hazard may occur more frequently than once in 5 years (greater than 20% chance per year).

4.3 Winter-Related Hazards

Severe winter storms can produce a wide variety of hazardous weather conditions, including heavy snow, freezing rain, sleet, and extreme wind and cold. A severe winter storm is one that results in four or more inches of snow over 12 hours, or six or more inches over 24 hours. The leading cause of death during winter storms is from an automobile or other transportation accident. Exhaustion or heart attacks caused by overexertion are the second most likely cause of winter storm-related deaths.

The National Weather Service issues outlooks, watches, warnings, and advisories for all winter weather hazards. These statements are defined as follows:

Outlook: Winter storm conditions are possible in the next 2-5 days
Watch: Winter storm conditions are possible in the next 36-48 hours
Warning: Life-threatening severe winter conditions have begun or will begin
Advisory: Winter weather conditions are expected to cause significant inconveniences and may be hazardous

The most severe winter storm to ever strike New England was the Blizzard of 1888. This storm occurred from March 11-14, 1888 and deposited up to 50 inches of snow. A century later, the Blizzard of 1978 dumped 24-36 inches of snow on the eastern part of the state and paralyzed much of the area for nearly a week. The winter of 2010-2011 produced some of the largest snowfall totals in the region's and state's history and included two blizzards, both occurring in January 2011. According to the National Weather Service, Boston received 80.1 inches of snow that winter, while the Merrimack Valley region received 74.5 inches.

The most significant annual snowfall years in the region, occurred in 1956 (120.5"), 2005 (110"), and 1969 (102.3"). More recently, the October 2011 snowstorm left 640,000 Massachusetts homes and residents without power, according to MEMA. Newburyport residents will not soon forget the winter storms of March 2018 when downed trees and utility lines resulted in power outages lasting several days throughout the Merrimack Valley. The NOAA Storm Events Database states that from eight to twenty-two inches of snow fell on Eastern Essex County. Numerous trees and wires were reported down. In addition to downed trees and power lines, Newburyport's Climate Resiliency plan states that, narrowing access for emergency vehicles, traffic,

Snow and Wind Down Power Lines on Merrimac Street, March 2018 – Newburyport Daily News

and parking. Snowbank covered sidewalks also force pedestrians into the narrow streets alongside traffic.

Property damage throughout Essex County, estimated at $120 thousand ($37k Western Essex and $83k Eastern Essex), was reported during the March 7 and 13, 2018 events. The March 13, 2018, event resulted in a FEMA Major Disaster declared on Jul 19, 2018.

Table 4.3.1 below details some of the most recent winter storms that have resulted in property damage since the prior MV Multi-Hazard Mitigation Plan.

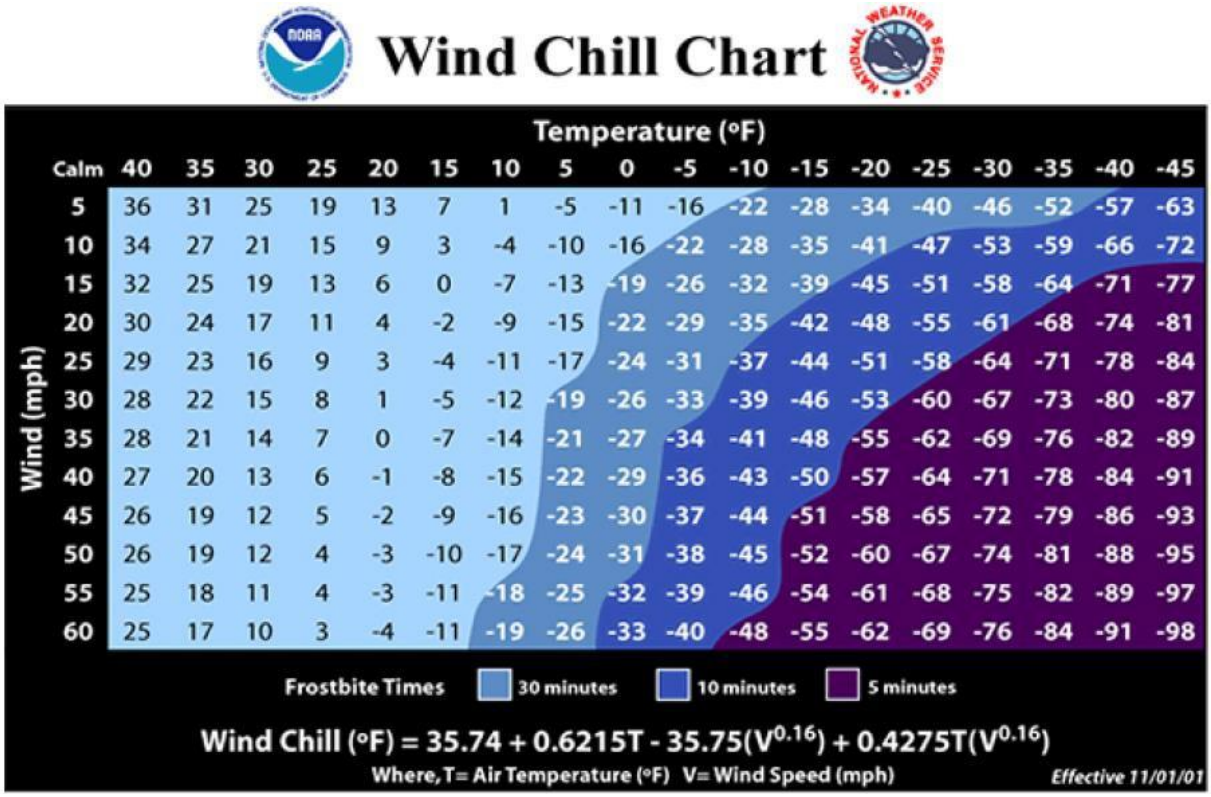
Table 4.3.1 Winter Storm Events and Property Damage, Eastern and Western Essex County 2015-2019 (NOAA)

Date of Event	Deaths	Injuries	Property Damage ($)
1/7/2017	0	0	0
2/9/2017	0	0	0
2/12/2017	0	0	0
4/1/2017	0	0	0
12/9/2017	0	0	0
1/4/2018	0	0	2,000
2/17/2018	0	0	0
3/7/2018	0	0	55,000
3/13/2018	0	0	65,000
1/19/2019	0	0	0
3/3/2019	0	0	0
2/1/2021	0	0	0

Blizzards are High frequency events in Newburyport. As defined by the 2018 Massachusetts State Hazard Mitigation and Adaptation Plan, this hazard occurs more than once in five years (a greater than 20% annual chance of occurring).

Oftentimes, the severity of winter related hazards is gauged through the extent (severity and magnitude) of extreme cold temperatures which accompany the event. This is typically measured through the Wind Chill Temperature Index. This index is defined as the temperature that people and animals feel when outside and is based on the rate of heat loss from exposed skin by the effects of wind and cold. In Massachusetts, a wind chill warning is issued by the National Weather Service (NSW) Norton Forecast Office when the Wind Chill Temperature Index is -25°F or lower for at least three hours. The NWS Windchill Chart (Figure 4.3.2) shows three shaded areas which are associated with how long a person can be exposed to windchill before developing frostbite.

Figure 4.3.1 NSW Wind Chill Temperature (WTC) Chart
from https://www.weather.gov/safety/cold-wind-chill-chart



Northeasters/Nor'easters

Nor'easters occur in New England more frequently than hurricanes and typically have a longer duration than hurricanes. A Nor'easter is a large New England storm formed from a weather system traveling from South to North, passing along or near the seacoast. The Nor'easter derives its name from the northeasterly direction of its counterclockwise cyclonic winds. It is not unusual for the sustained winds of a Nor'easter to meet or exceed hurricane force. The duration of a Nor'easter may outlast a hurricane event by many hours or even days. High winds associated with a Nor'easter can last from 12 hours to 3 days, while the duration of a hurricane rarely exceeds 12 hours.

Nor'easters pose a threat to infrastructure, including critical facilities. During the height of a storm, blizzard conditions present a hazard to driving or any other outdoor activity. A blizzard is defined as a storm with winds in excess of 35 mph, with falling and blowing snow reducing visibility to less than ¼ mile for at least three hours. Heavy snow disrupts transportation and may impede the passage of emergency vehicles. Heavy snow may also bring down power lines and trees, and lead to roof collapses. The Blizzard of 1978 dumped 24-48 inches of snow on eastern Massachusetts and paralyzed the region for many days. Most recent blizzard events in Essex County include January 26, 2015 (31.4" reported in nearby Methuen) and March 14, 2017, when heavy snow and strong winds combined to create blizzard conditions.

In early March of 2013, the latest in a series of powerful coastal storms combined with damaging high tides blasted a path of destruction along Plum Island in Newbury and along Salisbury Beach in Salisbury. On Plum Island, according to a *Daily News* account, "a ferocious morning tide proved to be the knockout blow for two Annapolis Way homes after high seas washed away the sand dune from beneath them, compromising their foundations and rendering them a danger to the public. Three other houses suffered significant structural damage in the storm and at least a dozen more were left teetering perilously close to the edge."

More recently, beginning on March 3rd, 2018, New England was impacted by the first of four significant storm systems that rode in atop of a nearly 10-foot tide (9.9 feet above mean low, low water or 5.6 feet NAVD88). Adding in a 2-3-foot storm surge resulted in a 12–13-foot storm tide (7.6-8.6 feet NAVD88). Aside from flooding the Plum Island turnpike, Old Point Road, and Sunset Boulevard, the combined level of the sea to the east and the river to the west, forced the water table under Plum Island to the surface to form ponds between dunes, streets and homes This ponding was not because of rainfall.

Recovery during the aftermath of a major snowstorm poses its challenges. Prolonged curtailment of all forms of transportation can have significant adverse impacts for people stranded at home, preventing the delivery of critical services such as home heating fuel supplies or the ability to get to a local food store. The cost of snow removal, repairing damages, and the loss of business can have severe economic impacts on local communities.

While the Fujita and Saffir-Simpson Scales characterize tornadoes and hurricanes, respectively, there is no widely used scale to classify snowstorms. The Northeast Snowfall Impact Scale (NESIS) developed by Paul Kocin of The Weather Channel and Louis

Uccellini of the National Weather Service characterizes and ranks high- impact northeast snowstorms. These storms have large areas of 10-inch snowfall accumulations and greater. The NESIS has five categories: Extreme, Crippling, Major, Significant, and Notable. The index differs from other meteorological indices in that it uses population information in addition to meteorological measurements. Thus, NESIS indicates a storm's societal impacts. This scale was developed due to the impact northeast snowstorms can have on the rest of the country in terms of transportation and economics.

NESIS scores are a function of the area affected by the snowstorm, the amount of snow, and the number of people living in the path of the storm. **Table 4.3.2** illustrates the NESIS values as calculated within a geographical information system (GIS). The aerial distributions of snowfall and population information are combined in an equation that calculates a NESIS score, which varies from around one for smaller storms to over ten for extreme storms. The raw score is then converted into one of the five NESIS categories. The largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers.

Table 4.3.2 The Northeast Snowfall Impact Scale (NESIS)

Category	NESIS	Value Description
1	1 – 2.499	Notable
2	2.5 – 3.99	Significant
3	4 – 5.99	Major
4	6 – 9.99	Crippling
5	10.0+	Extreme

Source: Paul Kocin and Louis Uccellini

Table 4.3.3 provides a listing of winter snowstorms impacting New England from 2015 through 2021. The table also ranks the storms on the NESIS scale. Eleven storms were rated as “Crippling” or “Extreme” during this time.

Table 4.3.3 NESIS Data for Massachusetts (2015-2021)

*Rank	Start Date	End Date	NESIS	Category	Description
48	2015-01-25	2015-01-28	2.62	2	Significant
17	2015-01-29	2015-02-03	5.42	3	Major
64	2015-02-08	2015-02-10	1.32	1	Notable
4	2016-01-22	2016-01-24	7.66	4	Crippling
23	2017-03-12	2017-03-15	5.03	3	Major
53	2018-01-03	2018-01-05	2.27	1	Notable
57	2018-03-01	2018-03-03	1.65	1	Notable
41	2018-03-05	2018-03-08	3.45	2	Significant
45	2018-03-11	2018-03-15	3.16	2	Significant
58	2018-03-20	2018-03-22	1.63	1	Notable
44	2020-12-14	2020-12-18	3.21	2	Significant
24	2021-01-30	2021-02-03	4.93	3	Major

*Source: https://www.ncdc.noaa.gov/snow-and-ice/rsi/nesis *Ratings of 66 high-impact storms since 1956*

Since the prior MV Regional Multi-Hazard Mitigation Plan, Massachusetts has experienced several extreme Nor'easter events including the following detailed in the 2018 SHMCAP and the NOAA Storm Events database:

- Severe Winter Storm, Snowstorm, and Flooding (FEMA DR4110)—February 8-10, 2013, which resulted in a state of emergency declaration for all counties on April 19, 2013.
- Severe Winter Storm, Snowstorm, and Flooding (FEMA DR-4214) —January 26-29, 2015, with the governor declaring a travel ban on January 27 and Logan International Airport closed through January 28.
- Severe Winter Storm and Flooding (FEMA DR-4372)—March 2-3, 2018 followed less than two weeks later by Severe Winter Storm and Snowstorm (FEMA DR-4379)—March 13-14, 2018 which resulted in a Federal Disaster Declaration on July 19, 2018, for Essex and several other Massachusetts counties.
- Nor'easter October 17, 2019 – Heavy rain, strong winds, and flooding left down trees and power lines and closed many roads.
- Nor'easter October 27, 2021 – Near hurricane winds battered the east coast leaving over 500k without power for several days.

Nor'easters are a high frequency event in Newburyport.

Ice Storms

Ice storms occur when a mass of warm moist air collides with a mass of cold Arctic air. As the less dense warm air rises moisture may precipitate as rain. The rain falls through the colder, denser air and comes in contact with cold surfaces where ice forms. Ice may continue to form until the ice is as much as several inches thick.

Ice storms may strain tree branches, telephone and power lines, and even transmission towers to the breaking point, and often create treacherous conditions for highway travel and aviation. The weight of formed ice (especially with a following wind) may cause power and phone lines to snap and the towers that support them to collapse under the load. The resulting debris-clogged roads can make emergency access, repair, and cleanup extremely difficult.

The December 2008 ice storm in New England and the Merrimack Valley region storm resulted in one fatality and left over one million people without power, some for as long as two weeks. Damage from the storm was measured in millions of dollars in property damage, lost business, and cleanup costs. Many of the expenses incurred were related to the clearing and disposal of downed trees and tree limbs. Given the magnitude of damage, the storm resulted in a Presidential Disaster Declaration.

More recently, the Halloween Nor'easter in 2011, caused billions of dollars in damage along the Eastern Seaboard. In Massachusetts, the ice storm accompanied by wind gusts up to 69 mph was responsible for six deaths and 420,000 power outages.

Ice storms equally as severe have been recorded in New England since 1929. The U.S. Army Corps of Engineers/Cold Regions Research and Engineering Laboratory estimates a 40 – 90-year return period for an event with a uniform ice thickness of between 0.75 and 1.25 inches. In other words, on average, a one-inch ice storm is likely every fifty years.

In Newburyport, Plum Island's electricity, Cable TV and internet communication lines are hung from a single row of utility poles that follow the turnpike from the mainland to Plum Island. The utility lines and poles themselves are vulnerable to wind, snow, and ice as they are set to the side of the roadbed and into the underlying marsh, which is wet and soft, especially when flooded. The substrate where these poles are set will only become softer as sea levels continue to rise.

Ice Jams

Ice jams occur when warm temperatures and heavy rain cause rapid snow melting. The melting snow combined with the heavy rain causes frozen rivers to swell, breaking the ice layer into large chunks that float downstream and pile up near narrow passages or near obstructions such as bridges and dams. Historically, there have been hundreds of ice jams in New England. Although relatively rare in the Merrimack Valley region, ice jams have been recorded on the Merrimack River in the community of Lawrence and on the Spicket River in Methuen. The major hazard associated with an ice jam is flooding.

4.4 Fire Related Hazards

Fire poses a danger to both developed and rural areas of Newburyport, as well as to forested and grassland areas. Wildland fire can be defined as any non-structure fire that occurs in wildland that contains grass, shrub, leaf litter, and forested tree fuels. Three distinct wildland fires have been defined and include wildfire, naturally occurring or human-caused, and prescribed fire. However, as this Plan focuses on natural hazards, the discussion is limited to wildfire/brush fire hazards.

Wildfires

A wildfire is an uncontrolled fire that spreads due to the presence of vegetative fuel. These fires often begin unnoticed and spread quickly. In this area of the country, wildfire season generally begins in March and ends in late November. Human beings start four out of every five wildfires through arson or carelessness. Lightning strikes account for most of the remainder. If heavy rain follows a major wildfire, other natural disasters can occur, including landslides and floods. Once groundcover is burned away, there is little left to

hold soil in place on steep slopes. Water supplies can also be affected. The loss of ground cover materials and the chemical transformation of burned soils can make some watersheds more susceptible to erosion.

A surface fire is the most common type of wildfire, burning slowly along the floor of a forest, destroying or damaging trees. Lightning typically starts a ground fire and burns on or below the forest floor; such fires are difficult to detect and extinguish. Crown fires spread quickly along the tops of trees and are driven by wind. Crown fires are seen when a high-intensity surface fire spreads or "ladders" upward through the lower foliage to the canopy.

The Massachusetts Department of Fire Services/Division of Fire Safety maintains a comprehensive database of all reported fire incidents in the Commonwealth, including wildfires and brush fires. According to statistics compiled by the Massachusetts Fire Incident Reporting System (MFIRS), during the five years from 2014 to 2018, there were 5,245 fires classified as "other fires" in Essex County (i.e., non-structure and non-vehicle fires), the vast majority of which were local brush fires. MFIRS reports 80 "other fires" for Merrimac during that period.

Historically there are more brush fires in April than any other month. Over a ten-year average, there are 24% more brush fires in April than in May, the next busiest month for brush fires according to the Massachusetts Department of Fire Safety.

Wildland/Urban Interface

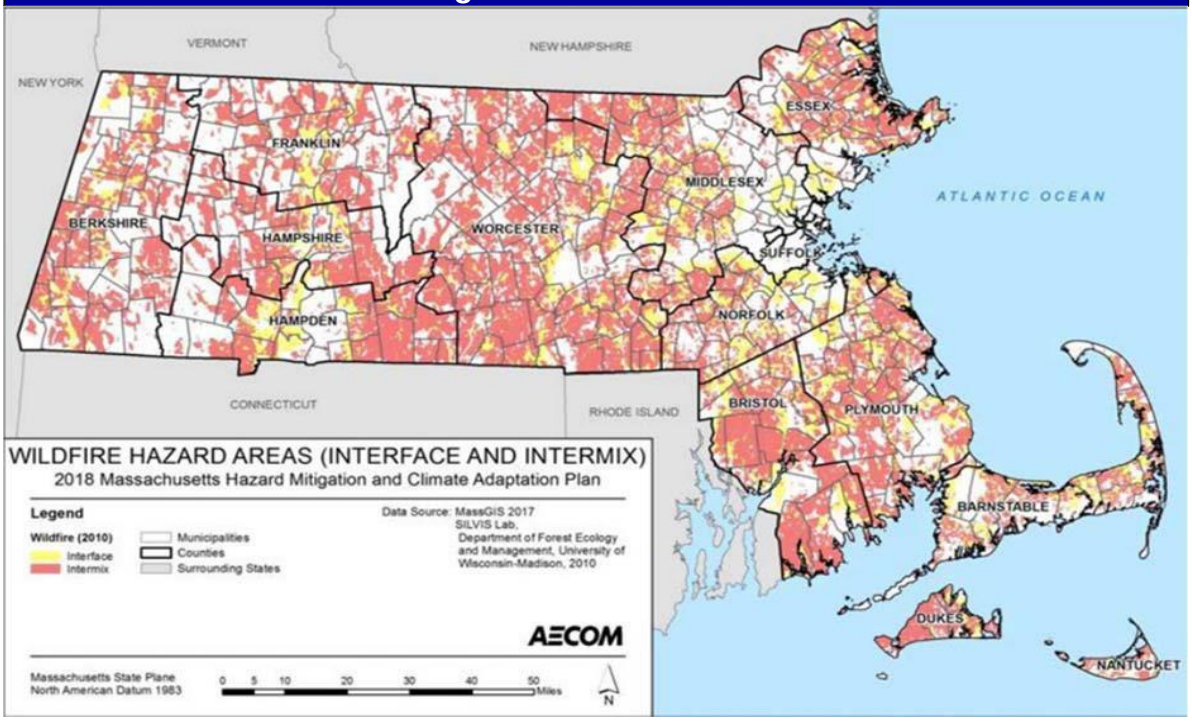
Wildland/urban interface areas exist wherever homes and businesses are built among trees and other combustible vegetation. Such areas are becoming increasingly prevalent throughout the Merrimack Valley region and Newburyport, as development continues to encroach into forest land. The wildland/urban interface problem stems from two different sources of fire and their impact on the community. Fire can move from forest, brush, or pastureland into the community or from the community into adjacent wild areas. In temperate areas, vegetative decay is a slow process, and logs, leave, and evergreen needles pile up on the forest floor. This accumulation of fuel increases the probability of large fires that are difficult to control. Ignitions are more frequent in the wildland/urban interface because of the increased presence of people. Carelessness, recreation use, damaged power lines, and industrial activity all are potential ignition sources.

Wildland/urban interface fires can cause large economic losses and severe social impacts. The impact to residents can include the loss of, or damage to, homes and irreplaceable items, and even death or serious injury. Financial costs include building and infrastructure damage and loss, business disruption, and fire suppression and evacuation costs. While Newburyport responds to several brush fires annually, none have resulted in significant

property damage or death. During MVP planning workshops, stakeholders identified a need for forest management to remove dead and dying trees which might serve as fuel for future fires. March's Hill and Maudsley were areas of concern noted in the 2018 Summary of Findings.[34]

The following map taken from the 2018 SHMCAP depicts wildlife hazard as "interface" or "intermix."

Figure 4.4.1 Wildlife Hazards



Wild/brush fires are considered a medium frequency event in Newburyport.

4.5 Geologic Hazards

The Merrimack Valley region is vulnerable to earthquakes and landslides, although both geologic hazards are infrequent.

Earthquakes

In the Northeast, earthquakes are not associated with specific known faults, as they are in California. In New England, the immediate cause of most earthquakes is the sudden release of stress along a fault or fracture in the earth's crust. Much of the research on

[34] Summary of Findings, Newburyport Municipal Vulnerability Preparedness Workshop, May 31, 2018. Horsley Witten Group.180531_newburyport_mvp_report_final_reduced.pdf(cityofnewburyport.com)

earthquakes in the northeast has involved attempts to identify pre-existing faults and other geological features that may be susceptible to such stress, but this has proven to be quite difficult. Unlike the situation in the western part of the country, where many plate boundary earthquakes occur, it is unclear whether faults mapped at the earth's surface in the northeast are the same faults along which earthquakes are occurring.

The magnitude of earthquakes is often measured by the Richter and/or Mercalli scale. The Richter scale measures the energy of an earthquake by determining the size of the greatest vibrations recorded on the seismograph, an instrument which records details of earthquakes such as force and duration. On this scale, earthquakes under 3.5 in magnitude are generally not felt, while earthquakes over 8 in magnitude bring serious destruction. One step up in magnitude (5.0 to 6.0 for example) increases the energy more than 30 times. Similarly, the Mercalli scale measures earthquakes via a twelve-point scale, where I is not felt and VII is catastrophic. This scale does not have a mathematic basis and is instead based on observable effects. Tables 4.5.1 and 4.5.2 show the Richter and Mercalli scales respectively.

Figure 4.5.1 Richter Scale Magnitudes and Effects

From https://www.mtu.edu/geo/community/seismology/learn/earthquake-measure/

Magnitude	Effects
< 3.5	Generally not felt, but recorded.
3.5 - 5.4	Often felt, but rarely causes damage.
5.4 - 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1 - 6.9	Can be destructive in areas up to about 100 kilometers across where people live.
7.0 - 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or >	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

Figure 4.5.2 Mercalli Scale Intensity and Description

From: https://www.usgs.gov/programs/earthquake-hazards/modified-mercalli-intensity- scale

Intensity	Shaking	Description/Damage
I	Not felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest,especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Very strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Severe	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Violent	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

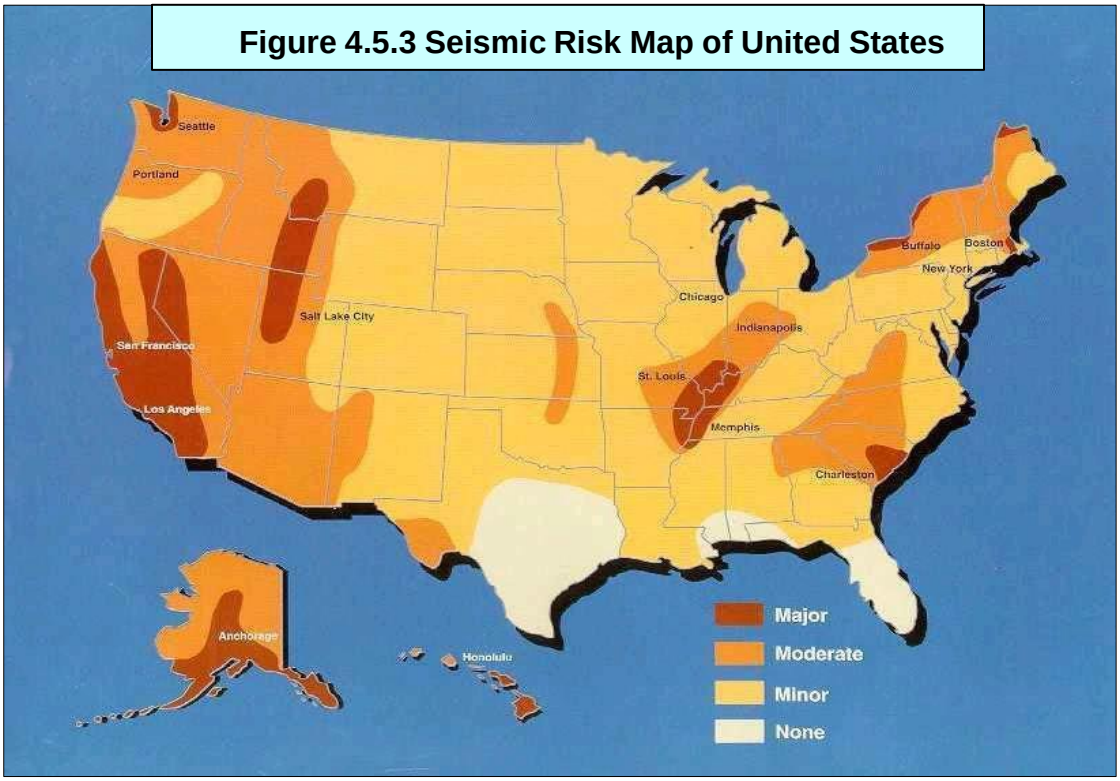
It is impossible to predict the time and location of future earthquakes in New England. The United States Geological Survey (USGS) has produced a series of earthquake hazard maps for the United States. These maps show the amount of earthquake- generated ground shaking that is predicted to have a specific chance of being exceeded over a certain period. Ground shaking caused by earthquakes is often expressed as a percentage of the force of gravity. Due to the difficulty of identifying specific seismically active geological features in the Northeast, the level of seismic hazard is based primarily on past seismic activity. These maps generally show that there is a 1 in 10 chance that in any given fifty-year period a potentially damaging earthquake will occur.

Essex County in Massachusetts is at moderate risk to the threat of an earthquake. Moderate risk means that there is a relatively long period between strong earthquakes. Between 1627 and 1989 there were 316 earthquakes recorded in Massachusetts. From 1924-1989 there were eight earthquakes with a magnitude of 4.2 or greater in New England. According to the Weston Observatory, the last earthquake to hit the New England Region with a magnitude of 3.0 or greater occurred on September 26, 2010, in the area of Contoocook, New Hampshire. New England experiences 30-40 earthquakes each year, although most are not felt. Potential earthquake losses total $4.4 billion annually in the United States, with the Northeast ranking third in the nation for annualized losses, according to FEMA. The $4.4 billion estimate includes only losses to buildings and business interruption; it does not include damage and losses to critical facilities, transportation infrastructure, and services, utilities, or indirect economic losses.

An area's vulnerability to a devastating earthquake is based primarily on two elements: the density of the population in the region, and the age of the region's buildings, and the lack of earthquake-proof design. Additionally, seismic waves travel further in the eastern

U.S. than in other parts of the country. Seismologists have determined that the likelihood of an earthquake with a magnitude of 5.0 or greater in the New England area is 41-56% by the year 2043.

Figure 4.5.3 Seismic Risk Map of United States



Earthquake magnitude is measured on two scales, the Richter Scale and the Mercalli Scale. The Richter Scale (expressed as “mb”) is an open-ended logarithmic scale that measures the amount of energy released by an earthquake. An earthquake registering 1.5mb on the Richter Scale represents that point at which some disturbance may be felt. At 4.5mb slight damage may be caused. An 8.5mb is considered a devastating earthquake. The Mercalli Scale is measured on a scale of I to XII and expresses more directly the damage caused by an earthquake. A Scale I earthquake on the Mercalli Scale would barely be felt, whereas a Scale XII quake would destroy all buildings. The intensity of the quake is evaluated according to observations at specific locations.

Ground movement during an earthquake is seldom the direct cause of injury or death. Collapsing walls, falling objects, and flying glass cause most casualties. Buildings with foundations resting on unconsolidated landfills, old waterways, or other unstable soils are most at risk. Buildings, trailers, and manufactured homes not tied to a reinforced foundation anchored to the ground are also at risk since they can be shaken off their mountings during an earthquake. In the eastern part of the U.S., a magnitude 5.5 earthquake can be felt as far as 300 miles from where it occurred and can cause damage out to 25 miles from the epicenter.

Based on records, the maximum experienced earthquake intensities on the Mercalli Scale

in Essex County have been in the range of VI (where there is damage to objects indoors, the tremor is felt by all people indoors and outdoors, movement is unsteady, moderately heavy furniture moves, and pictures fall off walls) to VII (where there is damage to architecture, the tremors are frightening, it is difficult to stand, cracks occur in chimneys and plaster, bricks may fall, and stream banks may cave in).

Figure 4.5.4 New England Earthquake Probability

Source: Weston Observatory, Boston College

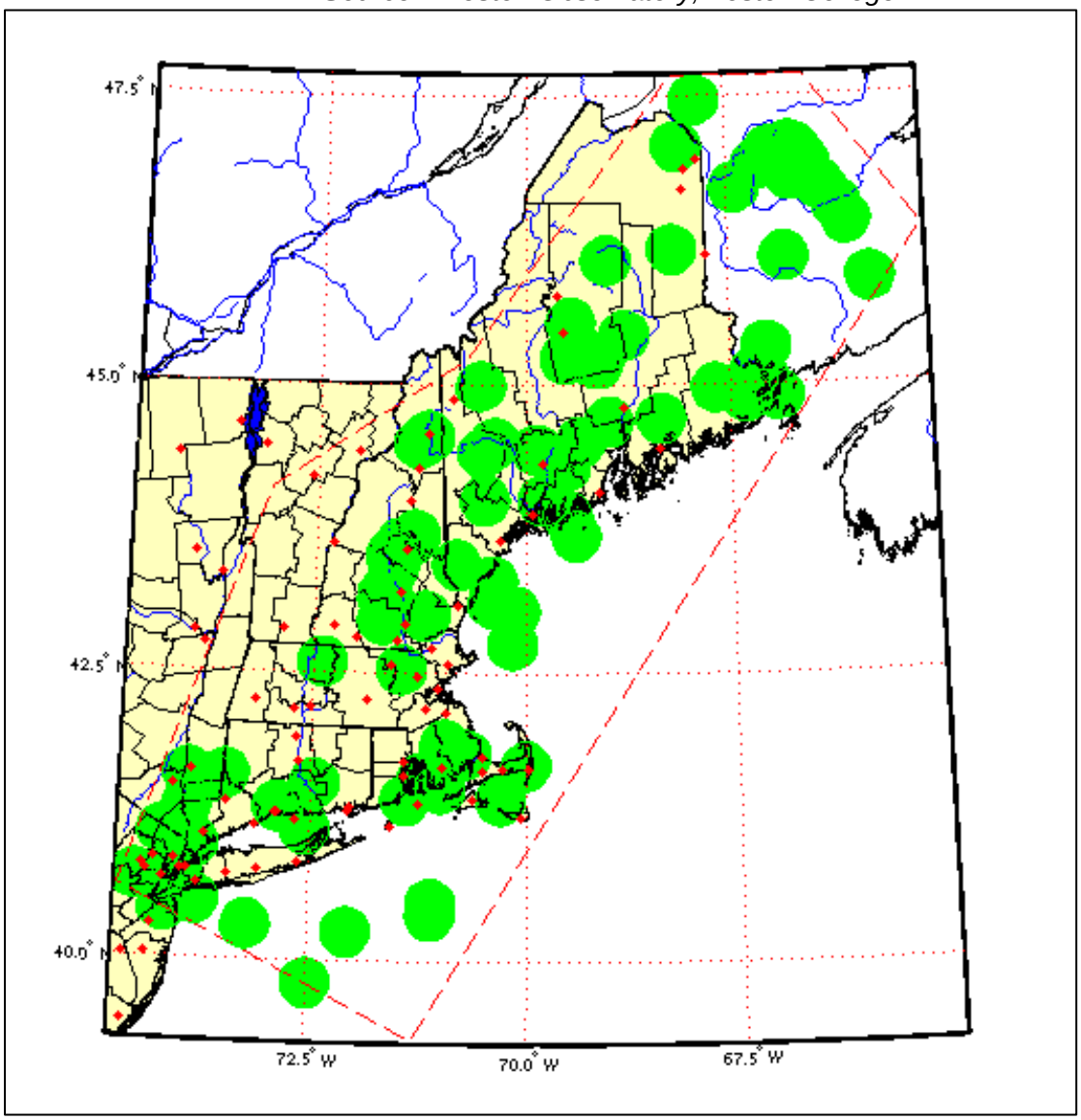


Figure 4.5.4 above shows the results of an earthquake probability analysis conducted by the Weston Observatory at Boston College. The study examined earthquake activity of magnitude greater than 2.7 between 1975 and 1998. According to the analysis, there is a 66% chance that the next earthquake of magnitude greater than 2.7 will occur in the green areas shown on the map above. A record of all seismic activity in the Northeast can be found at the following link on the Weston Observatory website: LatestNewEnglandEarthquakes(bc.edu).

Failure to design structures with earthquakes in mind will also affect the potential damage caused by an earthquake. Regulations that require buildings and structures to meet some minimum seismic criteria were only recently put in place. Newburyport complies with the most recent version of the state Building Code.

Tsunamis

A tsunami is characterized by a series of extreme waves with elongated wavelengths that can move hundreds of miles per hour in the open ocean and move onshore with waves of 100 feet or greater. Tsunamis are normally caused by geologic activity (earthquakes, volcanic activity) or other natural events (landslides, glacier calving, meteorites) which trigger underwater disturbances. Unlike wind-driven waves, tsunamis move through the entire water column. As the waves travel inland and reach shallow water, their speed decreases, and their height increases. According to NOAA, when tsunamis hit land, most are less than 10 feet in height, but in extreme cases, can be greater than 100 feet. These extreme tsunamis can devastate coastal communities and cause flooding in low-lying coastal areas.

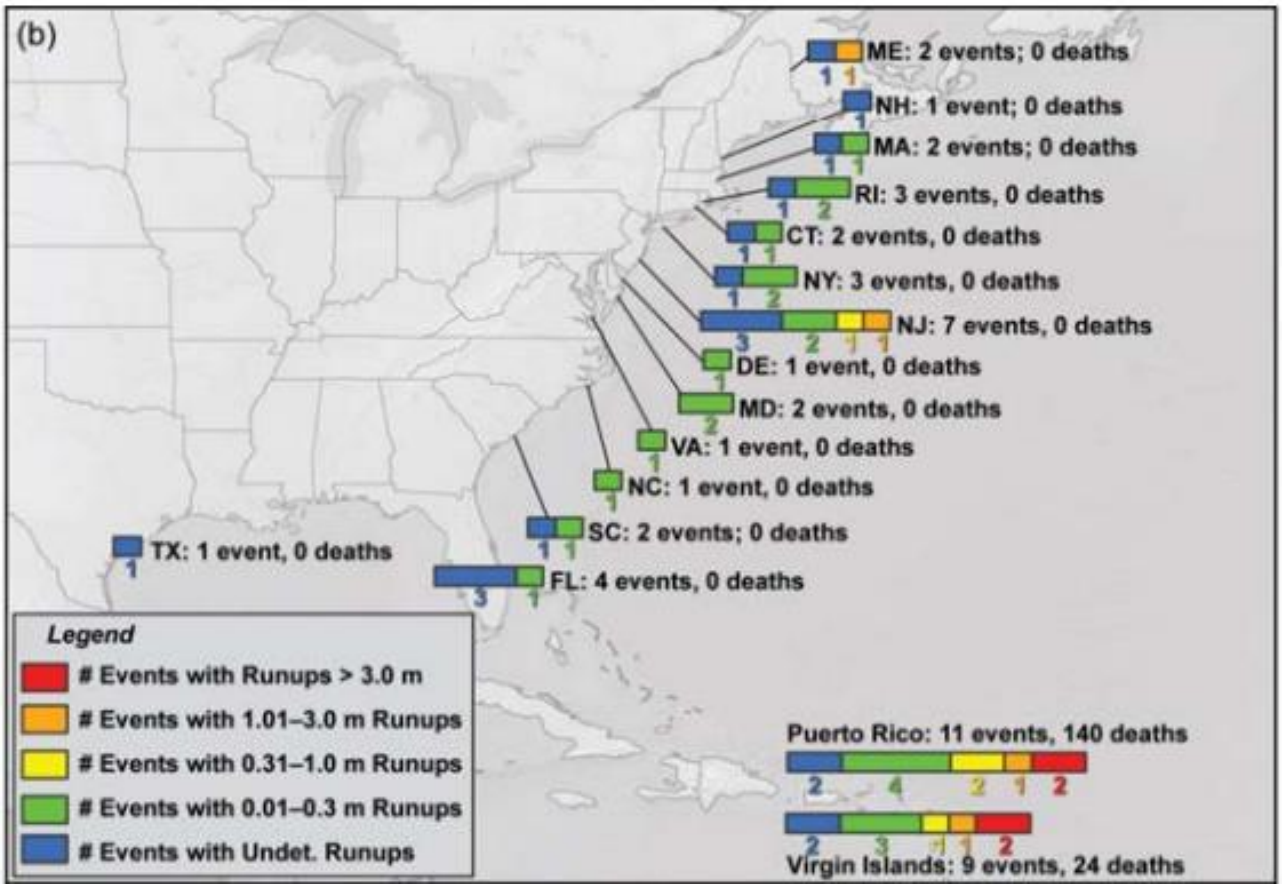


Figure 4.5.5 Total number of tsunami events that have occurred in the Atlantic Ocean with run-up heights of 0.01-3.0 meters (Dunbar and Weaver 2015).

Hazard Location: While all of coastal Massachusetts is exposed to the threat of tsunamis, the Atlantic Coast of the United States has experienced very few tsunamis in the last 200

years (Figure 4.5.5). According to NOAA, the majority of the tsunamis occur in the Pacific Ocean, which accounts for 71% of all world occurrences. Most tsunamis (78%) have been caused by earthquakes, with destructive tsunamis occurring after a 7.5 magnitude earthquake or greater (Source: International Tsunami Information Center). While Essex County Massachusetts is at a moderate risk for earthquakes, the state has only experienced two severe earthquakes in its recorded history (intensity IV in 1668 and magnitude 6.0 in 1755).[35] The Maine Geological Survey identifies convergent margins as conditions in which earthquakes are most likely to occur. In Massachusetts, the closest tectonic boundary is the divergent Mid-Atlantic plate, which is less likely to trigger earthquakes. Within the Atlantic Coast, US states and Territories closer to the convergent plate boundary in the Caribbean Sea or the volcanic island-arc in the Canary Islands are at greater risk for tsunami occurrence. As Massachusetts is far from both of these locations, the risk is considerably lower.

Previous Occurrences and Severity: According to the NOAA Storm Events Database, no tsunamis have been reported in Massachusetts since tracking begin in 1950 and no Presidential Disaster Declarations have been made for tsunamis in the state.[35] In their study, Dunbar and Weaver (2015) report only two small tsunami events that have occurred in Massachusetts since recording begin in the 1800s, with neither considered significant events.[36]

According to the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan, the frequency of tsunamis is influenced by the frequency of the events that cause them (seismic, volcanic, or landslide activity). Therefore, the probability of future tsunamis in Newburyport is low to very low based on historical data and the frequency of causal activities.[37] However, while the likelihood of a damaging tsunami in Massachusetts is low compared to other hazards, the impacts could be high. The 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMP) references a 1-mile coastal buffer which was established as part of the 2013 SHMP to define the geographic extent of tsunami hazards in the state. This buffer will be updated once modeling and inundation mapping are completed. Areas of Newburyport fall within this buffer zone and are considered vulnerable locations were a tsunami to occur.

Climate change: The effect of climate change on tsunamis is unclear, however, early studies suggest that it will contribute to increased tsunami occurrence and severity.[38] This will primarily occur due to increased temperatures melting ice cover which in turn will reduce downward pressure on the earth's crust, allowing the crust to rise and triggering earthquakes and underwater landslides. Additionally, collapsing glaciers on the surface of the water may also cause landslides, resulting in tsunami events. Heightened sea-level could further exacerbate the severity of tsunami events for low-laying coastal communities.

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[35] *National Oceanic and Atmospheric Administration, National Centers for Environmental Information, Storm Events database. http://www.ncdc.noaa.gov/stormevents/*

[36] *Dunbar and Weaver (2015). U.S. States and Territories National Tsunami Hazard Assessment: Historical Records and Sources for Waves-Update. NOAA Report*

[37] Massachusetts SHMCAP, September 2018

[38] McGuire.2010. *Potential for a Hazardous* Geospheric *Response to Projected Future Climate Change. Royal Society 368:119.*

Landslides

A landslide is the downward movement of a slope and its materials under the force of gravity. Human activity such as construction and mining, and natural factors such as topography, geology, and precipitation influence landslides. Landslides often develop when water rapidly accumulates in the ground, such as during periods of heavy rainfall or rapid snowmelt. Other factors contributing to a landslide include earthquakes and erosion by rivers and streams. Construction-related failures related to road cuts and trenching can also occur.

Nationally, landslides constitute a major geologic hazard, as they are widespread, occurring in every state, cause an estimated 25 fatalities annually, and result in $1-2 billion in property damage each year. Landslides are common throughout New England but are generally limited to mountainous or hilly terrain. Newburyport and the Merrimack Valley region are considered to be at very low risk for this type of natural hazard. The SHMCAP identifies a very small portion of the population (2010 Census) in Essex County vulnerable to unstable slopes that may be more prone to landslides (SHMCAP 4-68).

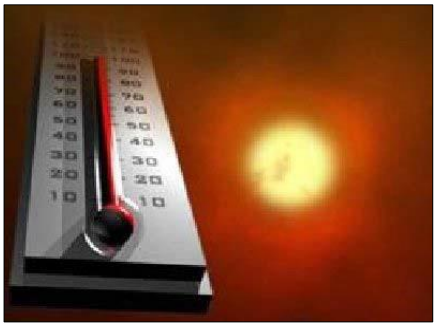
Table 4.5.1 2010 Population in Unstable Slope Areas

County	Population	Unstable Areas		Moderately Unstable		Low Instability	
		Number	% Total	Number	% Total	Number	% Total
Essex	743,159	290	0.0	7,708	1.0	13,739	1.8

Source: 2010 U.S. Census, Slope Stability Map, 2017

4.6 Heat Waves/Extreme Heat

A heat wave is three consecutive days during which the air temperature reaches or exceeds 90 degrees Fahrenheit on each day. Temperatures that hover ten degrees or more above the average high for the region and last for several weeks are defined as extreme heat. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a dome of high-pressure traps hazy, damp air near the surface.



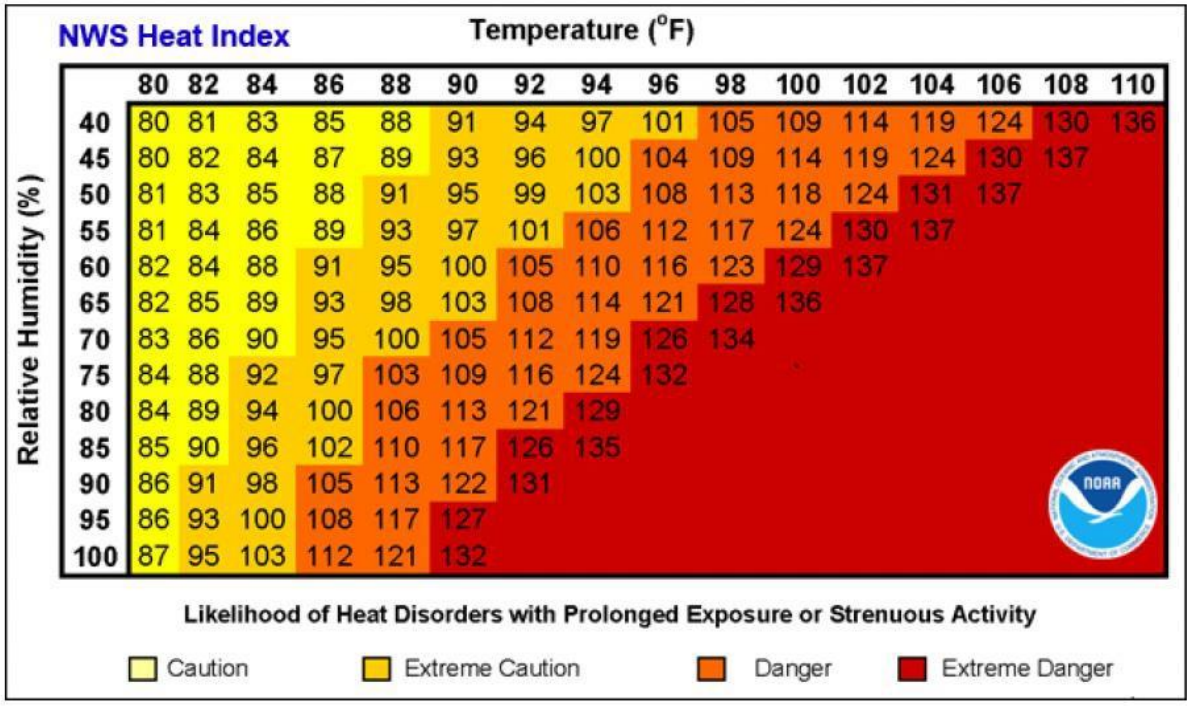
Heat kills by pushing the human body beyond its limits. Most heat disorders occur because the victim has been overexposed to heat or has over-exercised for his or her age and physical condition. The most severe heat-induced illnesses are heat exhaustion and heatstroke. If left untreated, heat exhaustion can progress to heatstroke and possible

death. Young children, the elderly, and those with existing illnesses are more likely to become victims. Other conditions that can cause heat-related illness include stagnant atmospheric conditions and poor air quality.

Extremely hot temperatures associated with heat waves are measured through the Heat index Scale, which combines relative humidity with actual air temperature to determine the risk to humans. The National Weather Station (NWS) issues an excessive heat warning when the daytime heat index is forecasted to reach 105°F for 2 or more hours, 95°F-99°F for 2 or more hours over 2 consecutive days, or 100°F-104°F for 2 or more hours over.1 day. Further, the NWS defines a heat wave as 3 or more days of 90°F temperatures. Figure 4.6.1 indicates the relationship between heat index and relative humidity.

Figure 4.6.1 NSW Heat Index

from https://www.weather.gov/safety/cold-wind-chill-chart



Heat waves cause more fatalities in the U.S. than the total of all other meteorological events combined. Recent statistics indicate that approximately 200 deaths per year are attributable to heatstroke. In 1980, high summer temperatures in central and southern States caused an estimated 1,700 excess deaths directly attributable to the heat. In July 1995, a heat wave in the mid-west caused 670 deaths, 375 in the Chicago area alone. In Essex County, July 1, 2018, an area of high pressure over the Eastern USA brought hot

and very humid air to Southern New England on July 1st. Heat Index values of 105 to 109 occurred in parts of Eastern and Northwestern Massachusetts. Heat Index values in much of the state reached 95 to 104.[39]

High cooling demands also increase the risk of utility blackouts as transmission systems are stretched to their limits. The occurrence of a heat wave in combination with a loss of air conditioning due to a blackout could have serious consequences for confined senior citizens and other at-risk populations in Newburyport. Extreme heat is considered a high-frequency event in Newburyport.

Drought

Drought is a normal recurrent feature of climate, occurring in virtually all climate zones. Drought originates from a deficiency in precipitation over an extended period, typically two winter seasons or more. Drought should be considered relative to the long-term average condition based on precipitation and evapotranspiration.

The first evidence of drought is usually seen in rainfall records. Within a short period, soil moisture can begin to decrease. The effects on stream and river flow, or water levels in lakes and reservoirs, may not be noticed for several weeks or months. Water levels in wells may not be impacted for a year or more after a drought begins.

The severity of a drought determines the scale of the event, which is categorized by the National Drought Mitigation center on a D0-D4 scale as shown in table 4.6.2.

Table 4.6.1 Drought Monitor Scale

From https://droughtmonitor.unl.edu/About/AbouttheData/DroughtClassification.aspx

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

[39] StormEventsDatabase-EventDetails|NationalCentersforEnvironmentalInformation(noaa.gov)

Massachusetts is generally considered to be a water-rich state, receiving an average of 45 inches of precipitation each year. This region can experience extended periods of dry weather, from single-season events to multi-year events, such as occurred in the mid-1960s. Historically, droughts in Massachusetts have started with dry winters, rather than dry summers.

A serious drought occurred in Massachusetts during the spring and summer of 1999.

Cumulative precipitation deficits reached 8-12 inches below normal over one year. Stream flows routinely fell below the 25th percentile of historical flows for the month. Groundwater levels were also below normal throughout the summer over nearly the entire state. During this period, the Massachusetts Emergency Management Agency developed a Massachusetts Drought Management Plan. The Plan includes groundwater data, surface water data, reservoir data, precipitation data, and streamflow conditions, as well as a report on fire danger and agricultural conditions. The Drought Management Plan provides specific action items to be implemented during a drought watch, drought warning, or drought emergency. A drought emergency is one in which state-mandated water restrictions, or the use of emergency supplies is necessary. The Plan underwent minor updates and was formally adopted in 2013.

In the subsequent 2016/2017 Drought, the most severe in Massachusetts since the 1960s, the 2013 Plan was implemented but was followed by an in-depth review of the previously developed indices by the Drought Management Task Force. This review resulted in a substantial update to the Plan. This included a change in methodology for calculating the indices and for calculating the thresholds for drought levels as well as the introduction of new and substantially updated actions for local and state government.[40] Unlike most droughts, which are slow-developing and long-lasting, the drought of 2016-2017, developed rapidly with conditions declining quickly from one month to the next which resulted in a new concept of “flash drought”.

Massachusetts has experienced multi-year drought episodes in 1879-1873, 1908-1912, 1929-1932, 1939-1944, 1961-1969, and 1980-1983. Recently, in September of 2020, all seven regions of the Commonwealth were in Level 2 – Significant Drought status. In February 2019, the Newburyport Department of Public Services (DPS) proposed to continue funding a Water Supply Resiliency Plan as part of the city’s Capital Improvement Project. This plan was originally funded for FY19, but additional monies are being sought to expand its scope. Additionally, a Capital Improvement Project has been proposed to update the Artichoke Watershed Protection Plan originally prepared by Weston and

[40] EOEEA & MEMA. 2019. Drought Management Plan.

Sampson in January of 2005. The city's surface water supply is largely unprotected as the reservoirs lie outside of Newburyport in West Newbury, and they are largely bordered by private property. The Department of Environmental Protection (DEP) has designated buffer zones around these public water supplies and abutting properties must comply with the regulations for these zones. However, concerns about future drought and additional heavy precipitation runoff have prompted the city to update its watershed protection plan.

Drought is considered a medium-frequency event in Newburyport.

4.7 Climate Change

Climate change is expected to alter the frequency and severity of weather-related natural hazards, increasing Newburyport's vulnerability to such hazards. During the period of 2015-2019, Newburyport completed four studies to assess its vulnerability to the impacts of climate change. The Climate Resiliency Plan (1/27/2020) summarizes these efforts and details climate change hazard and identifies adaptation strategies and recommendations to minimize its risk exposure. Using this Plan and Newburyport's MVP Summary of Findings, the following section will highlight the effects of climate on Newburyport's top hazards of concern, including sea level rise, severe winter and coastal storms, heavy precipitation, extreme temperatures, and drought.

Sea Level Rise

Rising temperatures have contributed to thermal expansion of the ocean and an influx in fresh water from melting glaciers, resulting in greater than 8 inches of increase in global sea level rise since 1950. In addition to thermal expansion and ice sheet melt, sea level is rising more quickly along the east coast than elsewhere due to the additional influence of land subsidence in response to land-based ice sheets melting at the poles and fluctuations in the speed of the nearby Gulf Stream.

Sea level rise (SLR) projections are all based on those developed by NOAA through the U.S. Interagency Sea Level Rise Task Force which was charged with developing Global Sea Level Rise scenarios for the 2018 National Climate Assessment.[41] Differences among sea level rise scenarios are based upon emissions assumptions and local factors. Output from the Interagency SLR report was used by the Boston Research Advisory Group (BRAG) to develop regional sea level rise scenarios for Boston.[42] Due to the influence of regional-scale processes such as land subsidence, variations in the speed of the Gulf Stream, and the gravitational effect of melting ice sheets, Regional Sea Level Rise (RSLR) in Boston will likely exceed the global average throughout the 21st century, regardless of which emissions trajectory is followed. BRAG's RSLR projections for Boston are applicable to Newburyport not only because of geographic proximity (Boston lies only some 30 miles to the south), but also because an extensive panel of experts incorporated a suite of regional and global scale processes into the Global Sea

[41] Sweet, et al. 2017. Global and Regional Sea Level Rise Scenarios for the United States. NOAA Report.
[42] The BRAG Report. 2016. Climate Change and Sea Level Rise Projections for Boston.

Level Rise data used by the 2018 National Climate Assessment to develop RSLR projections for Boston.

Subcommittee members of the Newburyport Resiliency Committee evaluated data from these two sources to conclude that (relative to year 2000) sea level rise of 6 feet was possible locally by the year 2100. Figure 4.7.1 Sea Level Rise Progression for Newburyport, depicts sea level rise projections for Newburyport during the period 2000-2010.

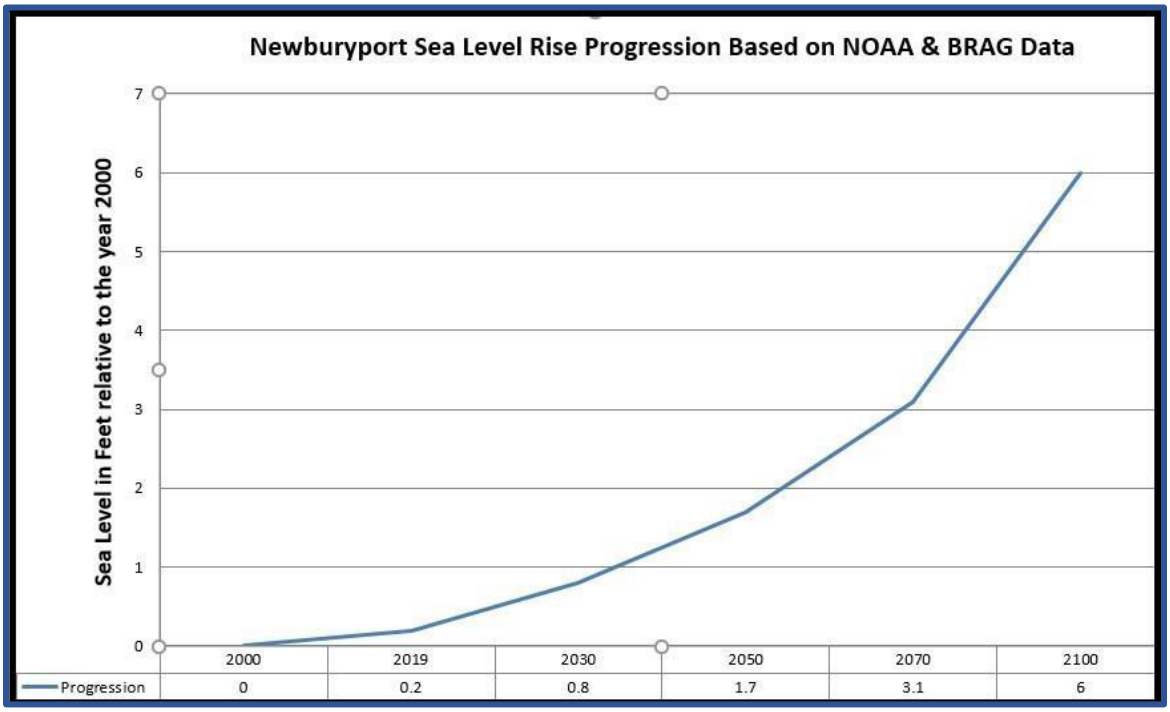


Figure 4.7.1 Sea Level Rise Progression for Newburyport

In Newburyport and the Merrimack Valley's other coastal and estuarine communities, increases in sea level rise poses severe consequences for both natural and man-made systems. Sea level rise will increase the height and negative impact of storm surges and associated coastal flooding frequencies, permanently inundate low-lying coastal areas (including commercially valuable shellfish beds), amplify shoreline erosion, and threaten barrier beach and dune systems. This risk also carries financial implications. A study was conducted in 2021, results of which are still considered draft, that assessed the fiscal and economic risk of sea level rise on Plum Island, a barrier beach system in Newburyport. Results indicate that while Plum Island currently has a positive net fiscal and economic impact to the City of Newburyport (~$3 million annually), the impact is expected to decline by 2050 without intervention.[43] Financially, flooding and erosion is expected to cause frequent damage to properties, reducing property values and decreasing fiscal benefits. Economically, these same factors will limit access and habitability on Plum Island, reducing activity and decreasing economic benefits. The report highlights the positive impact that early intervention of climate investments (such as maintaining primary access across the Plum Island Turnpike) can have to keep the island accessible for numerous island homes

[43] Horsley Whitten Group. 2021. Plum Island: Exploring the Fiscal and Economic Implications of Sea Level Rise. URL: https://www.mass.gov/doc/final-report-29/download

and their residents and sustain fiscal and economic benefits of the barrier beach system for as long as possible. Early investments in public infrastructure, such as access roads, can take advantage of the time remaining before floods become overwhelmingly impactful and the cost of maintaining infrastructure on the island is no longer financially feasible. The report does highlight that this action is not a long-term solution in the face of sea level rise, but rather that it will buy time for the community and allow for a gradual adaptation to new fiscal and economic realities. To proactively pursue climate adaptation strategies in Newburyport, additional collaboration, innovation, and funding will be needed**.**

Severe Winter Storms, Nor'easters, and Coastal Storms

According to the Fourth National Climate Assessment issued in 2018, heavy precipitation events in most parts of the United States have increased in both intensity and frequency since 1901. There are important regional differences in trends, with the largest increases occurring in our northeastern United States.

The frequency and intensity of heavy precipitation events in Newburyport and the Merrimack Valley are projected to continue to increase throughout the 21st century. The northern United States, including New England, is projected to receive more intense precipitation in the winter and spring, while parts of the southwestern United States are projected to receive less precipitation in those seasons. Winter precipitation (generally in the form of rain) is expected to increase by 12% to 30%, while the number of snow events is expected to decrease.[44] While more winter precipitation is likely to fall as rain than snow, historical data show that the frequency of extreme snowstorms in the U.S. doubled between the first half of the 20th century and the second.[45] Consequences of more extreme storm events include infrastructure failures, disruptions to local economies, and increased public safety risks with more demands on local government and first responder capacity.

Storms of heavy winds and rain along with severe winter storms are the most frequent naturally occurring hazard in Massachusetts. With climate change, the intensity and frequency of these storms will rise. Nor'easters have caused major tree damage, flooding, and infrastructure disruption to Merrimac, memorably in October 2017 and March 2018 when storms precipitated road closures and extended power outages throughout the region. The shift toward more rainy and icy winters would have serious implications in terms of possible damaging ice storms, similar to the storm that severely impacted the region in December 2008.

The accumulation of heat in our oceans and atmosphere represents a reservoir of energy for storms to capitalize upon. A warmer ocean produces more water vapor and convection, and a warmer atmosphere can hold more water and thus deliver more rain and snow.

[44] EEOEA & the Adaptation Advisory Committee. 2011. Massachusetts Climate Adaptation Report.
[45] Massachusetts SHMCAP. 2018

Changes to our jet stream favor extra-tropical (northeasters) and tropical storm development, as well as the creation of slow-moving storms such as Hurricanes Harvey in August 2017 and Florence in September 2018. Moreover, in response to the polar jet stream weakening and retreating during the summer months, the tropical storm track is expected to shift northward to include New England.

While there is debate as to the absolute change in number of tropical storms during any given year, once the meteorological variables align, development of these tropical storms is rapid and intense. This was observed with Hurricanes Humberto (2007), Mathew (2016), Harvey (2017), Maria (2017), and Florence (2018), for example.

Newburyport is in the mid-latitudes of the northern hemisphere. As presented the figure below, the frequency and intensity of mid-latitude storms (extra-tropical or northeasters for example) has been on the rise since at least 1950.

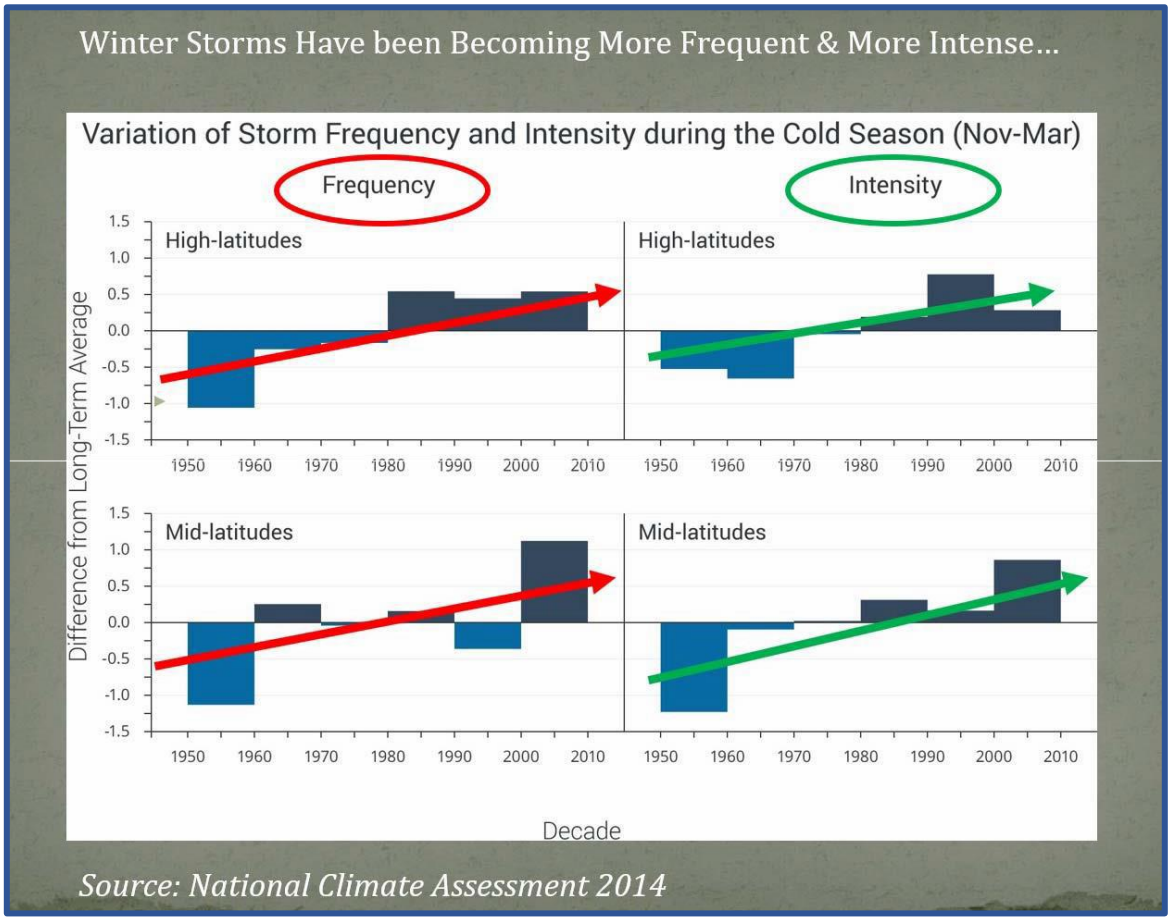


Figure 4.7.2 Frequency and Intensity of Winter Storms

Heavy Precipitation Events & Inland Flooding


Merrimack River – MVPC Photo

The risk of flooding events is heightened by the effects of climate change which portends higher precipitation levels in winter/spring seasons and more frequent, intense storms. Between 1958 and 2012, the Northeast saw more than a 70% increase in the amount of rainfall measured during heavy precipitation events, more than in any other region in the United States. The parameters of the so-called 100-year storm are changing. In the 1960s, a 24-hour event that produced 6.5 inches of rain was categorized as a 100- year storm. By 2015, the threshold for the 100-year storm (i.e., storm with 1% occurrence odds in any year) was 8.4 inches of rain over 24 hours.[46]

Further, more winter rain is expected to cause more high-flow and flooding events during the winter, earlier peak flows in the spring, and extended low-flow periods in the summer months. Such hydrologic changes would impact water resources, including an increase in flooding, pollutant-laden overflows from stormwater and wastewater systems during high periods of flow and increased stress on surface and groundwater drinking sources during periods of low flow or drought.

Newburyport is located at the mouth of the Merrimack River, where it discharges into the Atlantic Ocean. Newburyport also includes a portion of the barrier island, Plum Island, and the back marsh system that has formed just south of the mouth of the Merrimack, as well as a portion of the Little River watershed, which discharges behind Plum Island. Considering this geography together with sea level rise, climate enhanced storm activity, and more frequent heavy precipitation events, flooding is very much a short and long- term hazard for Newburyport. Flooding in Newburyport is influenced by three primary factors:

1. precipitation and the resulting runoff
2. sea level rise
3. storm surge

Independently, each variable can cause flooding. When combined, flooding can be extreme. Floods caused by high-intensity precipitation, and exacerbated by other factors, will impact the region and the state. Should these events occur with greater frequency as many climate experts predict, future damage may be severe and cumulative, straining local and state resources. Extreme weather events can disrupt power, limit access to safe and nutritious food, damage property, and impact health care services.

Extreme Temperatures

Massachusetts' climate is changing – nineteen of the 20 warmest years all have occurred since 2001, according to the NASA climate change website. Average global temperatures

[46] NOAA. Atlas 14 Precipitation Frequency Atlas of the United States & Technical Paper # 40, U.S. Dept. of Commerce. https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.

have risen steadily in the last 50 years.[47] Ambient temperature has increased by approximately 1.8°F from 1970 through the first decade of the 21st century and sea surface temperature has increased by 2.3° F. These warming trends have also been associated with more frequent days with temperatures above 90°F, reduced snowpack, and earlier snowmelt and spring peak flows.[48] The Intergovernmental Panel on Climate Change predicts that, by the end of the century, Massachusetts will experience a 5° to 10°F increase in average ambient temperature, with several more days of extreme heat during the summer months. From 1971 to 2000, the Merrimack Valley annually had an average of seven days with temperatures above 90 °F. By the end of the century, Merrimac and the region are projected to have fourteen (14) to as many as fifty- six (56) more days per year with temperatures rising above 90 degrees.

Higher temperatures will have a negative effect on air quality and human health. Increased rates of respiratory illness, worsening of allergies and asthma, increased vector-borne diseases, and degraded water quality are expected. With higher temperatures, electricity demand in Massachusetts could increase by 40% in 2030. Total heating degree days will be 15-37% lower, but cooling degree days are projected to triple by the century's end, requiring significant investment in peak load capacity and energy efficiency measures.[49]

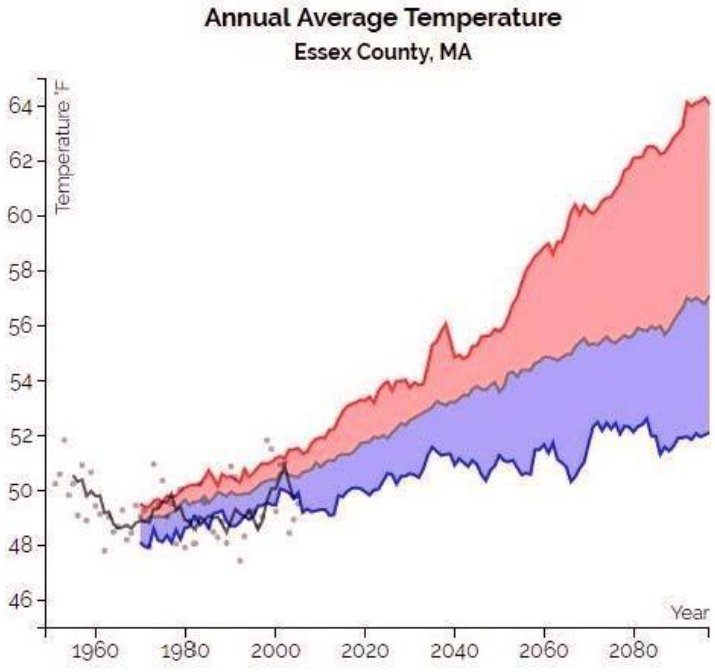


Figure 4.7.3 Northeast Climate Adaptation Science Center

Drought

[47] NASA. 2021. Global Temperatura. https://climate.nasa.gov/vital-signs/global-temperature/
[48] Frumhoff, et al. 2006. Climate Change in the U.S. Northeast: A Report of the Northeast Climate Change Impacts Assessments, Union of Concerned Scientists, Cambridge, MA.
[49] Ibid.

Higher summer temperatures, less summer precipitation, and an increase in drought frequency will impact water quality and quantity. Intermittent streams will cease flowing earlier in the season and some cold-water habitat will be replaced with warm water habitat. As discussed above, average summer and fall temperatures in the Merrimack River Basin could increase 12° F by the century's end. The annual number of extreme heat days greater than 90°F is expected to increase by as much as 32 more days in 2050.[50] Extended heat waves could significantly impact public health as well as infrastructure, economic systems including agriculture and ecosystems of forests and wetlands. As higher temperatures lead to greater evaporation and earlier snowmelt, the frequency and intensity of droughts are predicted to increase in summer and fall in the Northeast.[51]

Also, for summer and fall seasons, data projections are showing variable precipitation levels with the potential for a moderate change in the number of consecutive dry days (less than 1 mm precipitation). The 1971 to 2000 baseline is 17 on average annual consecutive dry days and that is projected to increase by 3 days by the end of this century.[52] Less winter snowpack, the result of more winter precipitation falling as rain, combined with earlier spring melt, may fail to adequately recharge groundwater aquifers.

Summary

Given the known natural hazard risks and the projected impacts of climate change, there are several reasons to integrate hazard mitigation and climate change adaptation. First, the decisions and choices made today will shape Newburyport's future and impact its ability to be resilient. Second, since significant time is required to develop adaptive strategies and implementation capacity, acting now will allow the time needed for Newburyport to work toward achieving long-term adaptation goals. Third, proactive planning is far less costly than reacting and responding to a disaster created by a hazard that has been exacerbated by the effects of climate change.

There are similar vulnerabilities across ecosystems based on projected temperature changes, increased storm intensity, precipitation changes, drought, and sea-level rise. Different organisms have different rates of response to climate change. It is expected that climate change will cause changes in species composition and forest structure. Climate change, in conjunction with other stressors, will alter forest function and its ability to provide wildlife habitat and could reduce the ability of forests to provide ecological services such as air and water cleansing. Also, the negative impacts of invasive species may increase, as native forests are increasingly stressed. In general, adaptive strategies for natural resources and habitats include land and water protection, land and water resource management, regulation changes, and increased monitoring.

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[50] University of Massachusetts Amherst, http://www.resilientma.org/resources/resource::2152 National Climate Science Center. 2018. Climate Change Projections. http://www.resilientma.org/resources/resource:2152

[51] Massachusetts Emergency Management Agency. 2018. Massachusetts State Hazard Mitigation and Climate Adaptation Plan. https://www.mass.gov/files/documents/2018/09/17/SHMCAP-September2018-Chapter4.pdf

[52] Ibid.

To help protect existing structures and minimize or prevent exposure from natural hazards exacerbated by climate change, sound land-use decisions should be promoted through review and updates to local bylaws and regulations. Hazard mitigation, evacuation, and emergency response plans should also be evaluated and updated to reflect changing climate conditions and new development patterns.

B. Risk Analysis and Vulnerability

The City of Newburyport's local planning team's risk analysis reviewed potential hazard events and based on frequency, intensity, and potential impact to the community categorized potential hazards as high, moderate-high, moderate, low-moderate, or low risk to the community. The Core Team utilized the definitions based on the Commonwealth of Massachusetts (prior) State Hazard Mitigation Plan (2013) as follows:

Frequency:

- Very low frequency: events that occur less frequently than once in 100 years (less than 1% per year).
- Low frequency: events that occur from once in 50 years to once in 100 years (1% to 2% per year).
- Medium frequency: events that occur from once in 5 years to once in 50 years (2% to 20% per year).
- High frequency: events that occur more frequently than once in 5 years (Greater than 20% per year).

Severity: extent or magnitude of a hazard, as measured against an established indicator

- 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.

Based on this analysis, Newburyport considers itself to be at ***high risk*** from flooding, coastal erosion, winter storms (blizzards/snow/ice storms), Nor'easters, and extreme temperatures; ***moderate risk*** from hurricanes, drought, earthquakes, and brush fires; ***low risk*** from tornados, dam failure, tsunamis, and landslides.

Table 4.B.1 Newburyport Natural Hazards Risk Assessment		
Hazard	**Frequency**	**Severity**
Flooding	**High**	**Minor to Extensive**
Coastal Erosion	**High**	**Minor to Serious**
Winter Storms (blizzard/snow/ice)	**High**	**Minor to Extensive**
Nor'easters	**High**	**Minor to Extensive**
Severe Thunderstorms	**High**	**Minor to Serious**
Extreme Temperatures	**High**	**Minor to Serious**
Hurricanes	**Medium**	**Serious to Catastrophic**
Drought	**Medium**	**Minor to Serious**
Earthquakes	**Medium**	**Minor to Extensive**
Forest/Brush Fires	**Medium**	**Minor to Serious**
Tornadoes	**Low**	**Minor to Extensive**
Dam Failure	**Low**	**Minor to Catastrophic**
Tsunami	**Low**	**Minor to Catastrophic**
Landslides	**Low**	**Minor**

Overview of Natural Hazards Vulnerability

Prior sections of this Multi-Hazard Mitigation Plan identify and describe the natural hazards that have occurred, or are most likely to occur, in Newburyport and the Merrimack Valley region. Since 1991, there have been 26 Presidential disaster declarations that included Essex County, as summarized in **Table 4.B.2.** Since 2014, when the region's last Hazard Mitigation Plan was prepared, there have been three additional Presidential disaster declarations in Essex County, two of which were the result of severe winter storms with flooding and the third being the ongoing COVID-19 pandemic. The vulnerability and risk assessment for Newburyport has been based on the frequency of disasters, data provided in the *2018 Massachusetts SHMCAP*, and the Hazard Assessment outlined in Section 4.A of this document.

TABLE 4.B.2 DISASTER DECLARATIONS FOR ESSEX COUNTY (1991 – 2020)

DISASTER NAME (DATE OF EVENT)	DISASTER NUMBER (TYPE OF ASSISTANCE)	DECLARED AREAS
Hurricane Bob (August 1991)	FEMA-914 (Public)	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (16 projects)
Severe Coastal Storm (October 1991)	FEMA-920-DR-MA (Public)	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	FEMA-920-DR-MA (IMA)	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	FEMA-920-DR-MA (HMGP)	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (10 projects)
Blizzard (March 1993)	FEMA-3103-EM (PA)	All 14 Massachusetts counties
Blizzard (January 1996)	FEMA-1090-EM (PA) (Public)	All 14 Massachusetts counties
Severe Storms and Flooding (October 1996)	FEMA-1142-DR-MA (PA)	Counties of Essex, Middlesex, Norfolk and Plymouth, Suffolk
	FEMA-1142-DR-MA (IFG)	Counties of Essex, Middlesex, Norfolk and Plymouth, Suffolk
	FEMA-1142-DR-MA (HMGP) and FY1997 CDBG	Counties of Essex, Middlesex, Norfolk, and Plymouth, Suffolk (36 projects)
Heavy Rain and Flooding (June 1998)	FEMA-1224-DR-MA (IFG)	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	FEMA-1124-DR-MA (HMGP) and FY1998 CDBG	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
Severe Storms and Flooding (March 2001)	FEMA-1364-DR-MA (IFG)	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	FEMA-1364-DR-MA (HMGP)	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (16 projects)
Snowstorm (March 2001)	FEMA-3165-DR-MA (IFG)	Counties of Berkshire, Essex, Franklin, Hampshire, Middlesex, Norfolk, Worcester
Terrorist Attack (September 11, 2001)	FEMA-1391(IFG)	MA residents who requested crisis counseling services following September 11th
Snowstorm (February 17-18, 2003)	FEMA-3175-EM (PA)	All 14 Massachusetts counties
Snowstorm (December 3-4, 2003)	FEMA-3191-EM (PA)	Counties of Barnstable, Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire,

TABLE 4.B.2 DISASTER DECLARATIONS FOR ESSEX COUNTY (1991 – 2020)		
DISASTER NAME (DATE OF EVENT)	**DISASTER NUMBER (TYPE OF ASSISTANCE)**	**DECLARED AREAS**
		Middlesex, Norfolk, Plymouth, Suffolk, Worcester
Flooding (April 2004)	FEMA-1512-DR-MA (IFG) FEMA-1364-DR-MA (HMGP)	Counties of Essex, Middlesex, Norfolk, Suffolk, Worcester
Severe Winter Storm (January 2005)	FEMA-1301-EM (PA)	All 14 Massachusetts counties
Hurricane Katrina (August 2005)	FEMA-3252-EM (PA)	All 14 Massachusetts counties
Severe Storms and Flooding (October 2005)	FEMA-1614-DR (IHP) FEMA-1614-DR-MA (HMGP)	Counties of Berkshire, Bristol, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, and Worcester HMGP funds available to all 14 Massachusetts counties
Severe Storms and Flooding (May 12-23, 2006)	FEMA-1642-DR-MA (PA) FEMA-1642-DR-MA (IHP) FEMA-1642-DR-MA (HMGP)	Counties of Essex, Middlesex Counties of Essex, Middlesex, Suffolk All 14 Massachusetts counties
Severe Storms and Flooding (April 2007)	FEMA-1701-DR-MA (PA) FEMA-1701-DR-MA (HMGP)	All 14 Massachusetts counties
Severe Winter Storm (December 2008)	FEMA-3296-EM-MA (HMGP)	Counties of Berkshire, Essex, Franklin, Hampden, Hampshire, Middlesex, Suffolk, and Worcester
Severe Storms and Flooding (December 2008)	FEMA-1813-DR-MA ((PA) FEMA-1813-DR-MA (HMGP)	Counties of Berkshire, Essex, Franklin, Hampden, Hampshire, Middlesex, Suffolk, and Worcester. HMGP funds available to all 14 Massachusetts counties
Severe Storm and Flooding (March-April 2010)	FEMA-1895-DR-MA (PA) FEMA-1895-DR-MA (IHP)	Counties of Essex, Suffolk, Plymouth, Middlesex, Norfolk, and Worcester
Severe Storm and Snowstorm (January 2011)	FEMA-1959-DR-MA (PA) FEMA-1959-DR-MA (HMGP)	Counties of Berkshire, Essex, Hampden, Hampshire, Middlesex, Norfolk, and Suffolk. HMGP funds available to all 14 Massachusetts counties
Severe Storm and Snowstorm (October 2011)	FEMA-4051-DR-MA (HMGP)	HMGP funds available to all 14 Massachusetts counties
Severe Winter Storm, Snowstorm, and Flooding (February 2013)	FEMA-4110-DR-MA	Counties of Barnstable, Berkshire, Bristol, Dukes, Essex, Hampden, Hampshire, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, and Worcester
Severe Winter Storm and Flooding (January 26-28, 2015)	FEMA-4214-DR-MA (HMGP)	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, and Worcester
Severe Winter Storms and Flooding (March 2-3, 2018)	FEMA-4372-DR-MA (HMGP)	Counties of Barnstable, Bristol, Essex, Nantucket, Norfolk, and Plymouth HMGP Funds available to all 14 Massachusetts counties
Massachusetts COVID-19 Pandemic (January 20, 2020, and continuing)	FEMA-4496-DR-MA	All 14 Massachusetts Counties

Key:

PA-Public Assistance Project Grants: Supplemental disaster assistance to states, local governments, certain private non-profit organizations resulting from declared major disasters or emergencies.

HMGP – Hazard Mitigation Grant Program: Project grants to prevent future loss of life or property due to disaster. A presidential declaration of a major disaster or emergency is needed to designate HMGP assistance.

TABLE 4.B.2 DISASTER DECLARATIONS FOR ESSEX COUNTY (1991 – 2020)		
DISASTER NAME (DATE OF EVENT)	**DISASTER NUMBER (TYPE OF ASSISTANCE)**	**DECLARED AREAS**
IHP – Individual Household Program: Formerly named IFG, this program provides grants and loans to individual disaster victims to address serious needs and necessary expenses, under the FEMA Disaster Housing, State IFG Program, and/or SBA Home and Business Loan Programs. **CDBG** – Community Development Block Grant: Project grants for community development-type activities to assist with long-term recovery needs related to both residential and commercial buildings.		

Potential Flood Damage as a Measure of Vulnerability

The most common and costly hazard in the Merrimack Valley is *flooding*. Estimates of the potential impact of flooding on Newburyport were calculated as one means of measuring the City's vulnerability to this most common natural hazard. Among all the hazards considered by this Plan, flooding is the one that is both most widespread and measurable. Also, methodologies to measure the geographic impact of flood events are well developed, and mitigation practices to reduce flood impacts are well understood.

Merrimack River Mother's Day 2006 (MVPC Photo)

The methodology utilized by MVPC estimated the total value of buildings within the 100-year floodplain using assessed value data from the 2020 tax assessor records in each community. The 100-year floodplain is a well-defined geographical area for which digital (GIS) map files are readily available. The Flood Insurance Rate Map (FIRM Q3) data layers were obtained from MassGIS showing the 100-year floodplains (Zones A, A1-30, and AE). MVPC superimposed these data layers on the building location data for Newburyport. The building location data was derived from a comprehensive, region-wide point file created by MVPC from recent digital aerial photography (2019). The buildings include both primary structures and secondary outbuildings (garages, barns, etc.), and are geo-referenced and linked to the assessors' property records.

From this intersection of floodplain and building location data layers, MVPC was able to determine both the total number of buildings in Newburyport's 100-year floodplain ***and*** their corresponding assessed values. This information was organized and recorded by land use category – i.e., residential (all types), commercial, industrial, and institutional – and is presented in **Table 4.B.3** (also shown in section 4.1).

The last column of the table shows the total value of buildings within the 100-year floodplain. Given the limitations in funding and methodology, no attempt was made to estimate the probable amount of damage from a 100-year storm event. Instead, the total

value of the buildings is the upper limit of potential damages. This limit would not be reached except in the case of a rare storm event exceeding the 100-year storm.

Table 4.B.3 Assessed Value of Buildings in the 100-Year Floodplain

City/Town	Number of Buildings	Assessed Building Value by Land Use Type				Total Assessed Value in 100-Yr
		Residential	Commercial	Industrial	Institutional	
Newburyport	968	$160,636,100	$19,006,500	$8,929,300	$11,792,300	$200,364,100.00

Source: MVPC digital imagery and local assessor records

The total assessed value of all buildings in Newburyport is $3,450,859,500 to provide context for the above. While the table figures provide an estimate of the building values, they do not include the estimated cost of replacing building contents. It is also important to note that loss of property does not reflect the entire cost of a region-wide flood event. There may also be added personnel (overtime) costs, rescue and evacuation costs, infrastructure repair/replacement costs, sediment and debris cleanup costs, and economic costs related to business closures.

Vulnerability to Future Natural Hazards

Based on the identification and profile of the natural hazards that have occurred throughout the region over time, a vulnerability matrix has been developed. The matrix, adapted from a prior Massachusetts Hazard Mitigation Plan developed by MEMA, was used to categorize each hazard based on frequency, severity, extent of impact, and area of occurrence. Historical data were utilized, as well as the best available scientific assessments, published literature, and input from subject area experts. The criteria were formulated based on the hazard identification profile and from the prior assessment performed for the region. There have been no significant changes in the region's vulnerability since the completion of the 2016 Regional Multi-hazard Mitigation Plan, however Coastal Erosion and Tsunamis have been included in this updated plan.

Table 4.B.4 lists the natural hazards to which the region is vulnerable, describes the expected frequency of occurrence, and the potential severity of the damage resulting from each hazard. The key at the bottom of the table describes the criteria used in the assessment.

Table 4.B.4 Newburyport's Potential Vulnerability to Natural Hazards

HAZARD (list reflects order addressed within plan)	FREQUENCY				SEVERITY				AREA OF IMPACT			AREA OF OCCURRENCE		
	VERY LOW	LOW	MODERATE	HIGH	MINOR	SERIOUS	EXTENSIVE	CATASTRO-PHIC	ISOLATED	LOCAL/ MUNICIPAL	REGIONAL	ISOLATED	LOCAL/ MUNICIPAL	REGIONAL
FLOOD				X		X				X	X		X	X
COASTAL EROSION				X		X				X			X	
DAM FAILURE		X				X				X			X	
HURRICANE			X			X					X			X
TORNADO			X				X			X	X		X	X
THUNDERSTORM				X	X						X			X
NOR'EASTER				X		X					X			X
SNOWSTORM/ BLIZZARD				X		X					X			X
ICE STORM			X			X					X			X
ICE JAM		X			X				X	X			X	
DROUGHT			X		X						X			X
WILDFIRE			X			X				X			X	
EARTHQUAKE		X				X					X			X
TSUNAMI	X						X				X			X
LANDSLIDES	X				X				X	X		X	X	
CLIMATE CHANGE				X			X				X			X

KEY:

FREQUENCY:

- Very Low: Occurs less frequently than once in 100 years
- Low: Occurs from once in 50 years to once in 100 years
- Moderate: Occurs from once in 5 years to once in 50 years
- High: Occurs more frequently than once in 5 years

SEVERITY:

- Minor: Limited and scattered property and infrastructure damage; essential services not interrupted
- Serious: Scattered major public and private property and infrastructure damage, brief service interruptions, injuries, and deaths possible
- Extensive: Widespread major public and private property and infrastructure damage with long term public service interruptions, many injuries, and fatalities probable
- Catastrophic: Destruction of private and public property and infrastructure with numerous deaths and injuries

AREAOFIMPACT:

- Isolated: Impact will only be realized in a small area within a local jurisdiction or parts of one or more local jurisdictions
- Local/Municipal: Impact will only be realized within a local jurisdiction or parts of one or more local jurisdictions
- Regional: Impact will be realized within two or more local jurisdictions on a more widespread basis

AREAOFOCCURRENCE:

- Isolated: Impact will only be realized in a small area within a local jurisdiction or parts of one or more local jurisdictions
- Local/Municipal: Impact will only be realized within a local jurisdiction or parts of one or more local jurisdictions
- Regional: Impact will be realized within two or more local jurisdictions on a more widespread basis

Hazards can be interrelated and the impacts of one hazard can create the occurrence of another. For example, an earthquake might trigger fires or landslides, and the impacts of climate change are known to increase the frequency and severity of storm events. **Table**

4.B.5 graphically outlines the potential secondary effects of each natural hazard.

Table 4.B.5 Secondary Impacts from Primary Natural Hazards

PRIMARY HAZARD (list reflects order addressed within plan)	SECONDARY IMPACTS													
	Structural damage	Utility outage	Chemical release	Commodity shortage	Emergency communications failure	Erosion	Structural fire	Disease	Flooding	Landslide	Dam failure	Tornado	Hail	Wildfire
FLOOD	X	X	X			X		X		X	X			
COASTAL EROSION	X	X				X			X					
DAM FAILURE	X	X	X			X		X	X					
HURRICANE	X	X	X	X	X	X		X	X			X		
TORNADO	X	X	X										X	
THUNDERSTORM		X					X					X	X	X
NOR'EASTER	X	X		X		X	X		X					
SNOWSTORM/ BLIZZARD	X	X		X			X							
ICE STORM	X	X	X	X	X		X							
ICE JAM	X								X		X			
DROUGHT				X										X
WILDFIRE	X		X				X							
TSUNAMI	X	X	X	X	X	X			X					
EARTHQUAKE	X	X	X	X	X		X			X	X			
LANDSLIDES	X					X								

Source: Derived from the 2013 Massachusetts State Hazard Mitigation Plan, MEMA

C. Non-Natural Hazards

The Massachusetts Emergency Management Agency (MEMA) is the state agency responsible for coordinating federal, state, local, voluntary, and private resources during emergencies and disasters in the Commonwealth of Massachusetts. MEMA provides leadership in developing plans for an effective response to all hazards, disasters, or threats; trains emergency personnel; provides information to the public; and assists individuals, families, businesses, and communities to mitigate against, prepare for, respond to, and recover from emergencies caused by both nature and humans.

Each municipality, including Newburyport, has a Comprehensive Emergency Management Plan (CEMP) in place. The CEMP combines the four phases of emergency management: mitigation, preparedness, response, and recovery. In the interest of holistically addressing mitigation and its interrelationship with emergency management overall, this Hazard Mitigation Plan provides an overview of several hazards that are non-natural and pose a threat to the state, the region, and the City of Newburyport.

This section of the Newburyport HMP is intended to highlight recent disasters in the region that have served as the backdrop to this community planning process and complement hazards at the regional and local levels. MEMA and the City maintain Comprehensive Emergency Management Plans (CEMPs), as well as other documents that outline the specific response and mitigation associated with non-natural disasters, crime, and other emergencies.

4.8 Public Health Emergencies and Hazards

Newburyport and the world are currently battling COVID-19, a new strain of coronavirus (similar to the H1N1 virus of 2009) that was first discovered in Wuhan, China in December of 2019 and first recognized in the United States in January of 2020. This virus, unlike any other since the 1918 flu pandemic, is overwhelming public health systems. Infectious disease emergencies are extremely rare - while previously the Massachusetts Department of Public Health (MDPH) received 10,000 case reports annually, as of December 4, 2021, there have been over 689,446 cases of COVID-19 with 8,461 deaths as reported to the CDC (December 4, 2020 – December 4, 2021).[53] While generally, health care providers, local boards of health, and the MDPH handle most infectious diseases routinely, this outbreak has presented unprecedented challenges including a state "stay at home" order in the spring of 2020.

Worldwide travel and the re-emergence of infectious diseases in more virulent forms have increased the rate of public health infectious disease emergencies and may continue to do so into the future. The Massachusetts Department of Public Health is the primary agency responsible for the study, planning, isolation/quarantine and actions, surveillance, and reporting for all public health emergencies. Any cluster or outbreak of any unusual disease or illness must be reported to the local board of health (or to MDPH if the local board of health is not available). Vaccines are now available to battle the current coronavirus outbreak, and nearly 5 million people in the state have been fully vaccinated with many more having at least one dose. However, the country, state, and individual communities still have much work to do to bring this virus under control as new variants of the virus are detected and continue to spread.

Furthermore, in addressing the public health challenges of this virus, the country, state, and communities have had to develop measures to address both social and economic fallout of the virus including high levels of unemployment and business closures as well as challenges to conducting the day-to-day operations of all state and municipal functions. All levels of society have been affected including education and social services. While many lessons have already been learned, new procedures to deal with future public health emergencies will certainly be needed once the current crisis has passed.

Government at all levels must also be prepared for bioterrorism, or the intentional use of (or threat to use) biological agents including but not limited to anthrax, botulism, brucellosis, cholera, pandemic influenza, plague, ricin, smallpox, tularemia, and viral hemorrhagic fevers.

[53] CDC. 2022. COVID Data Tracker. https://covid.cdc.gov/covid-data-tracker/#datatracker-home

4.9 Infrastructure Failure

Infrastructure failure includes technological emergencies that result in an interruption or loss of a utility service, power source, life support system, information system, or equipment needed to keep the businesses in operation. Examples include:

- Utilities such as electric power, gas, water, hydraulics, compressed air, municipal;
- Sewer systems, water treatment plants, and wastewater treatment plants;
- Security and alarm systems, elevators, lighting, life support systems, heating, ventilation, and air conditioning systems, and electrical distribution systems;
- Manufacturing equipment and pollution control equipment;
- Communication systems, both data and voice computer networks; and
- Transportation systems including air, highway, railroad, and waterways.

In late afternoon September 13, 2018, the towns of North Andover, Lawrence, and Andover, experienced a series of simultaneous natural gas explosions and fires caused by the release of high-pressure gas into a low-pressure distribution system. The event occurred as Columbia Gas-contracted construction crews were working on a major infrastructure upgrade to replace 7,506 feet of low-pressure gas mains including cast iron segments originally installed in the early 1900s.

The explosions and fires ignited by natural gas-fueled appliances damaged 131 structures in the three communities. Leonel Rondon, an 18-year-old Lawrence resident, was killed when a house chimney collapsed onto his parked car in a building explosion on Chickering Road in Lawrence. At least 21 people received treatment at area hospitals for injuries.[54] The three municipal Fire Departments responded to initial calls and required mutual aid from departments throughout eastern Massachusetts, New Hampshire, and Maine.

Residents with homes served by natural gas were told to shut off gas service and to evacuate. As a safety precaution, National Grid shut down electrical power to the affected communities. Local roads and the regional highways became gridlocked as State Police closed Interstate 495 ramps into Andover, North Andover, and Lawrence and as resident evacuations took place through the afternoon commute peak and into the evening.

On September 14, 2018, in response to the severity of the situation, Governor Baker made a State of Emergency declaration. In Andover, officials on short notice set up an overnight shelter at the Senior Center. Schools were closed, and Merrimack College temporarily evacuated its buildings. Before power could be restored and people allowed to return to their homes and businesses in the days and weeks following, teams of

[54] NTSB. 2018. NTSB Preliminary Report PLD13MR003 10/11/2018 and Safety Recommendation Report PSR-18/02.

inspectors would enter each building to conduct safety checks and ensure no concentrations of trapped gas were present.

By the weekend of Sept. 15-16, officials were transitioning from Emergency Response to the Recovery phase of operations, a massive effort that extended into December. Gas service restoration to the 8,600 impacted area Columbia Gas customers involved the replacement of 48 miles of gas lines in the three communities. With utility construction crews dispatched to the Merrimack Valley from throughout the country, the gas line replacement work was completed weeks ahead of the Nov. 19 scheduled completion date, but full-service restoration to individual properties was a time-consuming process complicated by requirements of code compliance in replacing appliances in older structures and the demand for more plumbers and contractors. Temporary housing for displaced residents in area hotels/motels and RV trailers was established. To house construction workers, Columbia Gas leased a cruise ship docked in Boston Harbor. Many businesses, including restaurants dependent on gas service, were forced to shut down for weeks and months as they awaited service restoration. Some reopened after converting their energy source to propane or electric. Restoration of heat and working appliances was finally completed for most properties by the end of December, but in some cases, work continued into 2019.

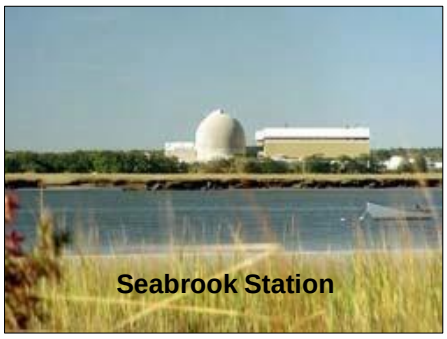
The Columbia Gas explosions emergency reinforced the importance of community engagement and planning on how to effectively respond and mobilize resources to protect and inform the public and shelter and provide for those displaced, especially the most vulnerable. Subsequent recovery efforts to bolster businesses that lost revenue during the disaster provided important lessons which, tragically were experienced again, and more severely, as a result of the COVID-19 pandemic.

Technological emergencies have the potential to occur in every municipality. Communities with limited infrastructure are more vulnerable to experiencing an incident because of the lack of redundant systems. Newburyport should continue mitigation measures already in process including installing emergency generators, burying cable, installing back-up systems, and undertaking regular system maintenance including vegetation management (tree and brush pruning) to help reduce risks.

4.10 Nuclear Event

As described in the joint Nuclear Regulatory Commission and Federal Emergency Management Agency publication “Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants” (NUREG-0654 REMA-REP-1 Rev.1), a radioactive plume released from a nuclear power plant consists of gaseous and/or particulate material. Three dominant modes of exposure have been identified from atmospheric releases: external whole-body irradiation, inhalation, and ingestion. External whole-body irradiation is direct exposure from gamma radiation in or from the plume. Internal exposure occurs primarily through the inhalation of airborne radioactive material in the plume or from breathing re-suspended material

deposited from a passing plume. Ingestion is exposure to radiation following the consumption of contaminated food or water by mouth.


Seabrook Station

Exposure to radiation is measured on a dose equivalent basis. Dose equivalent (or effective dose) combines the amount of radiation absorbed and the medical effects of that type of radiation. For beta and gamma radiation, the dose equivalent is the same as the absorbed dose. By contrast, the dose equivalent is larger than the absorbed dose for alpha and neutron radiation, because these types of radiation are more damaging to the human body. Units for dose equivalent are the roentgen equivalent man (rem) and sievert (Sv), and biological dose equivalents are commonly measured in 1/1000th of a rem (known as a millirem or mrem).[55] Linear no-threshold (LNT) dose-response relationship is used to describe the relationship between radiation dose and the occurrence of cancer. This dose-response model suggests that any increase in dose, no matter how small, results in an incremental increase in risk. The U.S. Nuclear Regulatory Commission (NRC) accepts the LNT hypothesis as a conservative model for estimating radiation risk. The greater the dose received the greater the potential for biological effect. However, it is impossible to predict precisely how an individual will respond to a particular dose, as effects will vary from one person to another.

The average annual whole body dose equivalent from all natural sources of radiation in the U.S. is estimated to be approximately 360 millirems. This dose results from exposure to cosmic and terrestrial radiation sources and radiation from internally deposited radio nuclides. Additionally, the use of x-rays and radioactive materials in medicine and dentistry add to overall population doses.

Radiation effects can be classified in two categories, early or delayed, but these categories are not mutually exclusive. Early acute effects of radiation exposure generally occur within 90 days from exposure, and may include fatalities, symptoms of acute radiation syndrome, or clinically detectable changes in blood and chromosomes. However, emergency protective actions can be taken to prevent or minimize these effects. Delayed effects of radiation exposure (i.e., biological effects that can only be observed on a statistical basis) could occur in some members of a population that has been exposed to radioactive materials. The effects may include fatalities or disabilities of anatomical or genetic origin.

The Nuclear Regulatory Commission (NRC) and the Environment Protection Agency (EPA) utilize the emergency planning zone (EPZ) concept. EPZs are designated areas for which plans are prepared to ensure that prompt and effective actions can be taken to protect the public in the event of an incident at a nuclear power plant. There are three EPZs that

[55] USNRC.2020. Measuring Radiation. http://www.nrc.gov/about-nrc/radiation/health-effects/measuring-radiation.html

impact Massachusetts. The Pilgrim Nuclear Power Station located in Plymouth and formerly operated by Entergy Nuclear Northeast was the only nuclear power generation facility located within the borders of Massachusetts. It ceased power generation in May of 2019. Two other licensed facilities are located just over the border from Massachusetts. These include the Vermont Yankee Nuclear Power Station (Vermont Yankee) located in Vernon, Vermont (shut down in December of 2014); and Seabrook Nuclear Power Station, located in Seabrook, New Hampshire, and operated by NextEra Energy.

The Seabrook Nuclear Power Station is located on 900 acres north of the Merrimack Valley region in the seacoast region of southern New Hampshire. The plant is sited in one of the lowest hazard zones for earthquakes, according to the U.S. Geological Survey, and is designed to withstand an earthquake significantly higher than any recorded in New England history. The plant lies two miles inland and is elevated 20 feet above sea level to protect against coastal flooding and extreme storm surges. With its 1244 megawatts of electrical output, Seabrook station is the largest individual electrical generating unit on the England power grid. The area approximately 10 miles around Seabrook Station is called the emergency planning zone and includes Amesbury, Merrimac, Newburyport, Salisbury, and West Newbury. Emergency Management officials in Newburyport coordinate regularly and are trained for the unlikely event of emergencies involving the Seabrook Station.

4.11 Chemical/Hazardous Materials Spills and Releases

Chemical agents are poisonous vapors, aerosols, liquids, and solids that have a toxic effect on people, animals, or plants. Such agents can be released by accident, by bombs, or sprayed from aircraft, boats, and vehicles. They can have an immediate effect (a few seconds to a few minutes) or a delayed effect (2 to 48 hours). While potentially lethal, chemical agents are generally difficult to deliver in lethal concentrations. Outdoors, the agents tend to dissipate rapidly. Chemical agents also are difficult to produce. A chemical attack could come without warning. Symptoms of a chemical release include difficulty breathing, eye irritation, loss of coordination, nausea, or a burning sensation in the nose, throat, and lungs. The presence of many dead insects or birds may also indicate a chemical agent release.

Chemicals are found throughout our communities. They are used to purify drinking water, increase crop production, and simplify household chores. But chemicals can be hazardous to humans or the environment if used or released improperly. Hazards can occur during production, storage, transportation, use, or disposal processes. Hazardous materials come in the form of explosives, flammable and combustible substances, poisons, and radioactive materials. These substances are most often released as a result of transportation accidents or because of chemical accidents at industrial plants. A hazardous material spill or

release can pose a risk to life, health or property. An incident can result in the evacuation of a few people, a section of a facility or an entire neighborhood.

There are several Federal laws that regulate hazardous materials, including: the Superfund Amendments and Reauthorization Act of 1986 (SARA), the Resource Conservation and Recovery Act of 1976 (RCRA), the Hazardous Materials Transportation Act (HMTA), the Occupational Safety and Health Act (OSHA), the Toxic Substances Control Act (TSCA) and the Clean Air Act. Title III of SARA regulates the packaging, labeling, handling, storage, and transportation of hazardous materials. The law requires facilities to furnish information about the quantities and health effects of materials used at the facility, and to promptly notify local and State officials whenever a significant release of hazardous materials occurs.

Communities with a large industrial base may be more likely to experience a hazardous materials release due to the number of facilities that use such materials in their manufacturing processes. Communities with major highways or rail corridors may also be at a greater risk due to the number of trucks or trains transporting hazardous materials.

The locations of facilities that store hazardous chemicals and other materials are known to all emergency operation personnel and community leadership. These facilities have disaster response plans and shut-down measures in place. These plans have been shared with Newburyport Emergency Management.

SECTION 5. EXISTING PROTECTIONS MATRIX

This section of the Plan presents an **Existing Protections Matrix** for Newburyport. The matrix is an inventory of zoning, land use, and environmental regulations already in place as well as ongoing or completed maintenance projects, and other programs and activities that are related to natural hazard mitigation. Compiling such an inventory allows gaps and deficiencies to be identified.

As part of the plan updating process, the 2016 information was reviewed and revised through a series of email communications and conversations with Core Team members and other Newburyport municipal staff. Also, local zoning bylaws, subdivision rules and regulations, EPA MS4 stormwater management materials, Newburyport Master Plan, Open Space and Recreation Plan, and the City website were consulted.

The updated existing protections inventory reflects current conditions and incorporates new measures that have been put in place over the last five years, as shown in the following matrix.

Examples of Local Hazard Mitigation Measures

Local Wetlands Protection Regulation

Regular Street Sweeping

Tree-pruning to Protect Utility Lines

Table 5.1 City of Newburyport Existing Protections Matrix: Plans and Policies

Type of Existing Protection	Description	Area Covered	Effectiveness/ Improvements Needed	Hazard
City participation in the National Flood Insurance Program (NFIP)	Regulates development activity and provides flood insurance for structures located in flood-prone areas	FEMA flood zones	Effective	Flooding
Local Citywide Wetlands Protection Ordinance and Regulations	Regulates activity throughout the city to conserve fragile natural resources	Inland and coastal wetland resource areas and buffer zones	Effective – Regulations updated in 2019 to include Land subject to coastal storm flowage and sea level rise	Flooding
Stormwater Management Ordinance and Regulations	Regulates development activity encompassing one acre or more within Urban Areas, consistent with NPDES permit program	Urbanized Areas of Newburyport as identified by U.S. Census	Effective - ordinance updated 2010; Rules & Regs Adopted April 2014	Flooding
Subdivision Rules & Regulations	Determines way land parcels may be divided, and the specific stormwater/flooding mitigation that is required	City-wide	Update needed	Flooding
Zoning Ordinance	Regulates uses /development in various geographic zones within the city promoting the health, safety, and welfare of city residents	City-wide	Current version August 23, 2021 – improvements to regulate in future flood-prone areas and water supply demand needed	All Hazards
Master Plan	Provides guidance for community growth and preservation of open space and natural resources	City-wide	Effective - Updated 2017- incorporates sustainability and energy including resiliency goals	All Hazards
Local Open Space & Recreation Plan	Proactive plan to preserve and protect City's open space and natural resources,	City-wide	Effective – Updated 2020 incorporates actions to mitigate effects of climate change including sea-level rise	Flooding, Drought

Open Space Residential Overlay District	Promotes cluster style residential development where appropriate to limit impervious surfaces and preserve open space and natural resources	Overlay District Area	Moderately effective – In need of update	Flooding , drought
Climate Resiliency Plan	A plan created to increase community resilience related to impacts of climate change including sea level rise, storm surge, flooding and extreme weather events throughout the City.	City-wide	Effective	Capital infrastructure, administration and regulation, communication and education, and carbon footprint reductions.
State Building Code	City enforces the Mass State building code	City-Wide	Effective	Multi-hazard
Strategic Land Us Plan	A strategy for conservation and development aimed at an area in the southern portion of Newburyport identified in the 2001 Master Plan.	Encompasses the City's industrial park, several residential neighborhoods, and an open space corridor extending into the Town of Newbury.	Moderately Effective- developed in 2004	Multi-Hazard
Comprehensive Emergency Management Plan	Details procedures to be followed in the event of an emergency of any type	City-wide	Effective - Maintain CEMP and upgrade as needed to ensure its applicability	Multi-hazard
Waterfront Strategic Plan	A plan developed from a public process that brought together a broad spectrum of stakeholders to serve as a blueprint for reestablishing a strong link between the city and its harbor.	Coastal	2003- Could be updated specifically to include climate change.	Flooding

Great Marsh Coastal Adaptation Plan	A holistic and integrated plan to reduce the growing vulnerability of communities within the Great Marsh to coastal hazards.	City-Wide	Effective – One time study produced in association with Hurricane Sandy Resiliency Grant	Multi-Hazard
Housing Production Plan	Proactive strategy for planning and developing affordable housing	City-wide	Effective- last updated 2018. Update planned for 2023.	Multi-Hazard

Together, these planning documents provide tangible goals for hazard mitigation, as well as guidance on how to manage and mitigate impacts resulting from natural hazards for the city of Newburyport. However, constant modifications and revisions are needed to ensure these planning documents remain accurate and relevant. Based on current condition, the following updates should be made:

- Update Subdivision Rules and Regulations Review, evaluate and revise Zoning and Building Regulations to improve resilience, water conservation, energy efficiency and discourage development in high hazard flood zones.
- Update Open Space Residential Overlay District.
- Develop and adopt a design flood elevation for all new and proposed renovations of properties in high hazard flood zones.
- Implement a storm water/impervious surfaces management program in compliance with EPA MS4 permit.

Table 5.2 City of Newburyport Existing Protections Matrix: Programs				
Type of Existing Protection	**Description**	**Area Covered**	**Effectiveness/ Improvements Needed**	**Hazard**
Estuary Management Plan—8 Towns & the Great Marsh	Promotes prudent use and conservation of natural resources in Newburyport portion of Great Marsh/Parker River ACEC	Area of Critical Environmental Concern (ACEC)	Moderately effective - More personnel and funding resources needed to carry out and monitor action Recommendations.	Flooding
GIS Infrastructure Inventory and arial drone imagery	Data-driven asset management system inc. MIMAP parcel/ infrastructure info	City-wide	Effective – continue adding data layers and updates	Multi-hazard
CodeRed Community Notification System & E-alerts	Code Red in place and active social media use for communications as well as Seabrook Plant sirens at EMS Communications Center	City-wide	Effective	Multi-hazard
Regional Shelter	Collaboration with Salisbury, Newbury, and Salvation Army in regional shelter services in emergency responses	City-wide	Effective – update MOU	Multi-hazard
Portable Generators	Newburyport EMS has 3 portable generators available. Additional available through DPS	Emergency Management	Effective	Flooding/ Drought
Municipal Maintenance	Storm drain systems, street sweeping, catch basin cleaning, roadway treatment, tree trimming, and snow disposal	City-Wide	Effective	Multi-Hazard
Public Education	Educating homeowners, businesses, schools, and residents on climate resiliency and adaptation issues especially related to flooding and other coastal hazards.	City-Wide	Effective, but could be expanded	Multi-Hazard

While Newburyport provides extensive public outreach and education, a few key areas could be further expanded by developing a public outreach and education program to educate residents and municipal boards/committees about this resiliency plan. Specifically: promote personal preparedness, community resiliency, natural hazard mitigation, public health impacts, and managing carbon footprints. Further, school-based programs could be created to educate future generations about climate change impacts and resiliency.

SECTION 6. 2016 MITIGATION MEASURES UPDATE

6.1 Implementation Progress from 2016 Plan

Newburyport's 2016 Mitigation Actions were part of the Merrimack Valley Regional Multi-Hazard Mitigation Plan. These actions were reviewed by various members of the planning team with responsibility for implementation and their status was updated to "complete," "in progress" or "not completed." Resiliency Committee members then reviewed the "in progress" and "not completed" actions to determine which should be carried forward into this Hazard Mitigation Plan Update.

The City of Newburyport has been proactive in its implementation of the prior mitigation actions. Completed actions include:

- Completion of Newburyport Climate Resiliency Plan
- Extensive Public Education and Awareness campaign following completion of Climate Resiliency plan including work by Storm Surge and Merrimack River Beach Alliance (MRBA) – presentations and speaker series
- Studied and implemented measures to protect Wastewater Treatment Plant including shoreline protection system and design for sidewall flood protection
- Department of Public Services fully accommodated in new administration building

In addition, the City of Newburyport has taken steps to implement findings from the 2016 Merrimack Valley Region Multi-Hazard Mitigation Plan Update via the following policy, programmatic areas, and plans:

- The City of Newburyport utilized the 2016 Hazard Mitigation Plan when it developed its 2020 Climate Resiliency Plan.
- In addition, Newburyport incorporated elements from the 2016 Hazard Mitigation Plan when it underwent its risk assessment process through the Commonwealth's MVP Program.
- Finally, the city has taken steps to implement findings from its 2016 Hazard Mitigation Plan into a Transportation Improvement Project (TIP) for the reconstruction of Route 1 and the Complete Streets Program

Table 6.1.1 City of Newburyport 2016 Mitigation Action Plan

Projects in Development

Category of Action	Description of Action	Hazards Addressed	Implementation Responsibility	Timeframe/ Priority in 2016	2022 Status (completed, in progress, not completed)	Include in 2022 Update?	Project Status
Emergency Response	Review & update mutual aid agreements with adjacent towns (Essex County) and state (MA and Southern NH) for accuracy and sufficiency	All Hazards	Fire, Police, DPS	Short Term/High	In Progress	No	In Process of department legal review
Planning/Prevention	Update Stormwater Management Program for compliance with pending EPA MS4 permit and identify sustainable funding source for implementation	Flooding	DPS/Engineering	Short-Term/High	Completed - will comply with future updates as necessary	Yes – continued enforcement of ordinance	Action pending issuance of EPA final MS4 permit in 2016 Next steps include Illicit Discharge Detection, catchment area prioritization, and Facilities O & M plans preparation.
Public Education & Awareness	Organize Education programs and outreach on Natural Hazard preparedness and mitigation	All Hazards	Emergency Mgmt	Short-Term/High	Completed - (Coastal Resiliency Plan 2017, Storm Surge Presentations (2020), Plum Island MVP Grant public process, ongoing MRBA – reference websites Resiliency and Storm Surge, MRBA – PlumIslandSeaLevelRise.com	No	Next steps include Sandy Coastal Resiliency planning forums; EPA, Flood Resilience workshops held Fall 2015; nonprofit sponsored community presentations with Storm Surge, MRBA
Prevention	Update zoning and building codes; consider enacting stricter standards for new development in terms of storm drainage, wind bracing, and floodplain development	All Hazards	Planning/Zoning Boards	Medium-Term/Moderate	In progress - Site Plan Review update under consideration – other zoning updates in process Waterfront Overlay District	Yes	Zoning review process underway inc. consideration of waterfront overlay district;
Planning/Prevention	Prepare Municipal Resiliency Plan for Sea Level Rise/Storm Surge Climate Change (plan for 2 to 5 feet sea level rise by 2100) Next steps include hiring resiliency coordinator, adding municipal or regional circuit rider staff capacity to lead effort	Flooding	Conservation/Engineering	Short-Term/High	Completed – October 2020	No	Two initiatives: Sandy Resiliency Project planning to be complete 2017; EPA workshops/charette Fall 2015;

Table 6.1.1. City of Newburyport 2016 Mitigation Action Plan							
Projects in Development							
Category of Action	**Description of Action**	**Hazards Addressed**	**Implementation Responsibility**	**Timeframe/ Priority in 2016**	**2022 Status (completed, in progress, not completed)**	**Include in 2022 Update?**	**Project Status**
Planning/Natural Resource Protection	Maintain natural resource buffer zones and increase capacity for enforcement of environmental regulations	Flooding/ Storms	Planning/Conservation DPS	Short-Term/High	Completed – wetlands protection ordinance in place	Yes – continued enforcement of ordinance	Local Wetlands Protection Ordinance in place and effective. Gap to be addressed is need for additional inspection staffing for enforcement.
Structural	Replace culvert Parker/Scotland at city line with additional capacity as recommended in the Malcolm Hoyt Road Drainage Improvement Flood Study Dec. 2011	Flooding	DPS/Engineering	Medium Term/High	Completed – road has been raised	No	Highest priority storm drain mitigation project
Structural	Improve drainage capacity at Business & Technology Park watershed area: Improvements to include short –term swale restoration and culvert upgrades. Areas targeted are Graf Road/Quail Run Hollow/Malcolm Hoyt Dr.; Hale St by pump station.	Flooding/ Storms	DPS	Long-Term/High	In Progress - short-term items complete – City owned portion restored, Maintenance Agreements being updated, maintenance is ongoing	Yes	2nd Highest priority storm drain capacity project
Structural	Investigate feasibility of elevating Plum Island Turnpike key access roadway vulnerable to flooding/sea level rise	Flooding/ Storms	DPS	Long-Term/Medium	Completed - cooperated with Town of Newbury on Plum Island accessibility	No	Funding for engineering study needs to be identified.
Structural	Improve drainage capacity with storage/culvert improvements at Cashman Park area.	Flooding/ Storms	DPS	Long-Term/Medium	Not completed – project not completed due to changes in funding priority. However, this task will be carried over into the updated action plan addressing Cashman Park	Yes	Included in 2011 Stormwater Management Plan DPS

Table 6.1.1. City of Newburyport 2016 Mitigation Action Plan							
Projects in Development							
Category of Action	**Description of Action**	**Hazards Addressed**	**Implementation Responsibility**	**Timeframe/ Priority in 2016**	**2022 Status (completed, in progress, not completed)**	**Include in 2022 Update?**	**Project Status**
Structural	Evaluate and correct drainage capacity structural problem @ Market Square.	Flooding	DPS/Engineering	Short-Term/High	In progress	Yes	Immediate term solution is construction of swale to be constructed by DPS in-house staff
Structural	Roadway improvements including drainage capacity upgrade at Merrimac St in area of Mersen USA & pump station.	Flooding	DPS/Engineering	Long-Term/Low	In progress	Yes	Localized flooding problem at this location which is key access gateway route to downtown. Project included in drainage master plan.
Structural	Feasibility study of options to protect Wastewater Treatment Plan, now vulnerable to sea level rise. Options to include elevation, relocation, or barrier protection.	Flooding	DPS/Engineering	Medium Term/High	Completed – shoreline protection system installed in spring 2021. Sidewall flood protection system under design in 2021	No	Issue raised in climate change resilience planning forums
Structural	Floodproof sewage pump stations	Flooding	DPS	Long-Term/High	In progress – this effort is currently being investigated for feasibility	Yes	9 potentially vulnerable pump stations with sea level rise
Prevention	Thin overcrowded forests	Brushfires	Fire/DPS	Long-Term/Medium	Not completed – project not completed due to limited funding, capacity and changes in priorities	No	Focus on vulnerable wooded areas March's Hill, Maudslay.
Emergency Services Protection	Renovate DPS facility to accommodate City employees during severe weather events & disasters. Facility has had long-term use of "temporary" office trailers.	*All Hazards*	DPS	Medium Term/Medium	Completed – Department of Public Works fully housed in new administration building (2016)	No	Next step is to develop revised bid package or seek additional funding after project bids came in over budget 2015.

Table 6.1.1. City of Newburyport 2016 Mitigation Action Plan							
Projects in Development							
Category of Action	**Description of Action**	**Hazards Addressed**	**Implementation Responsibility**	**Timeframe/ Priority in 2016**	**2022 Status (completed, in progress, not completed)**	**Include in 2022 Update?**	**Project Status**
Emergency Response	Purchase firefighting equipment—Two fire trucks in procurement 2015	All Hazards	Fire	Short Term/High	Completed	No	Action is emergency services response need.
Structural	Provide redundant water and sewer systems. Target focus of Plum Island which is vulnerable to breach.	All Hazards	DPS	Long-Term/Medium	In progress - replaced fire hydrants and water piping valves (stainless steel – corrosion eliminated). New actions identified – high groundwater and SLR study	Yes	Next step of feasibility study/design
Structural/Emergency Services Protection	Extend T1 hardware communications between municipal communication systems to DPS facility and PITA Hall	All Hazards	DPS (Emergency Mgt/Newburyport & Newbury)	Short-Term/High	Completed for Department of Public Works and City Hall	No	ID budget funding
Public education and awareness	Organize education programs and outreach on natural hazard preparedness and mitigation	All Hazards	Director DPS/recycling, energy & sustainability/planning director/conservation administrator	Short-term/High	Completed	Yes	new related education and outreach goals to be addressed in new plan

Success/LessonLearnedStories:

Newburyport has had many successes since the adoption of the 2016 Hazard Mitigation Plan. Primary among this is the $32 million capital investment made to the City's Wastewater Treatment Facility to address the aging infrastructure at the plan. The City was also able to begin to address the facility's flood vulnerability by raising it slightly higher than the current 100-year flood elevation.

The City also completed the construction of a rail trail bike path alongside the WWTP that was built 1.5' above the current FEMA 100-year flood elevation to address future sea-level rise (SLR) for purposes of protecting the WWTP. However, that project is along the riverfront, which is parallel to the water. The City needs to complete the plant's flood protection perimeter berm by constructing flood walls/berms on the western and eastern sides so that they connect to the bike path berm to the north and the higher elevation of Water Street to the south. These sidewalls will complete the flood protection of the WWTP for about 1.5 feet of sea level rise. The City is currently in the design phase of the sidewalls and hope to construct as soon as funding is available, but no sooner than 2022 when the design is anticipated to be complete.

Newburyport considered building the bike path higher to protect against higher SLR amounts, but it was of no value. There are too many areas downtown where the land elevation is slightly below the bike path elevation so the ocean will simply enter those areas, enter the sewer manholes and underground sewer mains, reducing the WWTP's capacity to treat. Not until those downtown areas are raised will a higher WWTP flood protection perimeter berm be beneficial.

SECTION 7. MITIGATION STRATEGY

This section of the Plan provides the overall strategy for Newburyport to follow in becoming less vulnerable to natural hazards. It serves as the framework for the specific mitigation actions which follow in Section 8 of the plan. It is based on MVPC's discussions with, and the consensus of, the Core Team and Stakeholders, along with the findings and conclusions of the hazard identification and analysis, MVP Workshops, HMP Planning Workshop, and the existing protection measures matrix. The purpose of the mitigation strategy is to provide Newburyport with the goals that will serve as the guiding principles for future hazard mitigation policy development, planning, and project design and implementation for the City.

44 CFR Requirement

44CFR Part 201.6c(3)(i):

The mitigation strategy shall include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

7.1 Mitigation Goals

The plan's mitigation goals represent broad statements thatare achieved through the implementation of more specific, action-oriented initiatives by Newburyport, acting independently and in concert with surrounding communities. In updating the Hazard Mitigation Plan, the goals of the earlier 2016 plan were reviewed and affirmed. Also, a new goal was added to address the impacts of climate change.

The overarching goal of the current plan is as follows:

Goal #1 **Reduce the loss of or damage to life, property, infrastructure, and natural, cultural, and economic resources from natural disasters.**

Complementing Goal #1 are the following additional goals:

Goal #2 **Improve the breadth and quality of the best available data for conducting hazard risk assessments and developing appropriate mitigation actions.**

Goal #3 **Increase Newburyport's financial capability to implement hazard mitigation measures through maximizing available outside grant funding opportunities as well as locally available fiscal resources.**

Goal #4 **Integrate hazard mitigation planning into existing local policies, plans, regulations, and practices to reduce or eliminate the impacts of known natural hazards.**

Goal #5 **Ensure that future development will meet all federal, state, and local standards to reduce and prevent the impacts of natural hazards on public and private property throughout Newburyport.**

Goal #6 **Increase the general public's awareness of natural hazard risks in Newburyport and the region, while also educating residents and businesses on the mitigation measures available to minimize those risks.**

Goal #7 **Develop and implement adaptation strategies and integrate climate resiliency and mitigation into community plans and policies to protect the public, critical infrastructure, property, and natural resources from the impacts of climate change.**

7.2 Mitigation Measures

The second step in formulating Newburyport's mitigation strategy involved identifying the range of mitigation activities that can help to achieve the mitigation goals cited above. The mitigation actions that follow in Section 8 are organized into the following six categories, as recommended in the FEMA *Local Multi-Hazard Mitigation Planning Handbook* (2013).

1. Prevention

Preventive activities are intended to keep hazard problems from getting worse and are typically administered through government programs or regulatory actions that influence the way land is developed and structures are built. They are particularly effective in reducing a region's or community's future vulnerability, especially in areas where development has not occurred, or capital improvements have not been substantial. Examples of preventive activities include:

- Planning and zoning
- Building codes
- Open space preservation
- Floodplain regulation
- Stormwater management
- Drainage system maintenance
- Capital improvements programming
- Shoreline / riverine / wetland setbacks

2. Property Protection

Property protection measures involve the modification of existing buildings and structures to help them better withstand the forces of a hazard, or the removal of the structures from hazardous locations. Examples include:

- Acquisition
- Relocation
- Building elevation
- Critical facilities protection

- Retrofitting (e.g., windproofing, floodproofing, seismic design techniques)
- Shutters, safe rooms, shatter-resistant glass
- Insurance

3. Natural Resource Protection

Natural resource protection activities reduce the impact of natural hazards by preserving or restoring natural areas and their protective functions. Such areas include floodplains, wetlands, steep slopes, and sand dunes. Parks, recreation, and conservation agencies and organizations often implement these protective measures. Examples include:

- Floodplain protection
- Wetland preservation and restoration
- Beach and dune preservation/restoration
- Forest and vegetation management (e.g., brush removal, fuel breaks, fire-resistant landscaping)
- Slope stabilization and erosion and sediment control
- Watershed protection measures and best management practices

4. Structural Projects

Structural mitigation projects are intended to lessen the impact of a hazard by modifying the natural progression of the hazard event via construction. Examples include:

- Dams / levees / dikes / floodwalls / seawalls
- Diversions / detention and retention basins
- Channel modification
- Beach nourishment
- Storm sewers

5. Emergency Services Protection

Emergency services protection measures are aimed at protecting emergency services before, during, and immediately after a hazard occurrence. Examples include:

- Emergency warning systems
- Emergency response training and exercises
- Evacuation planning and management
- Protection of critical facilities and public facilities
- Health and safety maintenance

6. Public Education and Awareness

Public education and awareness activities are used to advise residents, elected officials, business owners, potential property buyers, and visitors about natural

hazards, hazard areas, and mitigation techniques they can use to protect themselves and their property. Examples of measures to educate and inform the public include:

- Community outreach projects
- School education programs
- Speaker series/demonstration events
- Hazard area maps
- Real estate disclosure of hazards
- Library exhibits and materials
- Regional and community websites, with links to MEMA and FEMA websites.

7.3 Mitigation Measures for Regional and Inter-Community Issues

Newburyport included neighboring communities as well as state and regional agencies in its stakeholder workshops to help identify hazard mitigation issues that can best be addressed through regional or inter-community efforts. Shoreline erosion, flooding, water supply, and land protection are three areas where Newburyport could rely on regional entities or partners to assist in the mitigation of natural hazards and resiliency to climate change. Understanding the capabilities of regional partners and their priorities is important to improving the outcomes of various hazard mitigation efforts proposed in Section 8. Regional partners include those who own land or infrastructure within Newburyport, neighboring communities who provide support in emergencies and/or maintain interconnected infrastructure, and partners who assist in mitigation efforts such as watershed associations. These partners include:

- The Towns of Salisbury and Newbury - planning participants recognized that coastal flooding and beach and dune erosion caused by storm surge and sea level rise affect all communities at the mouth of the Merrimack River. Through government leadership and the Merrimack River Beach Alliance (MRBA), the three communities are working to address natural hazards that affect coastal infrastructure and resources.
- The Town of West Newbury – much of Newburyport's drinking water supply comes from the upper and lower Artichoke Reservoirs which are in both Newburyport and West Newbury. Most of the land abutting the reservoirs is in West Newbury and much of it is privately owned. Protecting the watershed will require community collaboration.
- Essex County Greenbelt Association – Assist with open space acquisition and protection at a regional level. ECGA also has a priority parcel analysis that can assist communities with protecting land that promotes resiliency.
- Other communities with connected infrastructure and/or mutual aid agreements – Newburyport, together with the municipalities of Amesbury, Boxford, Georgetown, Ipswich, Merrimac, Newbury, Rowley, Salisbury, and West Newbury comprise the Northern Essex Regional Emergency Planning Committee (REPC). Emergency Planning Committees are responsible for protecting their communities from incidents involving hazardous materials. This includes developing emergency response plans and educating the community

about chemical facilities and the actions that could be taken if there is a chemical accident.

- Merrimack River Watershed Council (MRWC) – Newburyport participates in Merrimack River related meetings and is working with MVPC and MRWC to operate a Bacteria Early Alert System to inform recreational users of the Merrimack River when CSO related events may affect water quality.

7.4 Mitigation Measures and New Development and Infrastructure

As discussed in Chapter 3, the age composition of Newburyport's population is anticipated to change with a 118 percent increase in the number of older adults (age 65 year and over). Hazard Mitigation Planning must consider this growth and change in population characteristics in light of any additional hazards that may occur. New development can increase existing vulnerabilities to infrastructure including water, sewer, and stormwater. New development and redevelopment must adhere to the Massachusetts State Building Code but must also consider local zoning, wetlands, sea level rise, and stormwater bylaws and regulations. To reduce flooding, increase groundwater recharge, and promote cooling, Newburyport must prioritize Low Impact Development and green infrastructure as the community expands.

To determine appropriate mitigation measures for the Newburyport, MVPC and the Core Team reviewed the MVP workshop findings, the Climate Resiliency Plan, the outcomes of the HMP planning workshop, as well as the mitigation protections currently in place. Gaps in the existing protections were particularly instructive in identifying areas for potential mitigation enhancement. Section 8 of the Hazard Mitigation Plan details the specific mitigation actions, both local and regional, for the City of Newburyport.

SECTION 8. MITIGATION ACTION PLAN

This section of the Hazard Mitigation Plan presents Newburyport-specific as well as regional mitigation actions that, if effectively implemented, will serve to minimize risks and reduce losses from natural hazards in the Merrimack Valley region. This section contains the **Local Mitigation Action Plan** to be carried out by the City of Newburyport. **Regional Mitigation Actions,** to be carried out collaboratively with neighboring municipalities, and partnering agencies and organizations on an inter-municipal level, have also been incorporated.

44 CFR Requirement

44 CFR Part 201.6c (3)(iii): ***The mitigation strategy shall include an action plan describing how the actions … will be prioritized, implemented, and administered by the local jurisdiction.***

Coordination. The proposed actions will be coordinated with other regional and community priorities, as well as with mitigation goals of state and federal agencies. Such coordination will improve access to technical assistance; provide broader support for implementation; and reduce duplication of effort. These actions have been further categorized into immediate, short-term projects and ongoing or longer-term measures.

Consistency with Goals & Objectives. In developing the mitigation action plans, MVPC and the Newburyport Resiliency Committee were directed by the major goals articulated in the preceding section of the Plan (Section 7), as well as the following mitigation *objectives*:

- Increase coordination between the Federal, State, regional, and local levels of government;
- Discourage future development in hazard-prone areas, such as floodplains;
- Protect and preserve irreplaceable cultural and historic resources located in hazard-prone areas;
- Ensure that critical infrastructure is protected from natural hazards;
- Develop programs and measures that protect residences and other structures from natural hazards;
- Protect electric power delivery infrastructure from natural hazards;
- Protect drinking water supplies from contamination or disruption from a natural hazard;
- Increase awareness and support for natural hazard mitigation among municipalities, private organizations, businesses, and area residents through outreach and education;
- Implement a broad range of mitigation measures that protect the region's vulnerable populations and infrastructure;

- Protect critical public facilities and services from damage due to natural hazards;
- Develop a mitigation strategy that considers the needs of area businesses and protects the economic vitality of the region;
- Update and maintain the Plan as resources permit;
- Provide information concerning hazard mitigation funding opportunities, and assist the city in the identification and development of specific mitigation projects; and
- Increase Newburyport's capacity for responding to a natural hazard event by promoting the adequate provision of emergency services.

Prioritization of Mitigation Actions. As part of the planning deliberations, MVPC and consulted with Resiliency Committee members to prioritize the proposed mitigation actions and projects. The priorities were developed through a consensus-building process that consisted of meetings and conversations with board and commission members, municipal staff, and town leadership. The following factors were considered in establishing the timeframe/priority for each action:

- The cost of the measure vs. the mitigation benefits;
- The availability of funding;
- The lead time required for design and implementation;
- Political feasibility and acceptability;
- The need for institutional and interagency agreements;
- Consistency with local and regional plans and priorities; and
- Whether the measure has been through a public process, needs City Council approval, or action by a permitting authority.

The cost of each mitigation action was not available for most listed action items. Projects categorized as "immediate" or "short term" are those which can go forward with little or no cost, or for which a funding source has been identified, and these projects are of high priority. Projects identified as "long-term" are either more costly or funding is not readily available, or the project may not be ready for implementation due to permitting issues or the need for design, or the project requires a long lead time, or new governmental processes will need to be established.

Those projects described as "annual" represent recurring actions that local, state, and regional bodies need to attend to regularly and factor into everyday decision-making. Examples include code enforcement (state building code, local zoning code, local wetlands regulation, etc.) and activities such as Planning Board promotion/approval of open space residential design projects that preserve 50% of a subdivision area as permanent green space. These projects are of the highest priority in that they mitigate natural hazards at a minimal cost and can be readily implemented.

It is envisioned that “immediate” projects will be implemented within 1 year, “short-term” projects within 2-3 years, and “long-term” projects in 4 or more years. Further, “ongoing” refers to an effort without a hard start or end date, such as the continued implementation of an ordinance or plan. The timeframe assigned to each project is indicative of local and regional project priorities.

This Mitigation Action Plan is an update of the 2016 Action Plan and incorporates the outcomes of Newburyport’s Resiliency Plan. It is organized in a series of matrices. The matrices note whether each particular action was included in the 2016 Plan or if it is a new action resulting from this or other planning processes. The implementation status of prior projects is noted in Chapter 6. Several of the actions contained in the 2016 Plan remain in the updated plan and continue to be a priority for Newburyport. The actions put forth in this current Hazard Mitigation Plan will be implemented as resources are made available.

Of these actions identified 10 were carried over from the previous plan. These actions include updating zoning and building codes to enact stricter standards for new developments in terms of storm drainage, wind bracing, and floodplain development, improving the drainage capacity at the Business Park, improving drainage capacity at Cashman Park, evaluating and correcting drainage capacity at Market Square, roadway improvements including drainage capacity updates at Merrimack Street, flood proofing sewage pump stations, enforcing the wetlands protection and stormwater ordinances and providing redundant water and sewer systems with a focus on Plum Island. These actions are either in progress and required continued efforts beyond the five-year timeline identified in the previous plan, or have been identified as infeasible due to capacity, funding, or public interest hinderances, and replaced with a new task which aim to accomplish the same goal. Alternatively, some tasks require ongoing support, such as the enforcement of the wetlands protection ordinance, and have thus been carried over to the new plan’s action items.

Benefits. Mitigation benefits for each action are evaluated using the following criteria:

- High – action will result in a significant risk reduction for people and/or property from a hazard event
- Medium – action will result in a moderate risk reduction for people and/or property from a hazard event
- Low – action will result in low-risk reduction for people and/or property from a hazard event

Cost. Costs are estimated using the following criteria:

- High – costs greater than $100,000
- Medium – Costs between $10,000 to $100,000
- Low – Costs under $10,000 and/or staff time

Funding Sources. Funding sources listed are potential options that are not guaranteed.

Projects may not necessarily qualify for all sources listed and/or may not be awarded funding. Once an action is advanced, the party responsible for implementation should further explore funding opportunities, including those identified.

The **Newburyport Mitigation Action Plan** is presented in **Tables 8.1.1**

Table 8.1.1 Newburyport Mitigation Action								
Category of Action	**Description of Action**	**Hazard Addressed**	**Implementation Responsibility**	**Timeframe/ Priority**	**Cost**	**Benefit**	**Resources/ Funding**	**In Prior Plan?**
Structural Project	Raise the Lower Artichoke Reservoir dam and spillway to protect it against the FEMA 100-year flood event and a breach by the Merrimack River. Incorporate some resiliency against future SLR	Flooding/Sea Level Rise/Storms	Director of DPS	Immediate/High	High	High	MVP competitive grant, American rescue plan (ARPA) funds	New
Structural Project	Design, permit and construct an emergency flood protection system at the Lower Artichoke Reservoir Dam to protect the water supply from a breach until the permanent dam and spillway has been raised	Flooding/Sea Level Rise/Storms	Director DPS/City Engineer	Immediate/High	Medium	High	Water/Sewer Enterprise Funds	New
Structural Project	Continue to implement temporary/deployable and permanent structural measures and strategic plans to protect vulnerable Critical Assets of the Wastewater Treatment facility	Flooding/Sea Level Rise/Storms	Director of DPS	Ongoing/Medium	Low	High	Water/Sewer Budget	New
Structural Project	Design, permit and build flood prevention berms around the WWTP to protect it against the FEMA 100-yr flood event. Incorporate some resiliency against future SL	Flooding/Sea Level Rise/Storms	Director DPS/City Engineer	Immediate/High	High	High	Municipal Vulnerability Preparedness (MVP) competitive grant program & BRIC grant program	New
Structural Project	Roadway improvements including drainage capacity upgrade at Merrimack St in area of Mersen USA & pump station	Flooding	DPS/Engineering	Long-term/Low	Medium	Medium	BRIC grant program, Hazard mitigation assistance program (HMGP), and/or MVP action grant	Prior
Structural Project	Provide redundant water and sewer systems. Target focus of Plum Island which is vulnerable to breach	All Hazards	DPS	Long-term/Medium	High	High	BRIC grant program, Hazard mitigation assistance program (HMGP), and/or MVP action grant	Prior
Structural Project	Continue to coordinate with National Grid in protection of vulnerable Critical Assets of the National Grid Substation	All Hazards	Recycling, Energy & Sustainability/City Engineer	Long-Term/Medium	Low	High	National Grid	New
Structural Project	Provide emergency backup drinking water supply and/or an emergency interconnect to neighboring community's water supply in the event our supplies are compromised by drought, algae blooms, or another hazard	All Hazards	Director of DPS	Short-Term/High	High	High	State Revolving Funds (SRS), Building Resilient Infrastructure and Communities (BRIC) grant program	New
Structural Project	Design, permit, and construct a raw water line from Indian Hill Reservoir to the Upper and Lower Artichoke Reservoirs and pumping station in order to draw water from any one of the three reservoirs in the event the others are compromised by algae blooms, drought, or otherwise	Flooding/ Storms/ Drought	Director DPS/City Engineer	Short-Term/High	High	High	State Revolving Funds (SRS), BRIC grant program, Hazard mitigation grant program	New

Table 8.1.1 Newburyport Mitigation Action Plan								
Category of Action	**Description of Action**	**Hazard Addressed**	**Implementation Responsibility**	**Timeframe/ Priority**	**Cost**	**Benefit**	**Resources/ Funding**	**In Prior Plan?**
Structural Project -	Raise and/or relocate 4 sanitary sewer pumping stations to protect against FEMA 100-year flood and provide some resiliency for future SLR: Savory St, Whites Court, Hilton Wharf, and Water Street Pump Stations.	Flooding/ Storms/Sea Level Rise	Director of DPS	Long-Term/High	High	Medium	BRIC grant program, Hazard mitigation grant program, and/or MVP competitive grant program	Prior
Property Protection -	For areas surrounding and including Cashman Park and Waterfront Park, perform a design, cost and feasibility analysis that considers elevating or protecting these properties to preserve their amenities vs. adapting and transitioning the assets to alternate uses in a rising sea and surge scenario	Flooding/ Storms/Sea Level Rise	Planning Director/City Engineer	Long Term/Low	High	Low	Community preservation act funds, MVP competitive grant	Prior
Structural Project	Strengthen the electrical grid by reducing conflicts with trees, burying utilities, and evaluating micro grids	All Hazards	Recycling, Energy & Sustainability	Short & Long-Term/Medium	High	Medium	MVP action grant and/or National Grid	New
Prevention	Develop and Implement maintenance of flood protection measures throughout the City in line with the Resiliency Plan	Flooding/Sea Level Rise/Storms	City Engineer/Conservation Administrator/Director DPS/City Engineer/Planning Director	Ongoing	n/a	Medium	General/ DPS Operating budget	New
Structural Project	Raise Water Street @ Union Street to keep road above floodwater level	Flooding/Sea Level Rise/Storms	Director of DPS	Long-Term/High	High	Medium	BRIC grant program, Hazard mitigation assistance program (HMGP), and/or MVP action grant	New
Structural Project	Raise the low-lying sections of the Plum Island Turnpike to keep road above floodwater level (in cooperation with Newbury)	Flooding/Sea Level Rise/Storms	Director of DPS/Newbury	Short & Long-Term/Medium	High	High	BRIC grant program, Hazard mitigation assistance program (HMGP), and/or MVP action grant	New
Structural Project -	Evaluate and correct drainage capacity deficiencies at Market Square and State Street	Flooding/Sea Level Rise/Storms	Director DPS/City Engineer	Short & Long-Term/Medium	High	Medium	BRIC grant program, Hazard mitigation assistance program (HMGP), and/or MVP action grant	Prior
Prevention -	Review, evaluate, and revise zoning and building regulations to improve resilience, water conservation, and discourage development in FEMA high hazard flood zones	All Hazards	Recycling, Energy & Sustainability/Planning Director	Immediate and Short- Term/High	Medium/ Low	Medium	City Staff	Prior
Prevention -	Continue to enforce existing Wetlands Protection act regulations governing barrier beaches and other natural resource buffer zones. Define enforcement responsibilities	Sea Level Rise/Flooding/ Storms	Conservation Administrator/Planning Director	Ongoing	Low	Medium	City Staff	Prior

Table 8.1.1 Newburyport Mitigation Action Plan								
Category of Action	**Description of Action**	**Hazard Addressed**	**Implementation Responsibility**	**Timeframe/ Priority**	**Cost**	**Benefit**	**Resources/ Funding**	**In Prior Plan?**
Prevention/ Public Education & Awareness	Develop a task force with Newbury to create and implement a long-term, sustainable, science-based plan to address the challenges facing Plum Island. Continue to work with the Merrimack River Beach Alliance, the Plum Island Foundation, the U.S. Army Corp of Engineers, Legislators and State Agencies in this process	Flooding/Sea Level Rise/Storms	Chief of Staff/Conservation Administrator	Short & Long-Term/Medium	Low	Medium	City Staff	New
Prevention	Evaluate alternative access options to Plum Island	Flooding/Sea Level Rise/Storms	Planning Director/City Engineer	Long-term/Medium	Medium	Medium	City Staff/ Consultants	New
Public Education & Awareness	Develop and implement an automated water quality monitoring and warning system to protect residents from the health risks associated with combined sewer overflows (CSO's). Continue to work with legislators to support efforts to upgrade upriver wastewater treatment facilities to reduce CSO's	Flooding	Chief of Staff	Immediate/High	Medium	High	American Rescue Plan funds	New
Prevention -	Continue enforcing EPA's MS4 permit requirements by implement a storm water/impervious surfaces management program and updating city's stormwater conveyance system as necessary	Flooding	City Engineer	Ongoing	Medium	Medium	City Staff	Prior
Public Education & Awareness	Develop recommendations and educational materials for personal resilience to assist and educate residents and other stakeholders to make their households resilient to flooding, storms and other hazards	All Hazards	Recycling, Energy &Sustainability/Planning Director/Conservation Administrator	Immediate & Short-Term/High	Low	Medium	City Staff/Local emergency management team/Merrimack River Beach Alliance	Prior
Prevention	Promote the need for the MBTA to improve the resiliency of the rail service in light of SLR and other climate hazards	Flooding/Sea Level Rise/Storms	Chief of Staff	Immediate/Medium	Low	Low	City Staff	New
Emergency Services/ Protection	Identify and procures an emergency shelter on Plum Island for public safety crews and necessary equipment	Flooding/Sea Level Rise/Storms	Fire Chief	Short-term	High	High	Hazard Mitigation Grant funds and or City Bond funds	New
Structural Project	Implement design and construction of upgrades to the Central Waterfront Park and repair of the central waterfront bulkhead to address projected sea level rise.	Flooding/Sea Level Rise/Storms	Planning Department	Short-term	High	Medium	Hazard Mitigation Grant funds and PARC Grant	New

Table 8.1.1 Newburyport Mitigation Action Plan								
Category of Action	**Description of Action**	**Hazard Addressed**	**Implementation Responsibility**	**Timeframe/ Priority**	**Cost**	**Benefit**	**Resources/ Funding**	**In Prior Plan?**
Property Protection -	Evaluate mitigation measures to address flooding in the low-lying areas of the Business Park.	Flooding	Department of Public Services	Short-term	High	Low	City Staff- City Engineer and DPS	Prior
Emergency Services/ Protection	Inventory and assess all generators at public and emergency facilities and implement a program to establish full functionality of all	All Hazards	Department of Public Services/Fire Chief	Short-term	Medium	High	BRIC grant program, HMPG program, City funds from the Fire Dept., Dept. of Public Services, and School Dept.	New
Emergency Services Protection	Purchase a High-Water Vehicle	Flooding/Sea Level Rise/Storms	Fire Chief	Immediate	High	High	City funds including Fire Dept. and Capital Improvement Plan Funds	New
Public Education & Awareness	To reduce risks from all natural hazards, establish and maintain City web page describing “tips and techniques” for hazard preparedness, mitigation, and response, with links to the MEMA and FEMA hazard mitigation websites.	All Hazards	Mayor/Fire Chief	Immediate/High	Low	High	Hosted across multiple City websites including Public Safety (Police and Fire), Dept. of Public Services, Public Health, Planning and Development.	New

SECTION 9. PLAN ADOPTION AND MAINTENANCE

This section discusses how the Newburyport Multi-Hazard Mitigation Plan will be adopted by the city, and how the Plan will be evaluated and maintained over time. It also discusses how the public will continue to be involved in the hazard mitigation and vulnerability planning process.

9.1 Plan Adoption

Under 44 CFR Part 201, hazard mitigation plans must be sent to the State Hazard Mitigation Officer (SHMO) for initial review and coordination. The State then forwards the plan to FEMA for formal review and approval. The final draft is submitted to the State and FEMA before seeking formal adoption of the plan by the Town. FEMA reviewers document their evaluation of the Plan using the Local Mitigation Plan Review Tool. A copy of the Tool is included in Appendix E.

Mitigation plans are approved by FEMA when they receive a "satisfactory" for all requirements outlined under 44 CFR Section 201.6. Once a final plan is submitted, the FEMA Regional Office generally completes the review within 45 days. If the plan is not approved, the FEMA Regional Office will provide comments on the areas that need improvement. FEMA will the complete review of the re-submittal within 45 days of receipt.

Once FEMA determines that the Plan is "approvable pending adoption", the local adoption process is initiated. The plan is adopted by an affirmative vote of Newburyport's City Council. A resolution signed by the City Council chair serves as documentation of the plan's local adoption. Upon submittal of the signed resolution to FEMA, FEMA issues a letter notifying the community of FEMA's approval of the plan.

9.2 Plan Maintenance

44 CFR Requirement

44 CFR Part 201.6c(4)(i): *The plan shall include a plan maintenance procedure that includes a section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.*

The measure of success of the Newburyport's HMP will be the number of identified mitigation actions implemented, either wholly or in part. For Newburyport to become more disaster and climate-resilient and better equipped to respond to natural hazards, there must be a coordinated effort between elected officials, appointed bodies, municipal staff, regional and state agencies, other stakeholder groups, and the general public. Thus, monitoring, evaluating, and updating the hazard mitigation plan are critically important steps to maintaining a viable, effective plan.

Accordingly, the Core Team of Resiliency Committee members will meet annually to review the plan. At this meeting, the Core Team will review the hazard mitigation measures that have been implemented as of that date and determine if these measures have had

an impact on mitigating the overall hazard risk(s). In the case of *structural* projects, in particular, this review will include site visits to locations where the measures have been implemented. Mitigation measures that have not been implemented will be reviewed to determine if they will still minimize natural hazards or if they are no longer a viable option. Additionally, the Core Team will determine any new options to include in an update of the plan.

Evaluation of the hazard mitigation plan in its entirety will be undertaken on a 5-year basis according to the Disaster Mitigation Act of 2000 or following any significant natural hazard disaster. Any new problems that arise will be reviewed by the Core Team and incorporated into the updated HMP. The updated plan will incorporate new or modified mitigation actions as determined from the review. This allows for updates to be made as the community grows and changes. The City's Conservation Agent, Planning Director, and City Engineer will oversee the Core Team's involvement in the review and updating process.

The public will be given opportunities to participate in the plan evaluation and updating process and to provide comments for consideration by the Core Team. Residents, businesses, and other potential stakeholders will be notified when plan updating deliberations are scheduled, and when significant hazard mitigation issues are brought before the City Council. Notification will be done through posting of meeting agendas in City Hall and on the Newburyport website.

Newburyport will be responsible for updating the Hazard Mitigation portion of the plan every five years following FEMA approval. Ideally, the plan update will begin in the fourth year following approval of the plan to remain eligible for FEMA mitigation grants, specifically the new Building Resilient Infrastructure Communities or BRIC grants. Newburyport may wish to pursue an update of its individual plan or rejoin the Merrimack Valley Regional Multi-Hazard Mitigation Plan which is anticipated to be updated in the coming year. Funding sources for the update may include the FEMA Hazard Mitigation Grant Program as well as the BRIC grants. Both grants provide 75% of the funding with a 25% local cost share.

SECTION 10. PLAN IMPLEMENTATION

10.1 Pivotal Role of Local Government

The City of Newburyport will play a pivotal role in hazard mitigation, especially in the area of floodplain management. The municipal Inspectional Services Department, Conservation Commission, and Board of Health have legal responsibilities to implement local floodplain bylaws, the National Flood Insurance Program (NFIP), construction standards incorporated into the Massachusetts State Building Code, floodplain guidelines incorporated into the Wetlands Protection Act, and Title 5 of the State Environmental Code (on-site wastewater disposal**).** **Table 10.1.1** on the following page provides a summary of local boards and departments and their corresponding roles in implementing the action items contained in the Hazard Mitigation Action Plans.

To the extent possible, these community-specific mitigation actions have been directed toward a particular department or board to assign responsibility and accountability and to increase the likelihood of implementation.

10.2 Broad Integration of Plan

The incorporation of the recommendations of this Plan into other local and regional planning documents and procedures is not only strongly encouraged but indeed is a requirement of the federal and state hazard mitigation planning process. Such planning documents typically include but are not limited to comprehensive or master plans, capital improvement plans, stormwater management plans, open space and recreation plans, building codes, zoning bylaws, subdivision regulations, and local wetland bylaws. Elected officials should be directly involved in the implementation of the Plan, as they can provide direction by establishing timeframes, assigning implementation responsibilities, and providing budget and financial oversight for implementation funding.

44 CFR Part 201.6c(4)(ii):

The plan maintenance process shall include a process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.

Excellent resources for Newburyport to consult for this work include *Hazard Mitigation: Integrating Best Practices into Planning*[56] and *Integrating Hazard Mitigation Into Local Planning: Case Studies and Tools for Community Officials.*[57]

[56] American Planning Association. 2010. Hazard Mitigation: Integrating Best Practices into Planning. https://s3-us-gov-west-1.amazonaws.com/dam-production/uploads/20130726-1739-25045-4373/pas_560_final.pdf

[57] FEMA. 2013. Integrating Hazard Mitigation Into Local Planning: Case Studies and Tools for Community Officials. https://www.fema.gov/emergency-managers/national-preparedness/frameworks/community-recovery-management-toolkit/recovery-planning/integrating-mitigation/case-studies-tools-community.

Table 10.1.1 Role of Local Boards and Departments in Plan Implementation		
Department, Board, or Committee	**Function**	**Effect on Loss Reduction**
Building Department/Inspector	The building inspector enforces the Massachusetts State Building Code that incorporates NFIP construction standards. The building inspector also enforces locally adopted zoning bylaws. The state building code also contains sections on wind, snow, structural loads, and seismic retrofitting. The building inspector is also responsible for assuring compliance with the local floodplain bylaw.	Insures that NFIP standards and other mitigation standards are uniformly applied across the community.
Department of Public Services (DPS)	The Department of Public Services is primarily responsible for municipal drainage and stormwater management issues, taking the lead in ensuring compliance with EPA MS4 Stormwater Permit requirements.	Ongoing maintenance and upgrading of local stormwater systems is crucial to reducing and managing flood risks.
Conservation Commission	The Conservation Commission is responsible for implementing the Wetlands Protection Act (MGL Chapter 131, Section 40, 310 CMR 10.00) including the Rivers Protection Act of 1996 (MGL Chapter 258, 310 CMR 10.58) and the Stormwater Standards. Newburyport also reviews projects under the Newburyport Wetlands Protection Ordinance and associated regulations. The Conservation Commission reviews, approves, or denies applications for projects in the 100-year floodplain, in the floodplain of a small water body not covered by a FEMA study, within 100 feet of any wetland or 200 feet of any river or stream. In Newburyport, the Conservation Administrator assists the building inspector in enforcing floodplain requirements.	These regulations contain performance standards that address flood control and storm damage prevention. The regulations also address stormwater management. Newburyport's Wetland Regulations incorporate 40" of sea level rise (by 2070) into the design and construction of structures and other activities proposed in Land Subject to Coastal Storm Flowage
Water and Sewer Commission	The Water and Sewer Commission assists with oversight for water and sewer business operations, budgets, policies and procedures.	These policies relate to the city's water supply and the operation of the city's sewage system.
Open Space Committee	The Open Space Committee was established in April 2001 as an advisory committee to the Mayor pursuant to the Master Plan. The OSC is charged generally with advocating for the protection of open space and specifically to monitor opportunities for open space acquisition.	Promoting open space acquisition and protection through identifying and evaluating parcels, gaining knowledge around relevant tools and resources, building relationships, seeking funding, and providing education and outreach
Resiliency Committee	The Resiliency Committee was formed in 2015 to take on the responsibility of evaluating Newburyport's risks from Climate Change and Sea Level Rise, and to develop and help execute a plan to mitigate those risks. After significant research and consultation with community stakeholders, Newburyport's Resiliency Plan was published in October 2020.	The Resiliency Committee now advocates for and oversees implementation of the Resiliency Plan's recommendations.
Planning Board	The Planning Board has authority under MGL Chapter 41 and implements local subdivision regulations. The Planning Board ensures that new development incorporates state and federal stormwater management "best management practices".	The Planning Board is responsible for ensuring new and re- development complies with all local regulations.

Board of Health	The Board of Health implements the State Environmental Code, Title 5, and 310 CMR 15: Minimum Requirements for the Subsurface Disposal of Sanitary Sewage. Newburyport has adopted local board of health requirements that are stricter than the state requirements.	Title 5 protects public health and mitigates losses due to adverse effects of improper sewage treatment in high hazard areas. The Board is also involved in issues related to water quality and infectious diseases following a disaster.
Mayor and City Council	In Newburyport, an elected mayor and eleven-member City Council is responsible for overseeing all aspects of City Government.	The City Council must adopt the Hazard Mitigation Plan. Also, their approval is necessary for hazard mitigation grant applications and potential projects.
Emergency Management Department	Newburyport has an emergency management director (fire chief) who is responsible for local emergency response and recovery, as well as mutual aid.	Emergency managers play a primary role in the development of the Comprehensive Emergency Management Plan (CEMP), as well as other plans required by MEMA and FEMA.

While Newburyport has a dynamic team to address vulnerabilities in its city, some of the challenges it faces, such as sea-level rise and coastal erosion, are not isolated to municipal boundaries. Therefore, future steps would involve developing and implementing a task force with the surrounding towns to implement a long-term, sustainable, science-based plan to address the multifaceted challenges facing adjoining jurisdictions such as Plum Island. This process would also involve continue to work with the Merrimack River Beach Alliance, the Plum Island Foundation, the U.S. Army Corp of Engineers, Legislators and State Agencies in this process. Additionally, a Municipal Resiliency Plan for Sea Level Rise/Storm Surge Climate Change should be developed. As part of this initiative, a resiliency coordinator should be hired to add municipal or regional circuit rider staff capacity to lead the effort.

SECTION 11. RESOURCES

Financial Resources

Appropriate action is needed to ensure that financial resources are available to implement hazard mitigation projects. The city of Newburyport is able to leverage funds through the following sources to address hazard mitigation activities:

- Capital improvements funding
- Authority to levy taxes for specific purposes
- Fees from water and sewer services
- Bonding capacity

In instances where additional funding is needed, Newburyport is well-situated to seek outside support through state and federal grants. In the past, Newburyport has received financial support from the Municipal Vulnerability Preparedness Program, American Rescue Plan Act, Building Resilient Infrastructure and Communities program, Hazard Mitigation Grant Program, National Grid funding, Community Preservation Act, and EPA Technical Assistance Grants.

Moving forward, Newburyport plans to continue to apply for funding to address vulnerability. Federal funding programs are available to eligible municipalities. The availability of current federal funding sources changes regularly and is dependent upon Congress' ongoing budget appropriations process. Currently, www.grants.gov is the comprehensive website to track available funding from federal agencies. Also, federal appropriations from Congress may be tracked through the Federal Registers at www.federalregister.gov.

The following is a summary of FEMA and other programs which fund hazard mitigation and resiliency projects and activities, including the primary sources of federal hazard mitigation funding in Massachusetts:

Table 11.1 FEMA and Other Funding Programs

FEMA Program	Type of Assistance	Availability	Managing Agency	Funding Source
National Flood Insurance Program (NFIP)	Pre-Disaster Insurance	Any time (pre- and post-disaster)	DCR Flood Hazard Management Program	Property Owner, FEMA
Severe Repetitive Loss (SRL) (Part of the NFIP)	Grants to state emergency management offices to reduce damage to insured severe RLPs	Varies	MEMA	Up to 90% FEMA/ 10% state government

Repetitive Flood Claims Program (RFC) (Part of the NFIP)	Grants to states and municipalities to reduce damage to insured RLPs	Any time	FEMA	100% FEMA
Community Rating System (CRS) (Part of the NFIP)	Disaster Insurance Discounts	Any time (pre- and post-disaster)	DCR Flood Hazard Management Program	Property Owner, FEMA
Flood Mitigation Assistance (FMA) Program	Cost-share grants for pre-disaster planning and projects	Annual pre-disaster grant program	DCR & MEMA	75% FEMA/25% local government or organization
Hazard Mitigation Grant Program (HMGP)	Post-disaster Cost-Share Grants	Post disaster program	DCR & MEMA	75% FEMA/25% local government or organization
Building Resilient Infrastructure and Communities (formerly the Pre-Disaster Mitigation Program)	National, competitive grant program for multiple hazard mitigation projects and "all hazards"	Annual pre-disaster mitigation program	DCR & MEMA	75% FEMA/25% local government or organization
Small Business Administration (SBA) Mitigation Loans	Pre- and Post-disaster loans to qualified businesses	Ongoing	MEMA	Small Business Administration
Infrastructure Support Program (formerly Public Assistance)	Post-disaster aid to state and local governments	Post Disaster	MEMA	FEMA
Municipal Vulnerability Preparedness Action Grans	Funding for designated MVP Communities to advance priority climate adaptation actions to address climate change	Annually	EOEEA	State of Massachusetts

The Federal Emergency Management Agency (FEMA), which is part of the Department of Homeland Security, administers the National Flood Insurance Program, the Community Rating System, the Flood Mitigation Assistance Program (FMA), the Hazard Mitigation Grant Program (HMGP), and the Building Resilient Infrastructure and Communities (BRIC). These programs are administered in coordination with DCR and MEMA. FEMA also prepares and revises flood insurance studies and maps as well as information on past and current acquisition, relocation, and retrofitting programs. The Mitigation Division provides expertise in other natural and technological hazards, including hurricanes, earthquakes, and hazardous materials, to state and local government agencies.

Immediately following Presidential declarations, FEMA's Response and Recovery Division works closely with state agencies, especially MEMA, in assisting in the short- term and long-term recovery effort. FEMA assists disaster-affected communities through emergency funding programs, such as Infrastructure Support and Human Services. In coordination with its Mitigation Division, Response and Recovery distributes information on hazard mitigation methods and acquisition/relocation initiatives as well as coordinating HMGP grants for mitigation projects to protect qualifying damaged public and private nonprofit facilities through the Infrastructure Support Program. In addition to these programs, FEMA also provides disaster recovery and hazard mitigation training at its Emergency Management Institute in Emmitsburg, Maryland.

For the latest information on this and other mitigation funding programs, go to FEMA's website at **www.fema.gov.**

National Flood Insurance Program (NFIP)

The National Flood Insurance Program (NFIP), established by Congress in 1968, provides flood insurance to property owners in participating communities. This program is a direct agreement between the federal government and the local community that flood insurance will be made available to residents in exchange for community compliance with minimum floodplain management requirements. Since homeowners' insurance does not cover flooding, a community's participation in the NFIP is vital to protecting property in the floodplain, as well as ensuring that federally backed mortgages and loans can be used to finance property within the floodplain.

Pursuant to the Flood Disaster Protection Act of 1973, any federal financial assistance related to new construction or substantial improvements (greater than 50% of a structure's market value) of existing structures located in the 100-year floodplain is contingent on the purchase of flood insurance. Such federal assistance includes not only direct aid from agencies but also from federally insured institutions. Thus, for property owners to be eligible for purchasing flood insurance, their respective community must be participating in the NFIP and in compliance with the NFIP.

Communities participating in the NFIP must:

- Adopt the Flood Insurance Rate Maps as an overlay regulatory district;
- Require that all new construction or substantial improvement to existing structures in the flood hazard area will be elevated; and
- Require design techniques to minimize flood damage for structures being built in high hazard areas, such as floodways or velocity zones.

The NFIP standards are contained in the Massachusetts State Building Code (Chapter 16 of the 9th Edition), which is implemented at the local level by municipal building inspectors. In Massachusetts, 341 out of 351 (97%) of Massachusetts municipalities participate in the NFIP.

Severe Repetitive Loss Program

The Severe Repetitive Loss Program was authorized by the Bunning-Beruter-Blumaneauer Flood Insurance Reform Act of 2004 with amended the National Flood Insurance Act of 1968 to provide funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss structures.

MEMA must apply for these funds but may work with other state agencies or local governments. Priority is given to programs that will have the greatest cost-benefit ratio in keeping with the purpose of the program. Grants may be used for acquisition, demolition, and relocation but cannot be used for maintenance or repair.

Funds are allocated to the state based on the percentage of validated SRL properties and may be up to 90 percent federal and 10 percent local.

Repetitive Flood Claims Program (RFC)

The Repetitive Flood Claims Program was authorized by the Bunning-Beruter-Blumaneauer Flood Insurance Reform Act of 2004 which amended the National Flood Insurance Act of 1968 to provide funding to reduce the risk of flood damage to repetitive loss structures.

The program is 100 percent federally funded and the applicant must demonstrate that the proposed activities cannot be funded under the Flood Assistance Program. (See below.)

Community Rating System (CRS)

A voluntary initiative of the NFIP, the Community Rating System (CRS) encourages communities to undertake activities that exceed the minimum NFIP floodplain management standards. Communities participating in CRS can reduce flood insurance premiums paid by policyholders in that community by performing such activities as maintaining records of floodplain development, publicizing the flood hazard, improving flood data, and maintaining open space. Communities can gain additional credit under CRS by developing a flood mitigation plan.

Flood Hazard Mitigation Program

Authorized by the National Flood Insurance Reform Act of 1994, the Flood Mitigation Assistance (FMA) program makes cost-share grants available for flood mitigation planning and projects, such as property acquisition, relocation of residents living in floodplains, and retrofitting of existing structures within a floodplain. Flood hazard mitigation plans, approved by the state and FEMA, are a pre-requisite for receiving FMA project grants. Communities contribute a minimum of 25% of the cost for the planning and project grants with an FMA match of up to 75%.

Hazard Mitigation Grant Program (HMGP)

Established under Section 404 of the Stafford Disaster Relief and Emergency Relief Act (PL 100-707), this program provides matching grants (75% Federal, 25% Local) for FEMA-approved hazard mitigation projects following a federally declared disaster. These grants are provided on a competitive basis to state, local and tribal governments as well as non-profit organizations. The grants are specifically directed toward reducing future hazard losses and can be used for projects protecting property and other resources against the damaging effects of floods, hurricanes, earthquakes, high winds, and other natural hazards. HMGP in Massachusetts encourages non-structural hazard mitigation measures, such as:

- The acquisition of damaged structures and deeding the land to a community for open space or recreational use
- Relocating damaged or flood-prone structures out of a high hazard area
- Retrofitting properties to resist the damaging effects of natural disasters. Retrofitting can include wet- or dry-flood proofing, elevation of the structure above flood level, elevation of utilities, or proper anchoring of the structure.

Funding proposals are submitted for review by Massachusetts' Interagency Hazard Mitigation Committee with final approval given by the Commissioner of the DCR, the Director of MEMA, and FEMA's Region I office. The committee uses a list of criteria which is described on page 34 of this plan as well as in the Hazard Mitigation Grant Program Administrative Plan.

Pre-Disaster Mitigation (PDM) Program now BRIC

The Pre-Disaster Mitigation (PDM) Program was authorized by §203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 USC, as amended by §102 of the Disaster Mitigation Act of 2000. As a result of amendments by the Disaster Relief and Recovery Act of 2018, the Pre-Disaster Mitigation program is being replaced with the new Building Resilient Infrastructure and Communities (BRIC) program. The BRIC program aims to shift the federal focus away from reactive disaster spending and toward research-supported, proactive investment in community resilience. All applicants must be participating in the National Flood Insurance Program (NFIP) if they have been identified through the NFIP as having a Special Flood Hazard Area (a Flood Hazard Boundary Map (FHBM) or Flood Insurance Rate Map (FIRM) has been issued). Also, the community must not be suspended or on probation from the NFIP. Applicants must also have an up to date HMP.

Small Business Administration Mitigation Loans

The SBA's Regional Mitigation Loan Program was developed in support of FEMA's Regional Mitigation program. Businesses proposing mitigation measures to protect against flooding must be in a Special Flood Hazard Area (SFHA). Businesses may consult FIRM maps to find out if the business is in a SFHA. For information pertaining to hazard identification mapping and floodplain management, contact the local community floodplain administrator or the State floodplain manager. To apply for a regional mitigation loan, a business must submit a complete Regional Mitigation Small Business Loan Application within the 30-day application period announced by the SBA. SBA will publish a Notice of Availability of Regional Mitigation Loans in the Federal Register announcing the availability of regional mitigation loans each fiscal year. The Federal Register notice will designate a 30-day application period with a specific opening date and filing deadline, as well as the locations for obtaining and filing loan applications. Furthermore, SBA will coordinate with FEMA and will issue press releases to the local media to inform potential loan applicants where to obtain loan applications.

Public Assistance Program

The Federal Emergency Management Agency's Public Assistance Program is triggered for counties declared major disaster areas by the President. Communities and public agencies in designated counties are eligible for partial reimbursement (75%) of expenses for emergency services and removal of debris, and partial funding (75%) for repair and replacement of public facilities that were damaged by the declared disaster. Massachusetts funds an additional 12.5% of these projects. Eligible applicants for Infrastructure Assistance include:

- State government agencies/departments;
- Local governments (county, city, town, village, district, etc.); and
- Certain private non-profit organizations.

Typical federal/state aid can include:

- Reimbursable payment of 87.5% of the approved costs for emergency protective measures deployed in anticipation of the storm;
- Reimbursable payment of 87.5% of the approved costs for emergency services and debris removal;
- Payment of 75% of the costs for the permanent repair or replacement of damaged public property; and
- Funding for repair/construction of damaged highways other than those on the Federal Aid System.

Special Appropriations Following State Disasters

Although there is no separate state disaster relief fund in Massachusetts, the state legislature will enact special appropriations for those communities sustaining damages following a natural disaster that are not large enough for a presidential, disaster declaration.

State Revolving Fund

This statewide loan program through the Executive Office of Energy and Environmental Affairs assists communities in funding local stormwater management projects which help to minimize and/or eliminate flooding in poor drainage areas.

Massachusetts Land and Water Conservation Fund

The Land and Water Conservation Fund provides 50 percent of the total project costs to purchase land for conservation or recreation purposes. Massachusetts has spent $95.6 million since 1965 to purchase almost 4,000 acres of land under this program. The program is administered by DCR.

Major Flood Control Projects

The state provides 50% of the non-federal share on the costs of major flood control projects developed in conjunction with the U.S. Army Corps of Engineers. This program is managed by DCR.

Municipal Vulnerability Preparedness (MVP) Action Grants

Once designated an MVP Community, the Executive Office of Energy and Environmental Affairs (EEA), through the MVP Program, offers funding resources to advance climate adaptation actions identified in the community's MVP Summary of Findings. In FY21, the MVP Program offered over $10 million in Action Grant Funding.

Social Resources

Knowledge networks are another major resource for Newburyport in addressing vulnerability. On a regional scale, Newburyport collaborates with a number of different groups, coalitions, and organizations to share knowledge, resources, and skills to strengthen its resiliency in the face of climate change and environmental hazards. These collaborations include:

- Merrimack Valley Planning Commission: Newburyport became a designated MVP community in 2018 and participates as an active MVPC Commissioner to oversee and assist in regional planning function for the 15 cities and towns in the district.
- Eight Towns and the Great Marsh: Newburyport participates (through one active representative) on this Upper North Shore Local Governance Committee (LGC) for the Massachusetts Bays National Estuary Program.
- Great Marsh Coalition: Newburyport collaborates on region-wide climate planning and adaptation measures, such as the Great Marsh Coastal Adaptation Plan (2017), a detailed document outlining local strategies for adaptation planning that integrates climate smart conservation.
- Merrimack River District Commission: Newburyport collaborates on river-wide concerns regarding water quality and health. For example, the city participated in a pilot program to develop a pre-notification alert system for swimming and boating hazards related to combined sewage overflow (CSO) hazards.
- Merrimack River Beach Alliance: Newburyport participates in MRBA, a long-standing ad hoc group of municipal, state and federal officials; elected officials; and local residents led by Senator Tarr. The focus of the MRBA is on short and long-term management and protection of Salisbury and Plum Island Beaches.
- Regional Emergency Planning Committee: Newburyport, together with the municipalities of Amesbury, Boxford, Georgetown, Ipswich, Merrimac, Newbury, Rowley, Salisbury, and West Newbury comprise the Northern Essex Regional Emergency Planning Committee (REPC). Emergency Planning Committees are

responsible for protecting their communities from incidents involving hazardous materials.

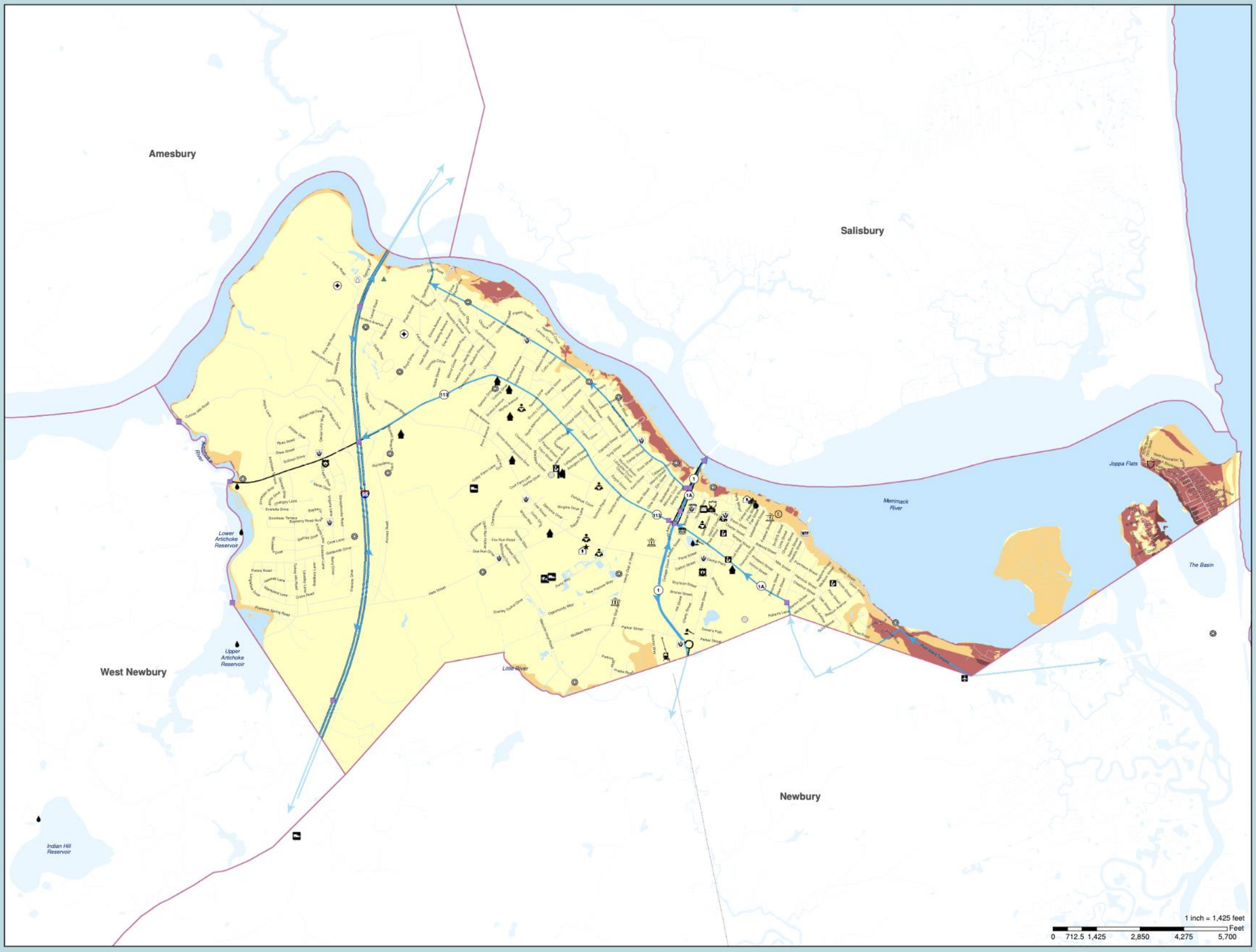
- Merrimack Valley Stormwater Collaborative: Newburyport, together with 14 towns within the watershed, convene monthly to discuss stormwater related issues and projects within the region to facilitate knowledge-sharing and skill building.
- Educational Collaborations: Newburyport partners with local and regional universities and academic institutions to research and address a range of environmental topics. This collaboration provides technical support and knowledge to Newburyport while offering real-life opportunities to study and address science-related projects.

Appendices

Appendix A: Composite Hazards Map

Merrimack Valley
Multi-Hazard Mitigation Plan
2021

NEWBURYPORT, MA
Composite Hazards



Legend

- Very Low (1 Hazard)
- Low (2 Hazards)
- Moderate (3 Hazards)
- High (4 Hazards)
- Town Boundary
- Hydrographic Features
- Interstate
- Major Roads
- Local Roads
- Rail Lines

Critical Facilities and Infrastructure

- Airport
- Armory
- City/Town Offices
- Community Organization
- Commuter Rail Station
- Court
- Electric Substation
- Emergency Shelter
- Emergency Operations
- Day Care Facility
- DPW
- Fire Station
- Historic Site
- Hospital
- Library
- Police
- Post Office
- School
- Sewer Infrastructure
- Special Population
- Waste Water Treatment Plant
- Water Supply Resources
- Water Filtration Plant
- Water Storage Tank
- Well Fields
- Bridges
- Dams
- Evacuation Routes

Preparation of this Plan was funded by grant # HMGP 1895-45 from the Massachusetts Emergency Management Agency (MEMA) in cooperation with the Department of Homeland Security-Federal Emergency Management Agency (FEMA). Matching funds were provided by MVPC.

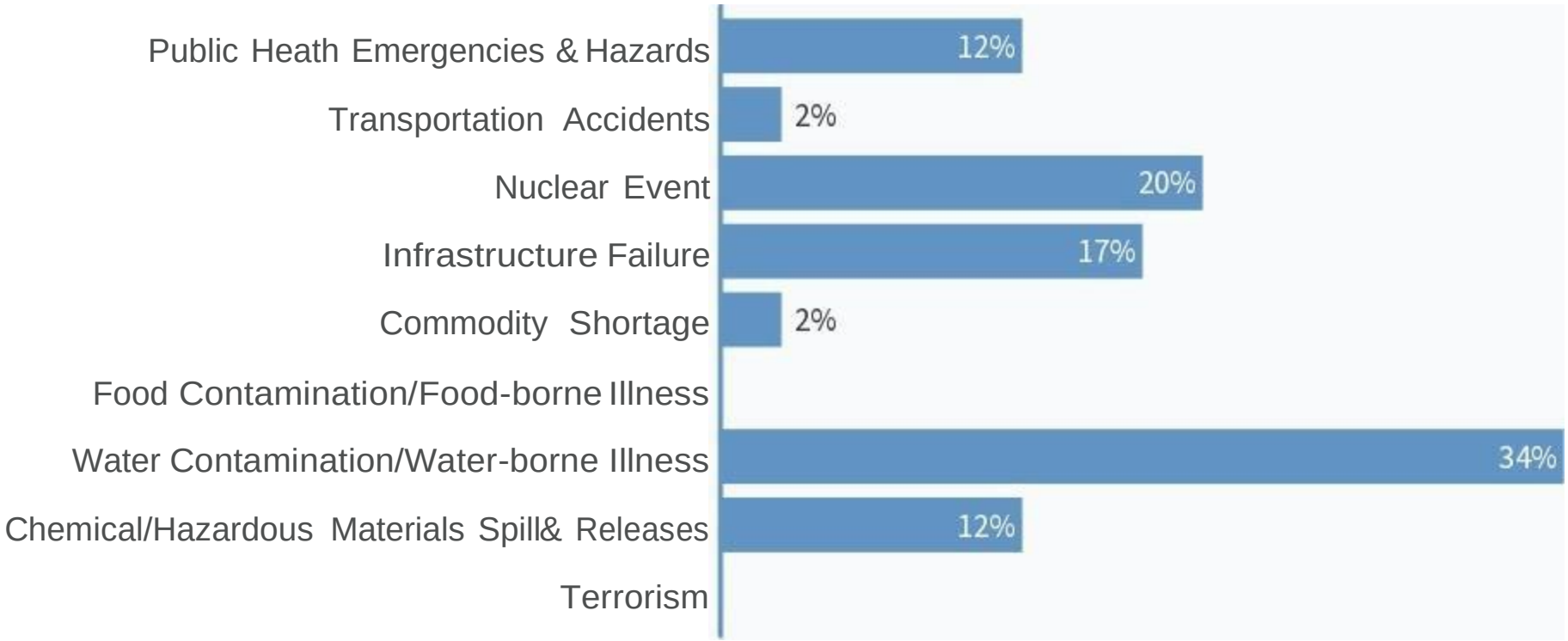
Data Sources: The data for this map was supplied by the Merrimack Valley Planning Commission, the Massachusetts Department of Conservation and Recreation, the Executive Office of Environmental Affairs/MassGIS (EOEA/MassGIS), and the municipality. The information depicted on this map is for planning purposes only. It may not be adequate for legal boundary definition or regulatory interpretation.

A State Designated Regional Service Center
"Mapping the Crossroads of New England"
Merrimack Valley Planning Commission (MVPC)
160 Main Street Haverhill MA, 01830

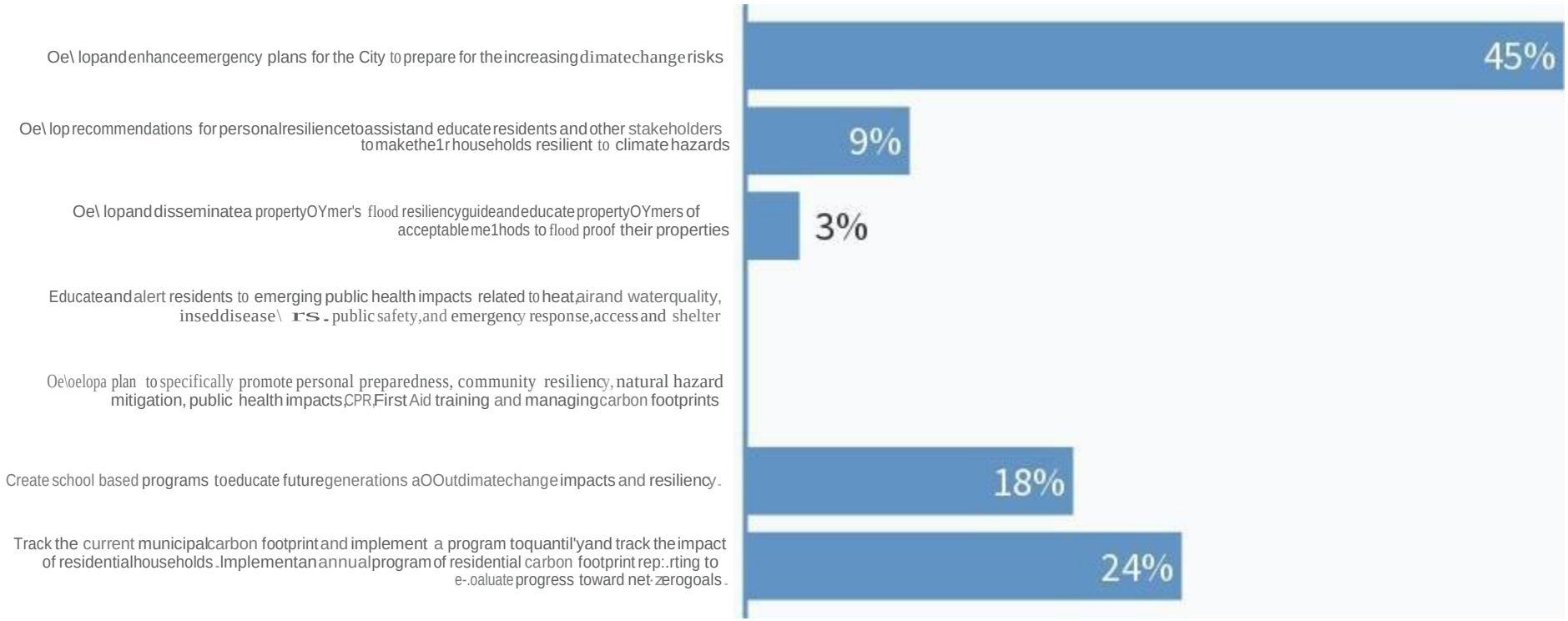
J:\ArcGIS\Mxd\proj\2021\MHMA CompHazards.mxd Sept 29, 2021 MM

Appendix B: Survey Results

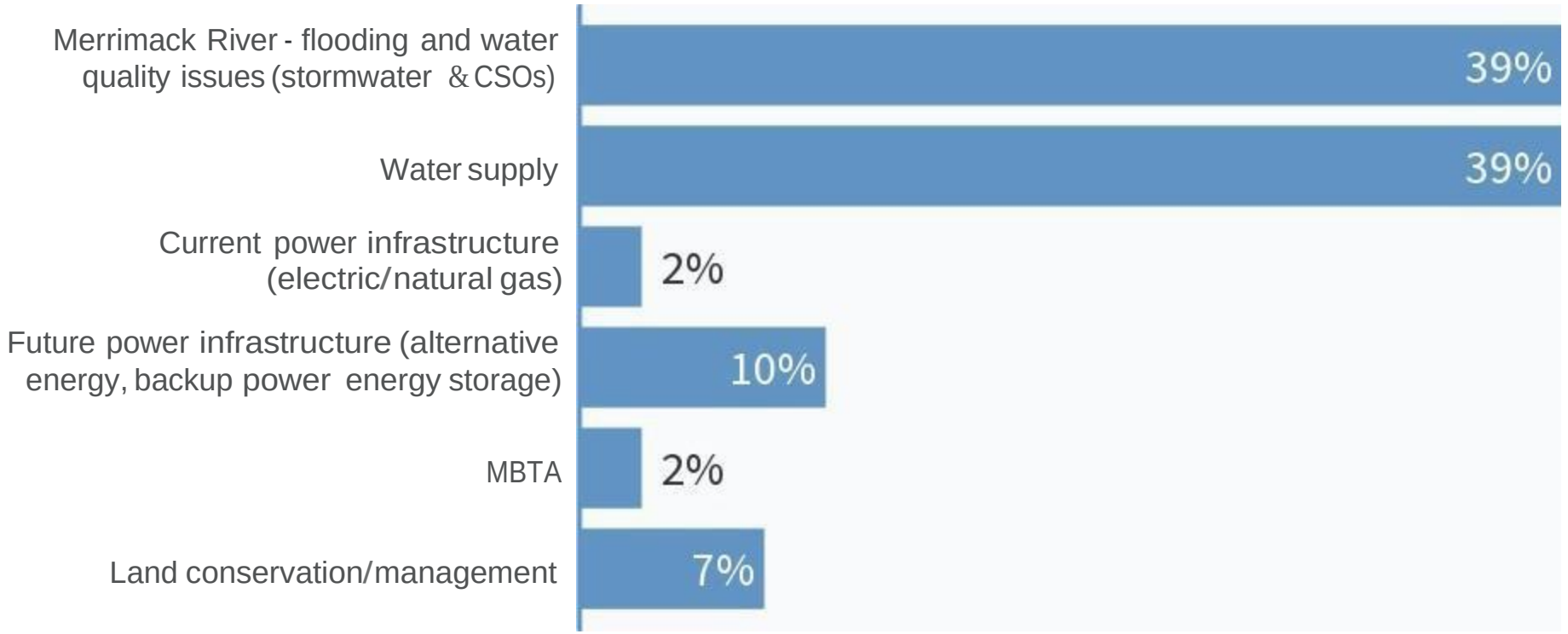
Which non-natural hazards should be in Newburyport's Hazard Mitigation Plan:



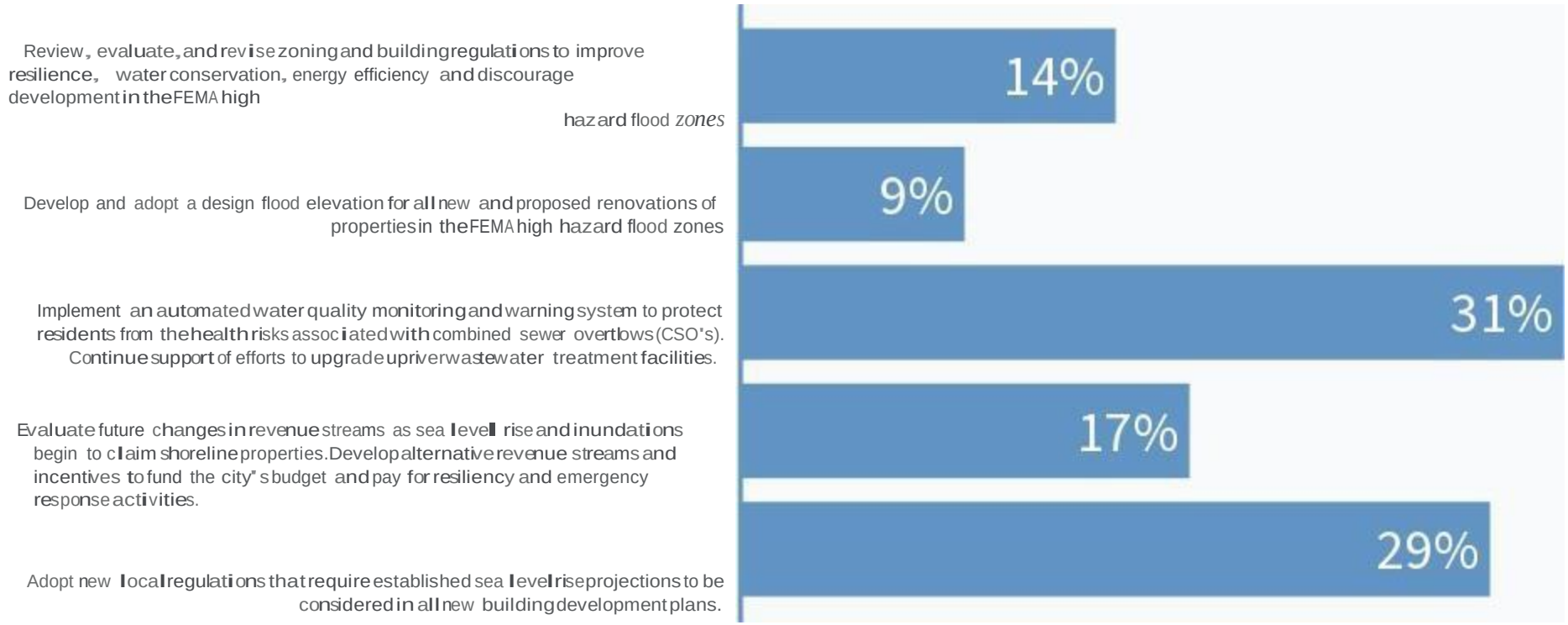
City-wide education and outreach actions for hazard mitigation and resiliency (choose top 2)



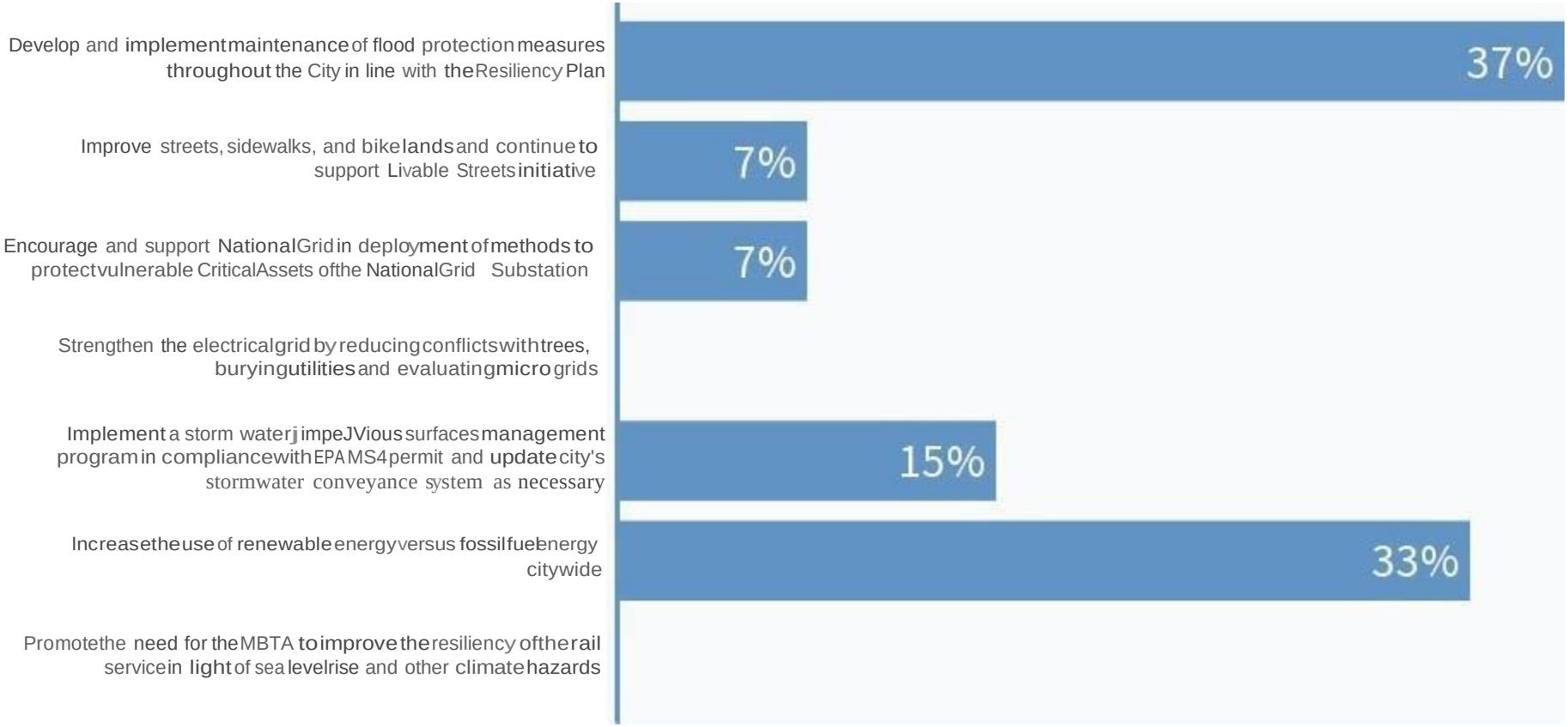
Vulnerabilities requiring inter-community/regional action (choose top 2)



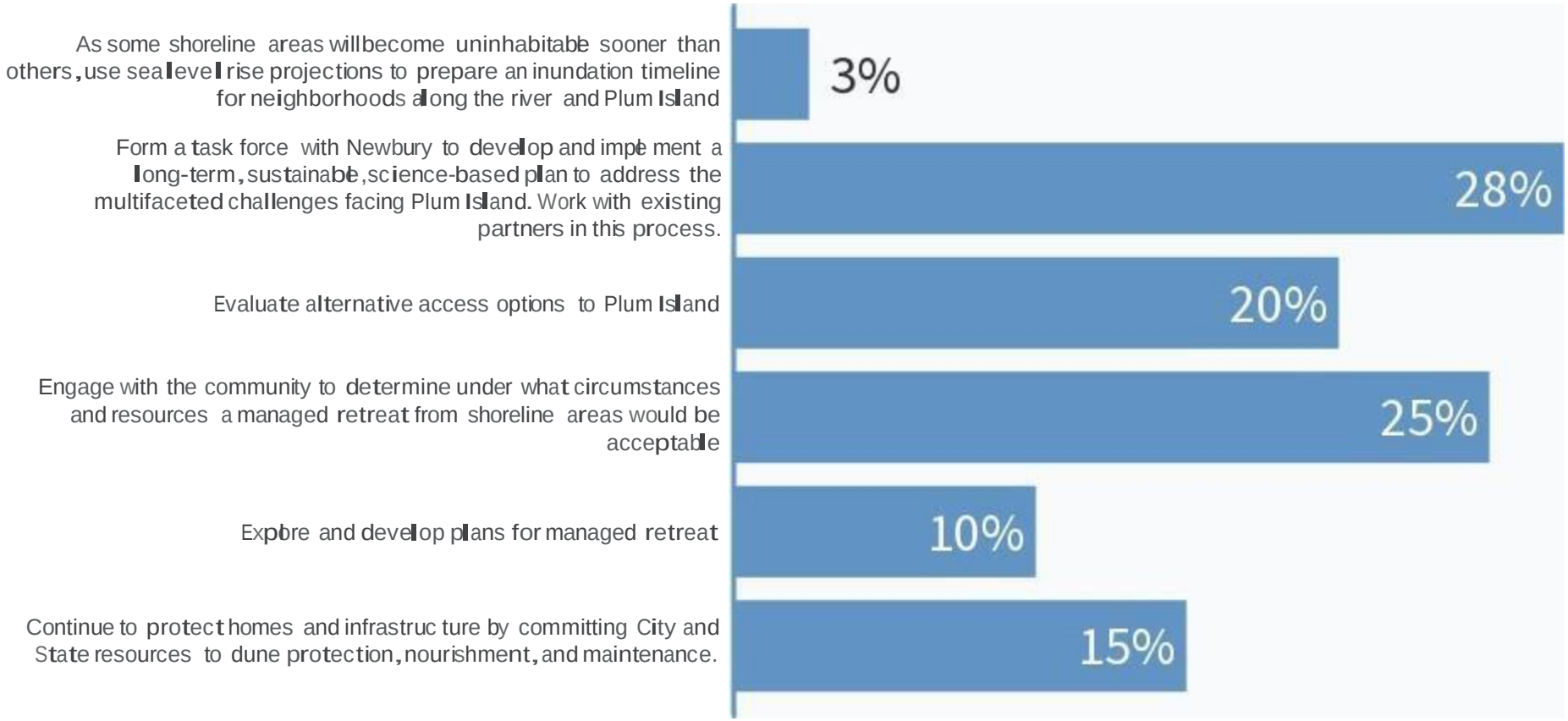
City-wide regulatory and budgetary actions for hazard mitigation and resiliency (choose top 2)



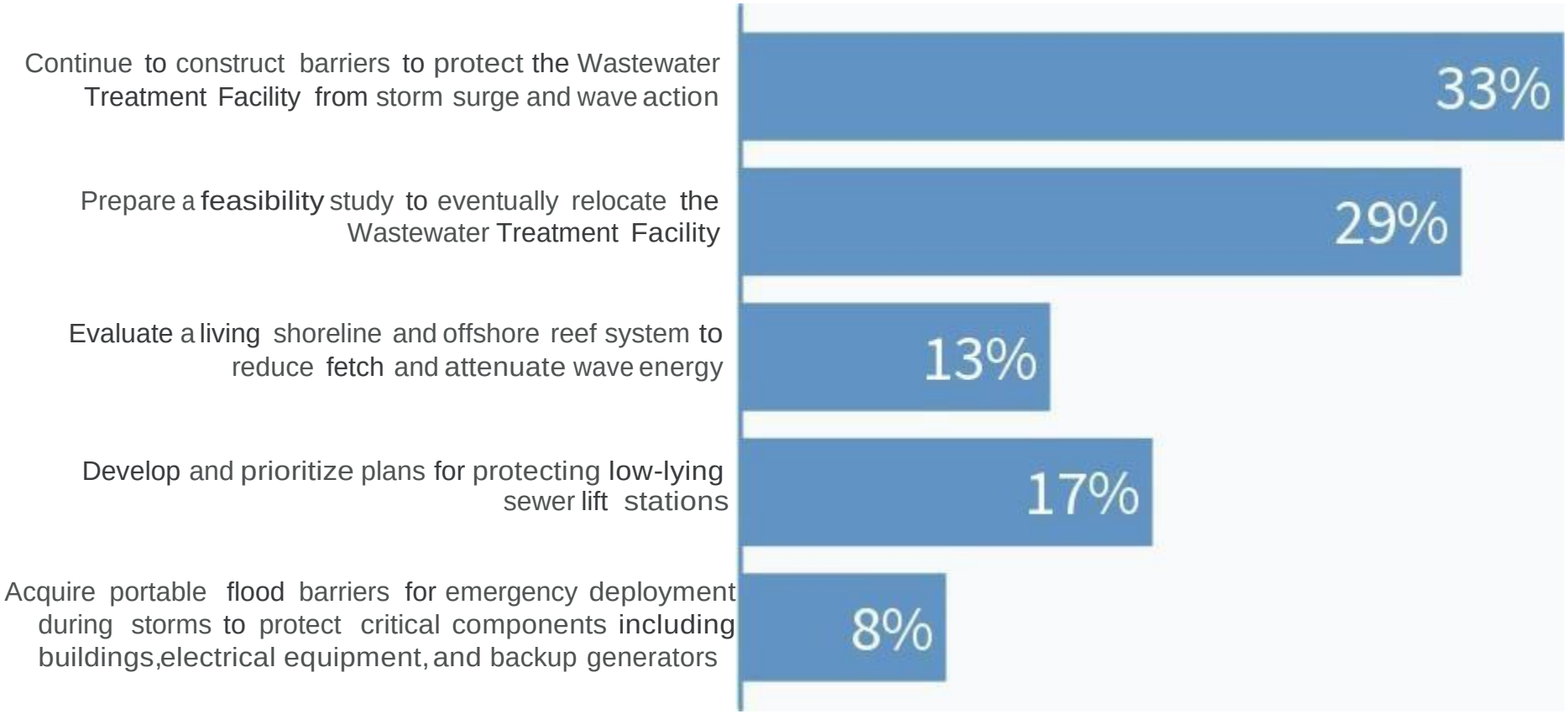
Actions to protect other infrastructure (choose top 2}



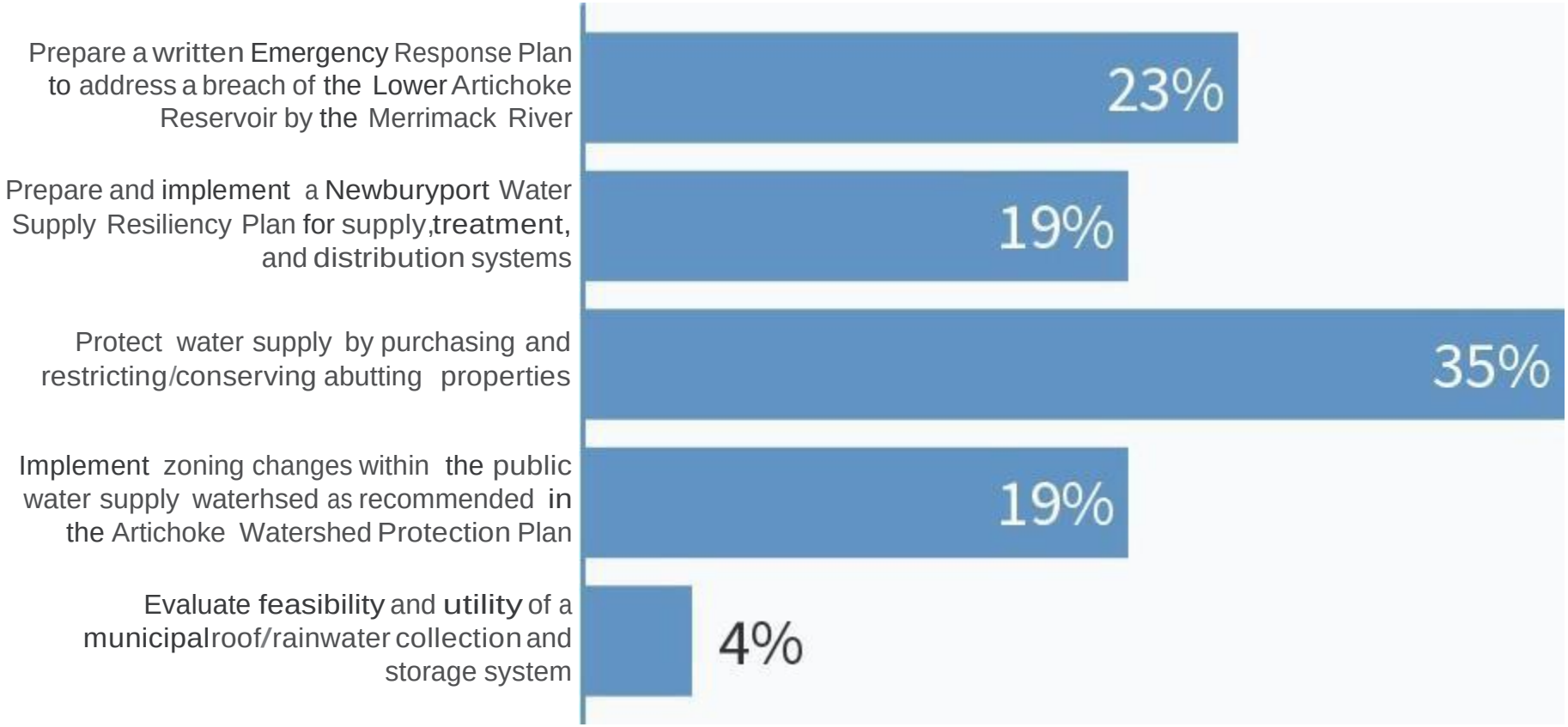
Priority actions for Plum Island



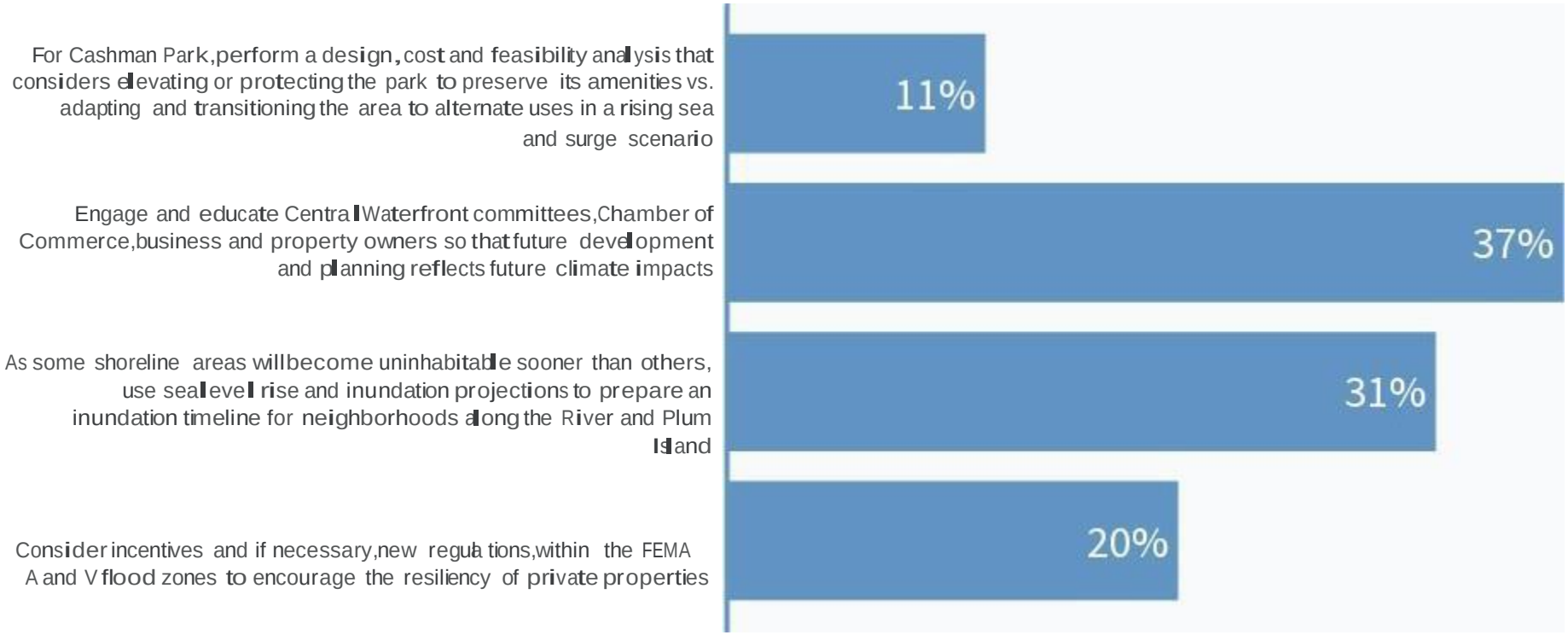
Wastewater Treatment Priority Actions {choose top 2}



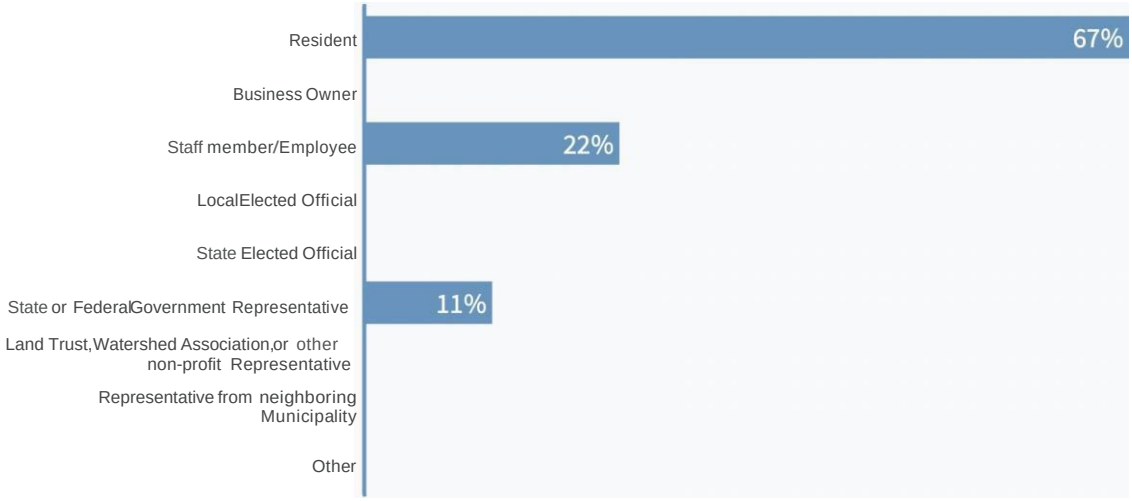
Priority Actions to Address Water Supply {choose top 2}



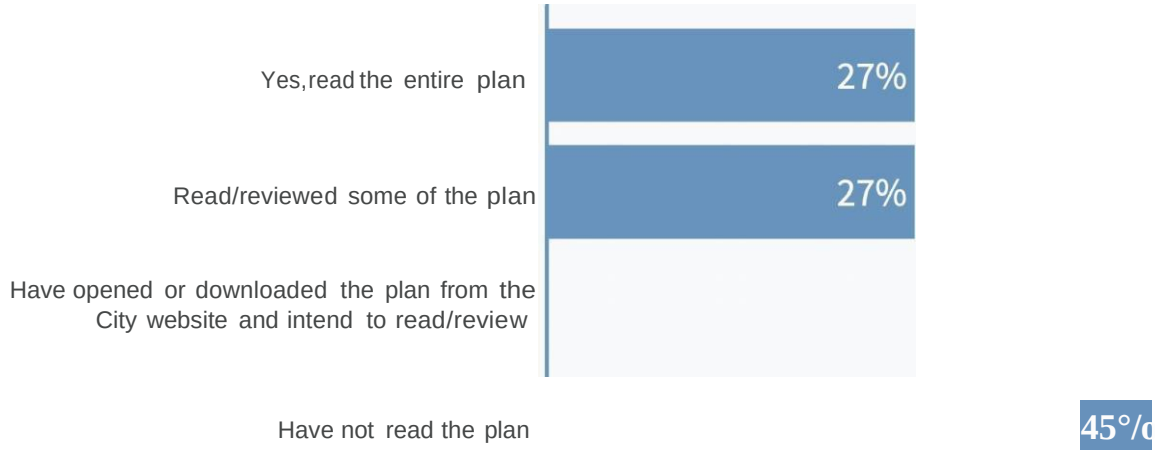
Priority actions to address waterfront neighborhoods and amenities (choose top 2)

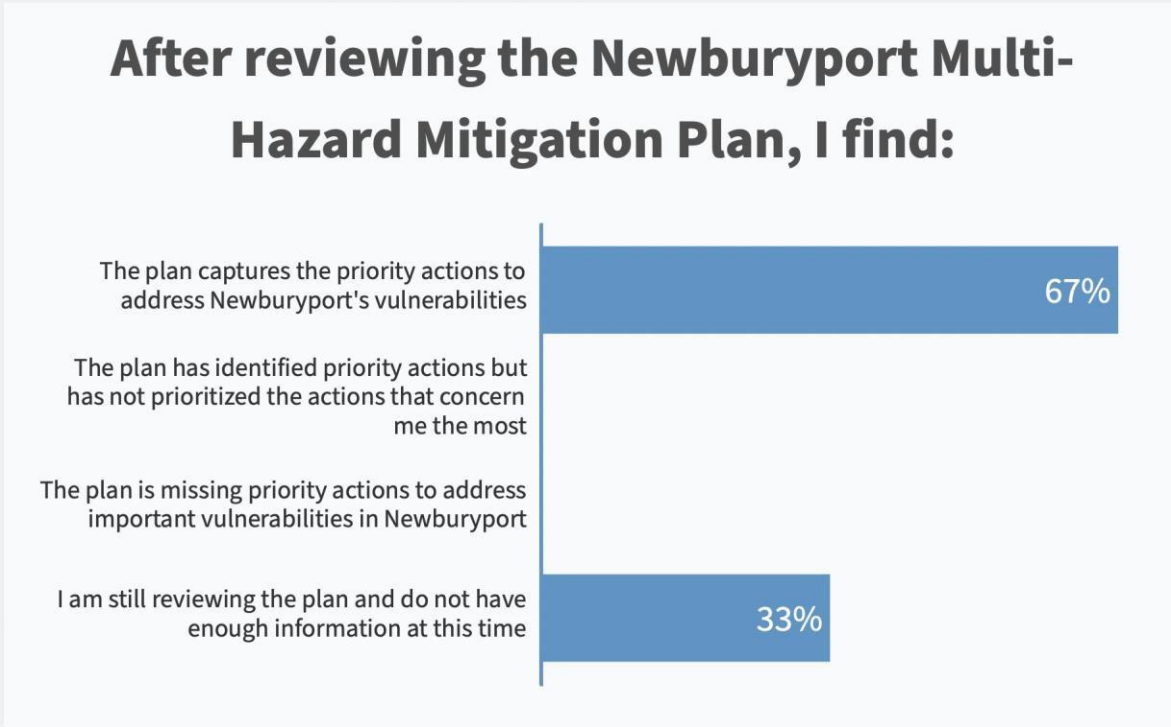


What is your affiliation/role with the City of Newburyport?



Have you read or reviewed Newburyport's updated Hazard Mitigation Plan





Question 4: “if there is an action you believe should be given higher priority, please identify it here”

Response	Via	Screen name	Registered participant	Phone number	Received at
street and sewer flooding	pollev.com/merrimackval42	Sarah Tappan			May 18, 2022, 03:30 PM
Continuing to work with Newbury to assess the cost-benefit of Plum Island Turnpike improvements and overall Plum Island resiliency/retreat	pollev.com/merrimackval42	Kristen			May 18, 2022, 03:30 PM
Coastal flooding	pollev.com/merrimackval42	Sarah Tappan			May 18, 2022, 03:29 PM
Continued focus on the water supply protection, all aspects (artichoke dam, indian hill pipeline, and emergency interconnect).	pollev.com/merrimackval42	Sarah Tappan			May 18, 2022, 03:29 PM
Sea Level Rise and increased flooding of coastal areas	pollev.com/merrimackval42	Andrew Port			May 18, 2022, 03:29 PM

Appendix C: Meeting Agendas

Newburyport Multi-Hazard Mitigation Plan

Planning Meeting

Zoom Meeting

August 18, 2021, 3 P.M. – 4 P.M.

AGENDA

I.	Welcome – Newburyport
II.	Overview of Hazard Mitigation Planning Process – Merrimack Valley Planning Commission (MVPC)
III.	Review of Priority Actions from Municipal Vulnerability Preparedness Plan and Climate Resiliency Plan – MVPC – Poll Everywhere Activity Poll Everywhere Link: https://pollev.com/merrimackval427
IV.	Discussion
V.	Next Steps in Hazard Mitigation Plan (HMP) Process

Virtual Meeting Information:

Please click the link below to join the webinar:

https://us02web.zoom.us/j/84659075838

Or via Phone (audio only): +1 301 715 8592

Webinar ID: 846 5907 5838

For more information, please contact Julia Godtfredsen at:
Email: jgodtfredsen@cityofnewburyport.com
Phone: 978-465-4400

Current plans can be viewed on the Resiliency Committee Website at the following link:
https://www.cityofnewburyport.com/planning-development/resiliency-sustainability

Newburyport Multi-Hazard Mitigation Plan

Listening Session

Zoom Meeting

May 18th, 2022 3 P.M. – 4 P.M.

AGENDA

I.	Welcome – Newburyport
II.	Overview of Hazard Mitigation Planning Process – Merrimack Valley Planning Commission (MVPC)
III.	Review of Newburyport Multi-Hazard Mitigation Plan – Hazards, Vulnerabilities and Priority Actions – Merrimack Valley Planning Commission
IV.	Public Input
V.	Next Steps in Hazard Mitigation Plan (HMP) Approval Process

Direct zoom meeting link:

https://us06web.zoom.us/s/85918075418

Or join webinar with the following methods

Phone one-tap

Phone one-tap: US: +13126266799,,85918075418#
or +16465588656,,85918075418#

Join by Telephone

For higher quality, dial a number based on your current location.

Dial:
US : +1 312 626 6799 or +1 646 558 8656 or +1 301 715 8592 or +1 346 248 7799 or +1 720 707 2699 or +1 253 215 8782

Webinar ID: 859 1807 5418

For more information, please contact Julia Godtfredsen at:
Email: jgodtfredsen@cityofnewburyport.com
Phone: 978-465-4400

Current plans can be viewed on the Resiliency Committee Website at the following link: https://www.cityofnewburyport.com/planning-development/files/draft-hazard-mitigation-plan.

Appendix D: Plan Review Tool

APPENDIX A:
LOCAL MITIGATION PLAN REVIEW TOOL

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

Jurisdiction: Newburyport MA	**Title of Plan: Newburyport Multi—Hazard Mitigation Plan**	**Date of Plan: November 2022**
Local Point of Contact: Julia Godtfredsen		**Address: 60 pleasant street, Newburyport MA 01950**
Title: Conservation Agent		
Agency: City of Newburyport		
Phone Number: 978-465-4400		**E-Mail: jgodtfredsen@cityofnewburyport.com**

State Reviewer:	**Title:**	**Date:**

FEMA Reviewer:	**Title:**	**Date:**
Date Received in FEMA Region ***(insert #)***		
Plan Not Approved		
Plan Approvable Pending Adoption		
Plan Approved		

SECTION 1:
REGULATION CHECKLIST

INSTRUCTIONS: The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the Plan by Element/sub-element and to determine if each requirement has been 'Met' or 'Not Met.' The 'Required Revisions' summary at the bottom of each Element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is 'Not Met.' Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in this *Plan Review Guide* in Section 4, Regulation Checklist.

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
ELEMENT A. PLANNING PROCESS			
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))	Section 2, pp 13-24		
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))	Section 2.3, pp 17-19, p 31 regulatory authority for development		
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))	Section 2.3, pp 17-19, section 2.5 pp 23-24		
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))	Section 2.1, 2.2, & 2.4, pp 13-17 & 20-23		
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))	Section 2.6, p 24		
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))	Section 9.2, pp 146-147		
ELEMENT A: REQUIRED REVISIONS			

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))	Section 4, pp 45-107		
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))	Section 4, pp 45-107, Section 4B pp 108-115		
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))	Section 4, pp 45-107, section 4B pp 108-115		
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))	Section 4.1 & Table 4.1.2, p 52		
ELEMENT B: REQUIRED REVISIONS			
ELEMENT C. MITIGATION STRATEGY			
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))	Section 5 pp 122-126, section 10 pp 149-150		
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))	Section 4.1 pp 49-52 & table 5.1 pp 123 (first row)		
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))	Section 7 pp 133-137		
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement	Section 8 and table 8.1.1. pp 138-144		
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement	Section 8 pp 138-144		
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))	Section 2 pp 13-16, Section 10 pp 148-150, Section 7 p 133, Section 6 p 127		
ELEMENT C: REQUIRED REVISIONS			

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))	Section 3.7 pp 38-39 & section 7.4 p 137		
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))	Section 6 pp 127-132		
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))	Section 8 pp 138-144		
ELEMENT D: REQUIRED REVISIONS			
ELEMENT E. PLAN ADOPTION			
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))	Unsigned adoption resolution on page 2		
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))	N/A		
ELEMENT E: REQUIRED REVISIONS			
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)			
F1.			
F2.			
ELEMENT F: REQUIRED REVISIONS			

SECTION 2:
PLAN ASSESSMENT

INSTRUCTIONS: The purpose of the Plan Assessment is to offer the local community more comprehensive feedback to the community on the quality and utility of the plan in a narrative format. The audience for the Plan Assessment is not only the plan developer/local community planner, but also elected officials, local departments and agencies, and others involved in implementing the Local Mitigation Plan. The Plan Assessment must be completed by FEMA. The Assessment is an opportunity for FEMA to provide feedback and information to the community on: 1) suggested improvements to the Plan; 2) specific sections in the Plan where the community has gone above and beyond minimum requirements; 3) recommendations for plan implementation; and 4) ongoing partnership(s) and information on other FEMA programs, specifically RiskMAP and Hazard Mitigation Assistance programs. The Plan Assessment is divided into two sections:

1. Plan Strengths and Opportunities for Improvement
2. Resources for Implementing Your Approved Plan

Plan Strengths and Opportunities for Improvement is organized according to the plan Elements listed in the Regulation Checklist. Each Element includes a series of italicized bulleted items that are suggested topics for consideration while evaluating plans, but it is not intended to be a comprehensive list. FEMA Mitigation Planners are not required to answer each bullet item, and should use them as a guide to paraphrase their own written assessment (2-3 sentences) of each Element.

The Plan Assessment must not reiterate the required revisions from the Regulation Checklist or be regulatory in nature, and should be open-ended and to provide the community with suggestions for improvements or recommended revisions. The recommended revisions are suggestions for improvement and are not required to be made for the Plan to meet Federal regulatory requirements. The italicized text should be deleted once FEMA has added comments regarding strengths of the plan and potential improvements for future plan revisions. It is recommended that the Plan Assessment be a short synopsis of the overall strengths and weaknesses of the Plan (no longer than two pages), rather than a complete recap section by section.

Resources for Implementing Your Approved Plan provides a place for FEMA to offer information, data sources and general suggestions on the overall plan implementation and maintenance process. Information on other possible sources of assistance including, but not limited to, existing publications, grant funding or training opportunities, can be provided. States may add state and local resources, if available.

A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Element A: Planning Process

How does the Plan go above and beyond minimum requirements to document the planning process with respect to:

- *Involvement of stakeholders (elected officials/decision makers, plan implementers, business owners, academic institutions, utility companies, water/sanitation districts, etc.);*
- *Involvement of Planning, Emergency Management, Public Works Departments or other planning agencies (i.e., regional planning councils);*
- *Diverse methods of participation (meetings, surveys, online, etc.); and*
- *Reflective of an open and inclusive public involvement process.*

Element B: Hazard Identification and Risk Assessment

In addition to the requirements listed in the Regulation Checklist, 44 CFR 201.6 Local Mitigation Plans identifies additional elements that should be included as part of a plan's risk assessment. The plan should describe vulnerability in terms of:

1) *A general description of land uses and future development trends within the community so that mitigation options can be considered in future land use decisions;*
2) *The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; and*
3) *A description of potential dollar losses to vulnerable structures, and a description of the methodology used to prepare the estimate.*

How does the Plan go above and beyond minimum requirements to document the Hazard Identification and Risk Assessment with respect to:

- *Use of best available data (flood maps, HAZUS, flood studies) to describe significant hazards;*
- *Communication of risk on people, property, and infrastructure to the public (through tables, charts, maps, photos, etc.);*
- *Incorporation of techniques and methodologies to estimate dollar losses to vulnerable structures;*
- *Incorporation of Risk MAP products (i.e., depth grids, Flood Risk Report, Changes Since Last FIRM, Areas of Mitigation Interest, etc.); and*
- *Identification of any data gaps that can be filled as new data became available.*

Element C: Mitigation Strategy

How does the Plan go above and beyond minimum requirements to document the Mitigation Strategy with respect to:

- *Key problems identified in, and linkages to, the vulnerability assessment;*
- *Serving as a blueprint for reducing potential losses identified in the Hazard Identification and Risk Assessment;*
- *Plan content flow from the risk assessment (problem identification) to goal setting to mitigation action development;*
- *An understanding of mitigation principles (diversity of actions that include structural projects, preventative measures, outreach activities, property protection measures, post-disaster actions, etc);*
- *Specific mitigation actions for each participating jurisdictions that reflects their unique risks and capabilities;*
- *Integration of mitigation actions with existing local authorities, policies, programs, and resources; and*
- *Discussion of existing programs (including the NFIP), plans, and policies that could be used to implement mitigation, as well as document past projects.*

Element D: Plan Update, Evaluation, and Implementation (*Plan Updates Only*)

How does the Plan go above and beyond minimum requirements to document the 5-year Evaluation and Implementation measures with respect to:

- *Status of previously recommended mitigation actions;*
- *Identification of barriers or obstacles to successful implementation or completion of mitigation actions, along with possible solutions for overcoming risk;*
- *Documentation of annual reviews and committee involvement;*
- *Identification of a lead person to take ownership of, and champion the Plan;*
- *Reducing risks from natural hazards and serving as a guide for decisions makers as they commit resources to reducing the effects of natural hazards;*
- *An approach to evaluating future conditions (i.e. socio-economic, environmental, demographic, change in built environment etc.);*
- *Discussion of how changing conditions and opportunities could impact community resilience in the long term; and*
- *Discussion of how the mitigation goals and actions support the long-term community vision for increased resilience.*

B. Resources for Implementing Your Approved Plan

Ideas may be offered on moving the mitigation plan forward and continuing the relationship with key mitigation stakeholders such as the following:

- *What FEMA assistance (funding) programs are available (for example, Hazard Mitigation Assistance (HMA)) to the jurisdiction(s) to assist with implementing the mitigation actions?*
- *What other Federal programs (National Flood Insurance Program (NFIP), Community Rating System (CRS), Risk MAP, etc.) may provide assistance for mitigation activities?*
- *What publications, technical guidance or other resources are available to the jurisdiction(s) relevant to the identified mitigation actions?*
- *Are there upcoming trainings/workshops (Benefit-Cost Analysis (BCA), HMA, etc.) to assist the jurisdictions(s)?*
- *What mitigation actions can be funded by other Federal agencies (for example, U.S. Forest Service, National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA) Smart Growth, Housing and Urban Development (HUD) Sustainable Communities, etc.) and/or state and local agencies?*

SECTION 3:
MULTI-JURISDICTION SUMMARY SHEET (OPTIONAL)

INSTRUCTIONS: For multi-jurisdictional plans, a Multi-jurisdiction Summary Spreadsheet may be completed by listing each participating jurisdiction, which required Elements for each jurisdiction were 'Met' or 'Not Met,' and when the adoption resolutions were received. This Summary Sheet does not imply that a mini-plan be developed for each jurisdiction; it should be used as an optional worksheet to ensure that each jurisdiction participating in the Plan has been documented and has met the requirements for those Elements (A through E).

MULTI JURISDICTION SUMMARY SHEET													
#	Jurisdiction Name	Jurisdiction Type (city/borough/ township/ village, etc.)	Plan POC	Mailing Address	Email	Phone	Requirements Met (Y/N)					
							A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Require-ments
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MULTI JURISDICTION SUMMARY SHEET												
#	Jurisdiction Name	Jurisdiction Type (city/borough/ township/ village, etc.)	Plan POC	Mailing Address	Email	Phone	Requirements Met (Y/N)					
							A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Require-ments
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