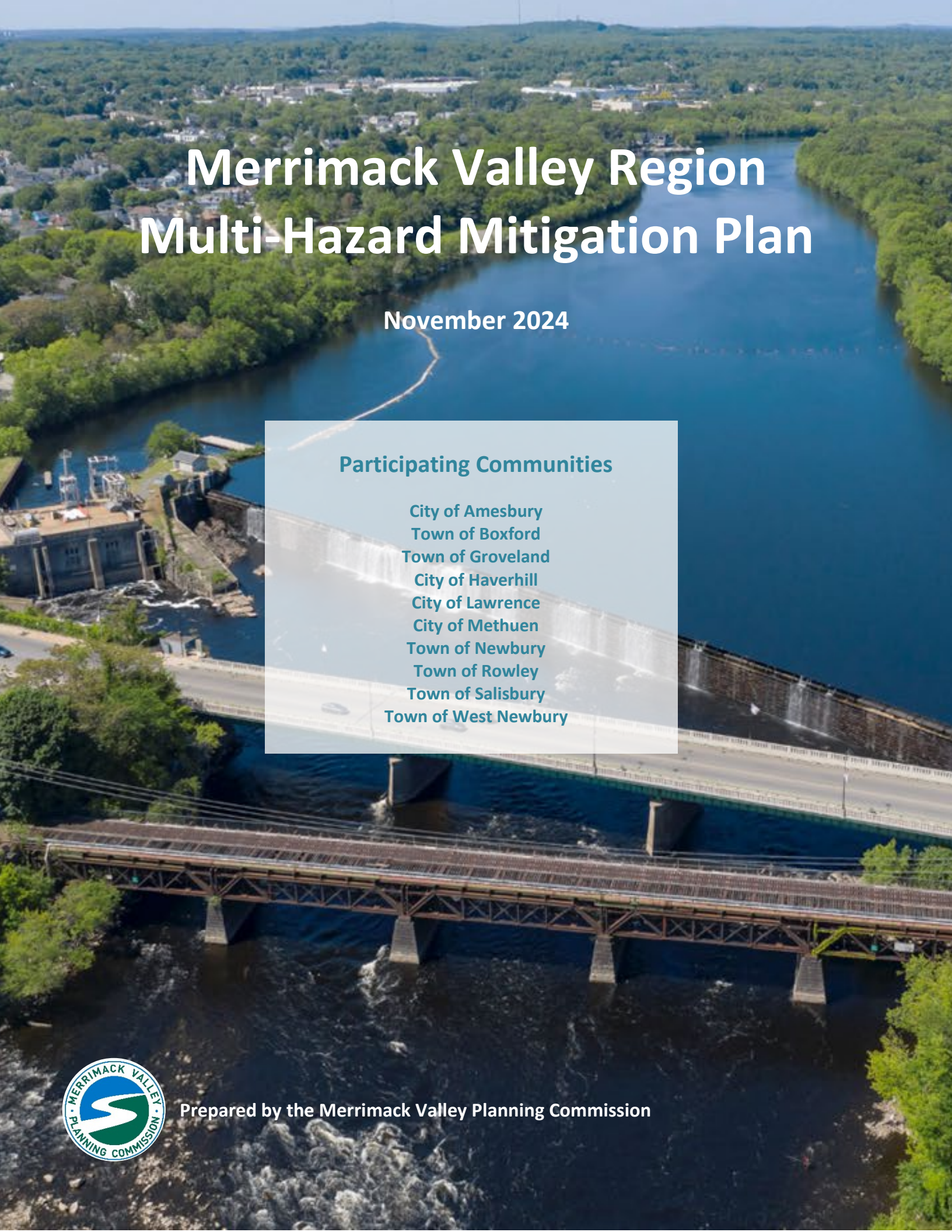

Merrimack Valley Region Multi-Hazard Mitigation Plan

November 2024

Participating Communities

City of Amesbury
Town of Boxford
Town of Groveland
City of Haverhill
City of Lawrence
City of Methuen
Town of Newbury
Town of Rowley
Town of Salisbury
Town of West Newbury

Prepared by the Merrimack Valley Planning Commission

Acknowledgements

The 2024 Merrimack Valley Region Multi-Hazard Mitigation Plan update was conducted in partnership with the following ten Merrimack Valley communities: Amesbury, Boxford, Groveland, Haverhill, Lawrence, Methuen, Newbury, Rowley, Salisbury, and West Newbury. Merrimack Valley Planning Commission (MVPC) extends it grateful appreciation to the Lead Representatives who played a critical role in coordinating this effort for their communities, as well as each communities' Local Hazard Mitigation Planning Team (LHMPT) who dedicated their time and expertise to providing information for the plan update.

Lead Representatives

- **Adam Durkee**, Police Officer & Deputy Emergency Management Director, Haverhill
- **Annie Schindler**, Town Planner & Conservation Agent, Groveland
- **Chris Olbrot**, Department of Public Works Superintendent, Boxford
- **Christine Wallace**, Department of Public Works Project Manager, West Newbury
- **Dan McCarthy**, Land Use Planner & Conservation Agent, Lawrence
- **James Nolan**, Fire Chief, Amesbury
- **Joseph Cosgrove**, Environmental Planner & Energy Manager, Methuen
- **Lisa Pearson**, Planning Director, Salisbury
- **Mark Emery**, Fire Chief & Emergency Management Director, Rowley
- **Martha Taylor**, Planning Director, Newbury
- **Rebecca Oldham**, Town Administrator, Groveland
- **Robert Pistone**, Chief of Police, Haverhill
- **Robert Serino**, Deputy Fire Chief, Amesbury

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Lastly, we also wish to acknowledge the following Commission staff for their contributions to this update:

- **Hanna Mogensen**, Coastal Resource Coordinator, Merrimack Valley Planning Commission
- **Cecelia Gerstenbacher**, Environmental Program Manager, Merrimack Valley Planning Commission
- **Jerrard Whitten,** Executive Director, Merrimack Valley Planning Commission
- **Stephen Lopez,** GIS/IT Program Manager
- **Mikayla Minor,** Senior GIS Analyst, Merrimack Valley Planning Commission
- **Joseph Barmashi,** GIS Specialist
- **Sarah Reny**, GIS Analyst, Merrimack Valley Planning Commission
- **Macklen Wier,** Environmental Planner, Merrimack Valley Planning Commission
- **Jenifer Dunlap,** Deputy Director/Finance Director, Merrimack Valley Planning Commission

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EXECUTIVE SUMMARY

Local hazard mitigation planning is the process of 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 Hazard Mitigation Plan (HMP) and update their plan every five years to be eligible for Federal Emergency Management Agency (FEMA) funding for hazard mitigation grants. The Merrimack Valley Regional Multi-Hazard Mitigation Plan was first created in 2008, and updated in 2016. This current 2024 update, completed by ten of the Merrimack Valley communities with assistance from the Merrimack Valley Planning Commission (MVPC), marks the Plan's second update.

To update the HMP, participating communities engaged in a multi-step process. Through completing ten modules, the communities: formed their local hazard mitigation planning teams (LHMPT), identified natural hazards in their communities, updated their community lifelines/critical facilities, developed vulnerability profiles, determined a set of mitigation goals, established action plans and associated mitigation plans to achieve their goals, sought public comment and input, integrated feedback to improve their plan, and ultimately finalized, sought approval, and adopted an updated Regional Multi-Hazard Mitigation Plan. This process began in December of 2022 and concluded in December 2024.

A broad range of individuals representing a diversity of interests and voices were engaged throughout this process to ensure that the Plan reflected the varied perspectives and needs of the communities within the Merrimack Valley region. As a multi-jurisdictional plan, participating communities took advantage of the opportunity for collaboration through participating in regional workshops and sharing resources and findings.

Through completing comprehensive planning aimed to protect and bolster our communities, natural systems, and built infrastructure against natural hazards, our region was able to identify vulnerabilities and outline actionable goals to reduce future risk. Through centering equity and integrating a holistic focus on climate change, the updated HMP sought to address vulnerability in a more comprehensive and proactive manner.

From this process, communities will continue to take active steps to implement their Mitigation Action Plans over the next five years. Through annual reviews, progress will be tracked and effectiveness assessed. The public will be provided opportunities to engage with community-specific actions and will be invited to contribute input to the progress and development of this Plan during subsequent updates, occurring every five years as required by the Disaster Mitigation Act of 2000.

SECTION 1. INTRODUCTION

*This section provides a general introduction to the updated **Merrimack Valley Regional Multi-Hazard Mitigation Plan 2024** (hereinafter "the Plan" or "HMP").*

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 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. It also required that all communities have an approved Multi-Hazard 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 federal mitigation and recovery funding. Plan updates must demonstrate that progress has been made in the last five years through a comprehensive review of the previous plan.

Hazard mitigation plans must identify measures that can be taken to reduce or prevent future disaster damage 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 2019, 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]

Hazard Mitigation Plans offer a number of benefits:

- Assessing natural hazards provides a comprehensive assessment of localized risk
- Identifying goals to manage risk outlines a road map with tangible next steps
- Submitting a compliant plan qualifies communities for Federal funding for both pre-disaster mitigation and recovery

The 2024 Merrimack Valley Regional Multi-Hazard Mitigation Plan updates the 2016 plan to reflect changes in development, populations, mitigation priorities, and recent hazards, including updated data science and related planning efforts. In accordance with changes made to FEMA's State and Local Mitigation Planning Policy Guide in April of 2022, additions were also made to consider equity and climate change impacts, ensure broad and dynamic representation from stakeholders, consider adoption and enforcement of building codes, and focus on High Hazard Potential Dams (HHPD).

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

1.2 Planning for a Changing Climate

In considering natural hazards for the region, the importance of integrating climate projections has become increasingly apparent. Using best available data to plan for current conditions *and* expected conditions relating to natural hazards is essential for ensuring the safety, productivity, and long-term success of our region.

Work to integrate future risk into current planning has been underway in Massachusetts. In 2016, Governor Baker issued Executive Order 569, directing State agencies to coordinate efforts to strengthen the resilience of Massachusetts communities, prepare for the impacts of climate change and mitigate damage from extreme weather events. The Commonwealth's response was the Municipal Vulnerability Preparedness (MVP) Grant Program which provides support to Massachusetts communities to plan for climate resilience and implement key adaptation actions. Through completing a resilience-based planning process, a city or town can become a formally designated MVP community, making them eligible for MVP action grants to undertake technical plans and design and construct priority resilience projects. Since the last regional update in 2016, all communities within the Merrimack Valley Region have become designated MVP communities (Table 1). Each community that participated in the regional update utilized this comprehensive planning process to integrate climate change impacts and adaptation strategies into local plans and policies.

Following this designation, a total of 12 of the 15 communities in the Merrimack Valley region have successfully applied for and received MVP Action Grant funding to advance actions identified through their MVP plans, resulting in a total of $4.46 million coming to the region to advance resiliency since 2018.

*Table 1.1 Designated MVP communities and associated Action Grant funding (Massachusetts Executive Office of Energy and Environmental Affairs, 2023). *Total funding amounts reflect grants received through FY2024. Funding received through joint grants was divided evenly across recipient communities to achieve totals listed below.*

Community	Year of MVP Designation	Recipient of MVP Action Grant Funding	Total Funding Received*
Amesbury	2019	Yes	37,500
Andover	2019	Yes	485,305
Boxford	2019	Yes	281,189
Georgetown	2020	No	0
Groveland	2020	Yes	225,852
Haverhill	2020	Yes	604,693
Lawrence	2018	Yes	213,518
Merrimac	2020	No	0
Methuen	2019	Yes	80,250
Newbury	2018	Yes	480,890
Newburyport	2018	Yes	1,493,958
North Andover	2021	No	0
Rowley	2020	No	0
Salisbury	2019	Yes	407,500
West Newbury	2020	Yes	150,000
Region	-	-	**4,460,655**

1.3 Natural Hazard Mitigation Planning in the Merrimack Valley

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. Climate change also acts as a force to alter the frequency and intensity of these events. Located in northeastern Massachusetts, the Merrimack Valley region is vulnerable to a wide array of natural hazards. Fifteen natural hazards are outlined within the State's 2018 Hazard Mitigation and Climate Adaptation Plan (SHMCAP). 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 for those who live, work, and play in the region.

While we cannot eliminate natural hazards, there is much we can do to lessen their impact 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 from natural hazards is generally referred to as ***hazard mitigation***. 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 natural hazards, and determining how to best minimize and manage risk."

Local hazard mitigation planning is the process of organizing community resources, identifying and assessing natural hazards, and determining how to best minimize and manage risk. 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 Master Plans or Open Space and Recreation Plans. Similarly, any proposed mitigation strategies and actions should consider other community goals and initiatives that could complement (or possibly hinder) their future implementation.

1.4 Plan Purpose

The purpose of the **Merrimack Valley Regional Multi-Hazard Mitigation Plan** 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 plan *before* disaster strikes, Merrimack Valley communities will be better able to prevent and minimize loss of life and property.

The Federal Emergency Management Administration (FEMA) 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. The goal of this update is to maintain compliance with the Federal Disaster Act of 2000 and in doing so, support communities in updating local mitigation strategies and implementation actions that address *priority* mitigation needs identified by each community, and are properly coordinated among the region's communities to maximize resources, encourage collaboration, and avoid duplication.

Because Hazard Mitigation Plans must be updated every five years to demonstrate that progress has been made in fulfilling the goals outlined in the previous plan, a review and update of each section of the plan is required. The Merrimack Valley Regional Multi-Hazard Mitigation Plan was first written in 2008 and updated in 2016. Through Building Resilient Infrastructure Communities (BRIC) grant funding, applied for and received by the City of Lawrence on behalf of the region, Merrimack Valley communities were able to complete another regional update in 2024. This document represents the second full update to the region's 2008 Hazard Mitigation Plan.

The 2024 HMP builds upon previous plans by:

- **Reassessing the natural hazards included in the previous plan, as well as new occurrences of hazard events and changes in the region's vulnerability.**
- **Integrating a greater focus on climactic changes and the region's capacity to adapt to and improve changing hazards as they relate to a changing climate in the future.**
- **Placing a greater focus on equity and how different populations may be disproportionally impacted by natural hazards.**
- **Identifying changes in development patterns, land use, and demographics as well as local and regional priorities.**
- **Reporting on progress made on previously identified mitigation actions and integrating new information and priorities for future mitigation.**

1.5 Geographic Scope

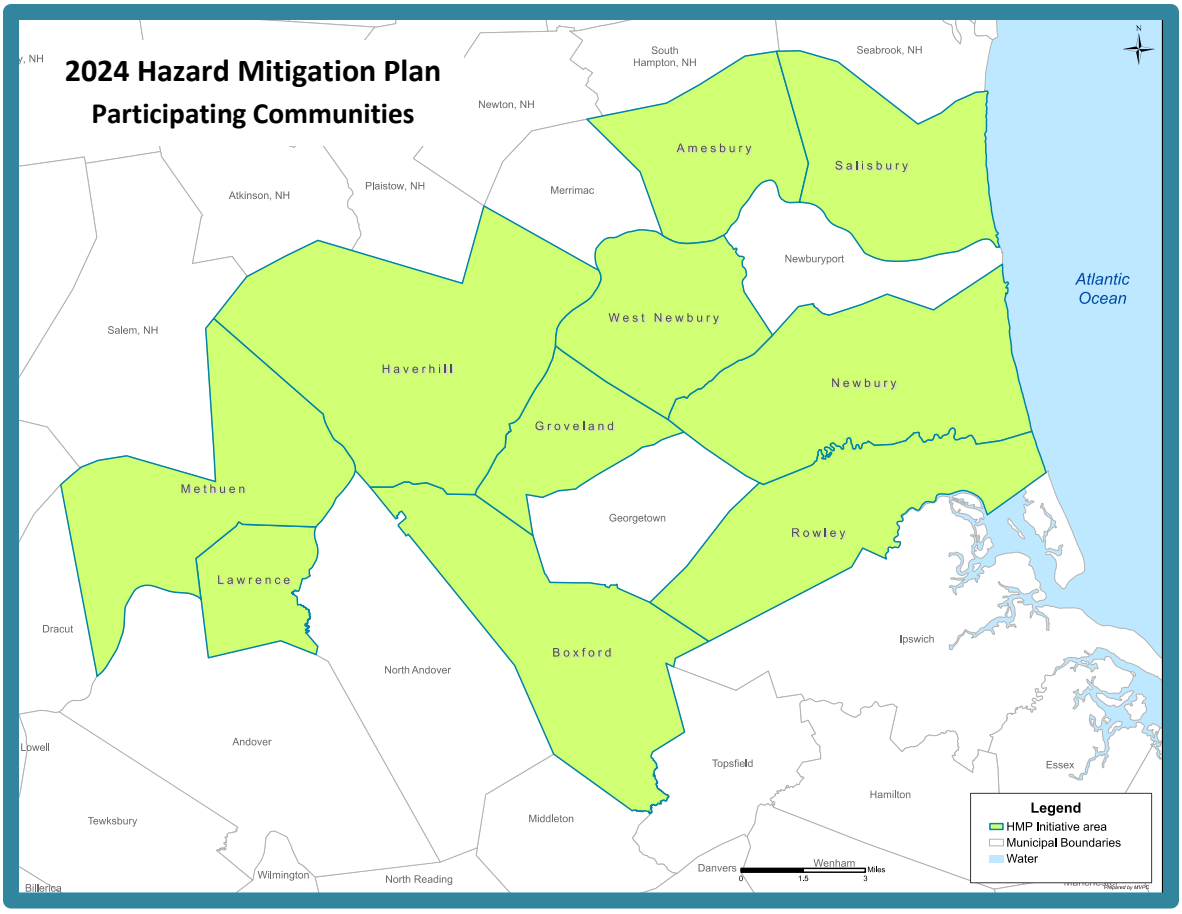


Figure 1.1 Map of participating communities in the Merrimack Valley Region.

The geographic scope of this Plan is 10 of the 15 municipalities that comprise the Merrimack Valley Planning Region in northeastern Massachusetts: Amesbury, Boxford, Groveland, Haverhill, Lawrence, Methuen, Newbury, Rowley, Salisbury, and West Newbury (Figure 1.1). Participation in the regional plan has fluctuated over the years, with 12 municipalities participating in the development the original Plan in 2008, 14 municipalities participating in the regional update of 2016, and 10 municipalities participating in the most recent update in 2024.

The MVPC region as a whole covers 264 square miles and is home to a resident population of 369,889.[2] Part of the New England "Seaboard Lowland," the region has a variegated terrain that was scoured and shaped by Pleistocene Epoch glaciers thousands of years ago. Prominent landforms include drumlin hills, outwash terraces and plains, and broad coastal marsh. Major hydrographic features include the Merrimack, Ipswich, Parker, Spicket and Shawsheen Rivers and their tributaries, as well as Plum Island Sound and the Atlantic Ocean. The ocean forms the region's eastern boundary from the New Hampshire state line to the southern terminus of Plum Island -- a coastline of approximately 10 miles. Elevations across the region range from sea level to 413 feet (Holt Hill in Andover), and average less than 100 feet mean sea level.

[2] United States Census Bureau. 2023. QuickFacts. U.S. Census Bureau QuickFacts: United States

SECTION 2. PLANNING PROCESS

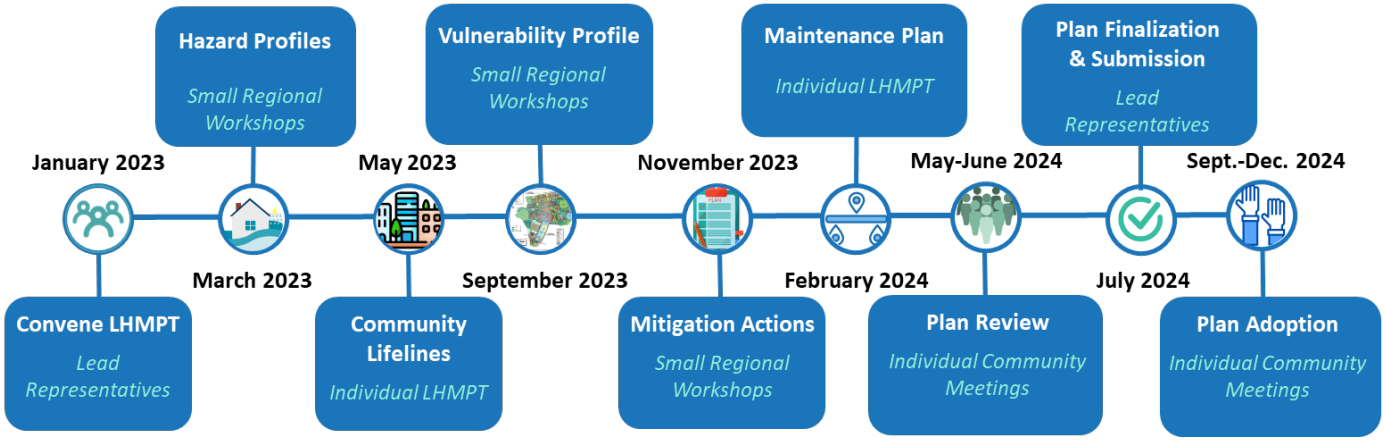
This section of the plan describes the update process undertaken by the ten participating Merrimack Valley communities and their stakeholders with guidance from the Merrimack Valley Planning Commission (MVPC) to develop the ***2024 Merrimack Valley Regional Multi-Hazard Mitigation Plan.***

2.1 Coordinating Role of Regional Planning Agency

The Massachusetts Emergency Management Agency (MEMA) has encouraged the Commonwealth's 13 Regional Planning Agencies to act as facilitators of local hazard mitigation planning efforts. The Merrimack Valley Planning Commission (MVPC) coordinated and facilitated the updating of the Regional Hazard Mitigation Plan in partnership with 10 of the regions 15 member communities and with input from partner organizations and stakeholders.

MVPC completed the region's initial Hazard Mitigation Plan in 2008, and the first update in 2016. This second update builds upon prior planning initiatives. To complete this update, recently developed plans, including comprehensive community plans and master plans, open space and recreation plans, economic development plans, municipal vulnerability plans, and emergency management plans have been consulted. The *Merrimack Valley Comprehensive Economic Development Strategy* was also considered in formulating the updated document. The *Merrimack Valley Priority Growth Strategy, Merrimack Valley Regional Transportation Plan*, and *Merrimack Valley Housing Production Plan* were all in the process of being updated at the time of this plan's completion, however efforts were made to coordinate information across the plans. New information regarding changes in development patterns, progress in local mitigation efforts, and changes in local and regional priorities have been incorporated into the update as well.

Timeline of the 2024 Merrimack Valley Multi-Hazard Mitigation Plan Update



2.2 Preparing for the Plan Update Process

In preparation for the Plan update, MVPC staff conferred with Massachusetts Emergency Management Agency (MEMA), attended FEMA- and MEMA-sponsored hazard mitigation planning conferences, and reviewed state and federal guidance documents pertaining to the development of an updated multi-hazard mitigation plan. MVPC staff also utilized FEMA's "Local Mitigation Planning Handbook" (2013) to guide the update process. Special attention was given to planning requirements described in FEMA's updated guidance document "Local Mitigation Planning Policy Guide" (2022) and additional supporting documents "State and Local Mitigation Planning Policy Guides: Summary of Changes" and "Local Mitigation Planning Policy Side-by-Side Comparison." Massachusetts's State Hazard Mitigation and Climate Adaptation Plan (SHMCAP, 2018) and ResilientMass (2023) were also referenced and used as a guide to organize the hazards outlined in this update. To understand community conditions, local planning documents including Municipal Vulnerability Plans, Open Space and Recreation Plans, Master Plans, among others, were also reviewed and incorporated. To understand the current and future projected impacts of natural hazards in the Commonwealth, best available data including data from the US Census Bureau, Massachusetts Executive office of Energy and Environmental Affairs, National Oceanic and Atmospheric Administration, Army Corps of Engineers, United States Geological Survey, Center for Disease Control, National Aeronautics and Space Administration, as well as other sources were used and referenced throughout the plan as in-text citations. To guide communities through the update process, a series of modules were developed. A copy of all module templates can be found in Appendix C.

2.3 Hazard Mitigation Planning Teams and Stakeholders

Project Announcement. On November 10th, 2022 MVPC issued a notification to local public officials and other interested community stakeholders throughout the Merrimack Valley Region, announcing the planning project's start-up and inviting recipients to attend a kick-off meeting.

Regional "Kick-off" Meeting. On December 7th, 2022, MVPC hosted a virtual "kick-off' to officially launch the plan updating project. This event was intentionally held virtually to increase participation, maximize attendance, and enable recording for broader distribution following the event. A total of 46 individuals attended, including numerous local emergency management personnel (police, fire, public works), city and town planners, conservation agents, municipal engineers, and building inspectors.

The meeting introduced local and regional hazard mitigation team members and other relevant parties to the plan update process and plan contents. The presentation provided an overview of the main components required in a multi-hazard mitigation plan and laid out an expected timeline for the update and the structural process. As part of the kick-off, MEMA Hazard Mitigation Grant Coordinator Michelle O'Toole also presented on the funding programs and opportunities associated with a successful Hazard Mitigation plan.

Formation of Planning Teams. Each participating municipality was asked to form a Local Hazard Mitigation Planning Team (LHMPT) to guide update efforts within their community. The LHMPTs incorporated a broad range of municipal staff and boards including, where possible: the community development director/planner, city/town engineer, public works director, emergency management director, conservation agent, health agent, police and fire chiefs, building inspector, appointed/elected officials, and other interested parties. This team was responsible for making decisions, engaging key

stakeholders, guiding the planning process, and agreeing upon the final contents of the plan. A full list of individuals who served on each community's LHMPT is included in Appendix A. Each community was asked to designate one member of their LHMPT as the Lead Representative. The role of the Lead Representative was to serve as primary point of contact and liaison between the MVPC planning staff and the LHMPT. The Lead Representatives along with key staff from the coordinating organization, Merrimack Valley Planning Commission, formed the Regional Hazard Mitigation Planning Team (RHMPT).

Regional Hazard Mitigation Planning Team Members

- **Adam Durkee**, Police Officer & Deputy Emergency Management Director, Haverhill
- **Annie Schindler**, Town Planner & Conservation Agent, Groveland
- **Chris Olbrot**, Department of Public Works Superintendent, Boxford
- **Christine Wallace**, Department of Public Works Project Manager, West Newbury
- **Dan McCarthy**, Land Use Planner & Conservation Agent, Lawrence
- **James Nolan**, Fire Chief, Amesbury
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- **Rebecca Oldham**, Town Administrator, Groveland
- **Robert Pistone**, Chief of Police, Haverhill
- **Robert Serino**, Deputy Fire Chief, Amesbury
- **Hanna Mogensen**, Coastal Resource Coordinator, Merrimack Valley Planning Commission
- **Cecelia Gerstenbacher**, Environmental Program Manager, Merrimack Valley Planning Commission

To facilitate the Hazard Mitigation update process, three different methods of engagement were used depending on the requirements of the task at hand. For some steps, Lead Representatives were convened virtually or in person at Merrimack Valley Planning Commission offices to roll out modules and report back on work completed by LHMPTs. For other steps, MVPC met directly with individual LHMTs to host community-specific workshops or town meetings to gather broader community input. In other instances, multiple LHMTs were convened together in small regional workshops with 3-4 community to actively complete more in-depth aspects of the Plan update. Overall, these in-person meetings generally formed the heart of the planning process, as they were instrumental in assembling much of information needed for the plan update and in engaging many of the individuals who will be responsible for the updated Plan's implementation.

2.4 Natural Hazard Identification

A series of three sub-regional community workshops were held across the valley in March 2023. During the workshops, LHMPTs identified their engagement/ outreach strategy to ensure broad and inclusive

participation in the planning process. Following this activity, each LHMPT reviewed the comprehensive set of state-identified natural hazards and assessed each hazard's location, previous occurrence, severity/extent, future probability, and overall risk to their community. Participants used a range of resources to complete this step, including previous HMP and MVP plans, best available scientific data, and community-specific and regional natural hazard maps. Following the workshop, participants were sent a digital survey to share local and acute examples of natural hazard events that have occurred since the last Plan update.

2.5 Identifying Community Lifelines

In May 2023, Lead Representatives from each of the participating communities were convened for a virtual meeting to identify their Community Lifelines. Community Lifelines include the most fundamental services in each community that enable all other aspects of society to function. Community Lifelines can include buildings and infrastructure, services, resources, and other assets. Teams used previous maps and datasets (compiled into excel workbooks) to confirm existing lifelines and incorporate newly developed lifelines or new lifeline categories into the plan. Individuals outside of LHMPTs were also consulted to ensure lifeline and community data was comprehensive and accurate. This included consulting utility groups, hospitals, clinics, community-centers, and other relevant parties who manage and provide critical services to the region. The community lifeline identification 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.

2.6 Vulnerability Assessment, and Existing Protections Matrix

A series of three sub-regional workshops were held across the valley in September 2023. Teams reviewed draft community profiles and developed challenge statements identifying risk in their community. Community profiles provided an overview of each participating community by detailing the current demographics, key services, recent development and land use changes, community lifelines, critical infrastructure, and community specific hazards. LHMPT reviewed profiles in depth and provided both larger structural edits as well as red-line edits for further refinement. Next, using a series of updated maps depicting current natural hazards, composite hazards, and projected community hazards due to climate change, each LHMPT developed a set of challenge statements outlining natural hazards, associated problems, and the vulnerability/risk to the community. These challenge statements were used in subsequent modules to identify goals and develop action plans to reduce vulnerability. Following the workshop, each community completed a digital workbook pre-populated with information on their existing capabilities (policies, plans, and programs), as well as their status and compliance with the National Flood Insurance Program (NFIP), Community Rating System (CRS), and High Hazard Potential Dam (HHPD) program.

2.7 Review and Development of Hazard Mitigation Action Plans

A series of sub-regional workshops were held in November and December 2023 to review and update Mitigation Action Plans. Using Mitigation Action Plans from the 2016 update, communities assessed each action and indicated what progress had been made since 2016. LHMPTs also provided an updated status for each action. After reviewing existing actions, communities used their challenge statements, other relevant community plans (such as MVP plans), and relevant scientific data to identify new actions to include in their updated Mitigation Action Plan. For each action, the associated hazard, implementing responsibility, timeline, cost, and potential funding source were identified.

2.8 Prioritization of Mitigation Actions and Development of Maintenance Plans

The comprehensive list of mitigation actions were then prioritized by each LHMPT by assessing each action using ten (10) different criteria: Funding- is it feasible to cover the associated cost of the project; Safety- how effective will the action be at protecting lives and preventing injury; Property- how significant will the action be at eliminating/reducing damage; Authority- does the community have authority to implement; Social- is there public support for the action; Community Resilience- will the action benefit a vulnerable group in the community; Environmental- are there potential environmental impacts of the action (+/-); Capacity- are there personal/admin resources to implement and maintain the action; Champion- is there a strong advocate for the action that can champion the effort; and Symbiosis- does the action advance other community objectives. LHMPTs also reviewed and specified their role in a comprehensive maintenance plan, to ensure continued public participation, monitoring, evaluation, and timely updating of the 2024 Hazard Mitigation Plan.

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

To ensure a comprehensive, accurate, and successful plan, broad community involvement is needed during development and implementation. Accordingly, a public involvement process was utilized to encourage governmental entities, adjacent communities, residents, businesses, and nonprofit organizations to participate in the planning process. This took the form of public engagement meetings to craft the 2008 plan, in which the public reviewed maps, helped to develop mitigation actions, and completed surveys and questionnaires. For the 2024 plan update, community-based organizations, non-profits and school districts, were directly involved through serving on Local Hazard Mitigation Planning Teams (Appendix A). Such groups included Groundwork Lawrence, which works closely with EJ communities in The Cities of Lawrence, Haverhill, and Methuen; Chambers of Commerce representing businesses in the region; and School Superintendents. For select communities with designated staff, participation from DEI and ADA Coordinators also ensured the needs of underserved communities were represented in the planning process. To expand input into the plan, each participating community also held two public meetings to gather public input; one to review the outcomes of the HMP update process and draft plan, and the second to review the final HMP Plan prior to adoption.

First public meetings were held in May and June 2024. Public meetings were advertised on the Public Meetings Calendar on local city/town websites. All LHMPT members were invited via email. Outreach was conducted to invite key stakeholders to provide input on the draft plan. This included non-profits, community-based organizations, businesses, Council on Aging organizations, utility companies, conservation organizations, elected officials and state departments. A comprehensive list of stakeholders directly invited to attend public meetings and review the draft plan is included in Appendix A. Public meetings were held using a diversity of approaches to try to reach a wide audience. Some meetings were held as part of existing Select Board and City Council meetings which were aired on public television and streamed over zoom. Other meetings were incorporated into town-wide events and forums.

At each public meeting MVPC in conjunction with each community presented the priority actions identified during the planning process and facilitated discussion with attendees. Following the first public meeting, the plan was made available for 5 weeks for public comment. The Public Comment period was promoted through posting on the MVPC website, MVPC blogs and social media platforms. Participating cities and towns amplified the announcement through their own websites, message boards, and social media platforms as well as direct outreach to key stakeholders identified above. Public comments were received through e-mail, survey forms, and over the phone. A hard copy of the plan was made available at Merrimack Valley Planning Commission offices in Haverhill.

Following the close of the public comment period, meetings were held with MVPC and Lead Representatives/ LHMPTs to consider all comments and integrate changes into the plan. Changes were made to address terminology, accessibility/readability, bolster local information around hazards, and amend and add new Mitigation Action goals. Following review and integration into the plan, follow-up was conducted to notify each respondent of what changes had been made to the plan based on their comments.

Second public meetings were held once comments from MEMA and FEMA had been received and the plan had Approvable Pending Adoption (APA) status and was ready to present to each communities' governing body for adoption. These meetings provided the public with the opportunity to again, share comments and feedback on the plan prior to adoption.

Section 3. Regional Profile

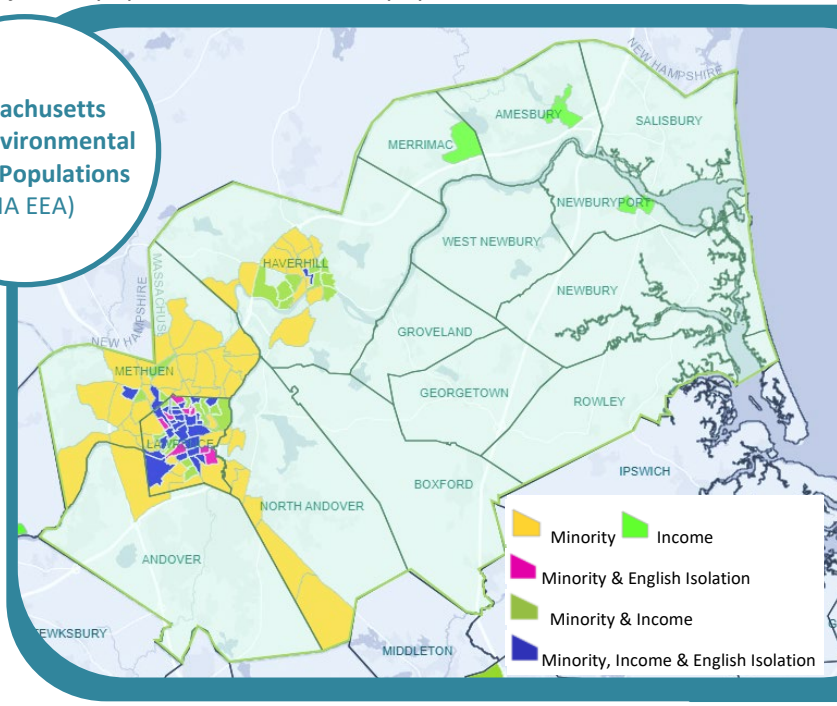
This section of the Plan provides an overview of the Merrimack Valley region and includes updated information on the region's population and economy, land use, transportation network, water resources, protected open space, and historic/cultural resources. It is intended to provide context for the natural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

3.1 Current Population, Housing, and Employment

3.1.1 Population. The Merrimack Valley region's 15 cities and towns cover 264 square miles and have a resident (year-round) population of 369,889.[3] During the summer months, the population swells considerably as vacationers and tourists flock to the seaside resorts of Salisbury Beach, downtown Newburyport, and Plum Island. The population density (persons per square mile) in the region ranges from 287 in semi-rural Newbury to 12,919 in densely-developed Lawrence, and averages 1,400 region-wide. Together, the three central cities of Haverhill, Lawrence, and Methuen account for over 57% of the region's total population.

3.1.2 Environmental Justice Populations. The Massachusetts Executive Office of Energy Environmental Affairs released updated maps of environmental justice populations in 2022.[4] These maps incorporate data from the 2020 U.S. census on environmental justice populations, defined as populations in which: the annual median household income is ≥65% of the statewide level; minorities comprise ≤40% of the population, ≤25% or more of households identify as speaking English less than "very well"; or minorities comprise ≤25% or more of the population and the median household income of the residing municipality is less than 150% of the statewide annual median household. In addition to these categories, the State 2018 Hazard Mitigation and Climate Adaptation Plan (SHMCAP) also identified additional priority populations as "people or communities who are disproportionately impacted by climate change due to life circumstances that systematically increase their exposure to climate hazards or make it harder to respond. In addition to factors that contribute to EJ status (i.e., income, race, and language), other

Massachusetts 2020 Environmental Justice Populations (MA EEA)



[3] United States Census Bureau. 2023. QuickFacts. U.S. Census Bureau QuickFacts: United States

[4] Massachusetts Executive Office of Energy and Environmental Affairs. 2022. Environmental Justice Populations in Massachusetts. Massachusetts 2020 Environmental Justice Populations (arcgis.com)

factors like physical ability, access to transportation, health, and age can indicate whether someone or their community will be disproportionately affected by climate change."[5]

3.1.3 Housing. The demand for housing in the Merrimack Valley has typically outpaced the available supply. *Figure 3.1* depicts the total number of dwelling units permitted in the MVPC region by year for the 20-year period from 2000-2020.[6] For the first five years of this period (2000 to 2005), permits increased steadily, reaching 1,317 in 2005 before plunging to a Great Recession low of 284 in 2009. Following the recession, dwelling unit permits increased again, reaching a second high in 2014 of 806 units permitted. The most recent data from 2020 indicates dwelling units permitted are at another relative low (350), with 234 of those permitted for Single Family, 51 for Five or More Units, 42 for Two Family, and 7 for Three and Four Family.

Although the rate of single-family residential growth has fluctuated some in accordance with economic cycles, single-family development has generally been strong and consistent over the past 20 years and continues to be the principal mode of development. Single-family residential growth accounts for the continued "sprawl" development occurring in the region's suburban and semi-rural communities. From a natural disaster (especially *flooding*) perspective, this pattern of development has several undesired consequences, including an accelerated loss of open space and natural flood storage capacity, increased impervious surface cover, and increased stormwater runoff. While recent progress has been made in the use of Smart Growth and open space residential design (OSRD) as a means of "clustering" home sites and preserving a greater proportion of the natural landscape, this style of development is still in its relative infancy in the Valley and remains a small percentage of the total housing starts.

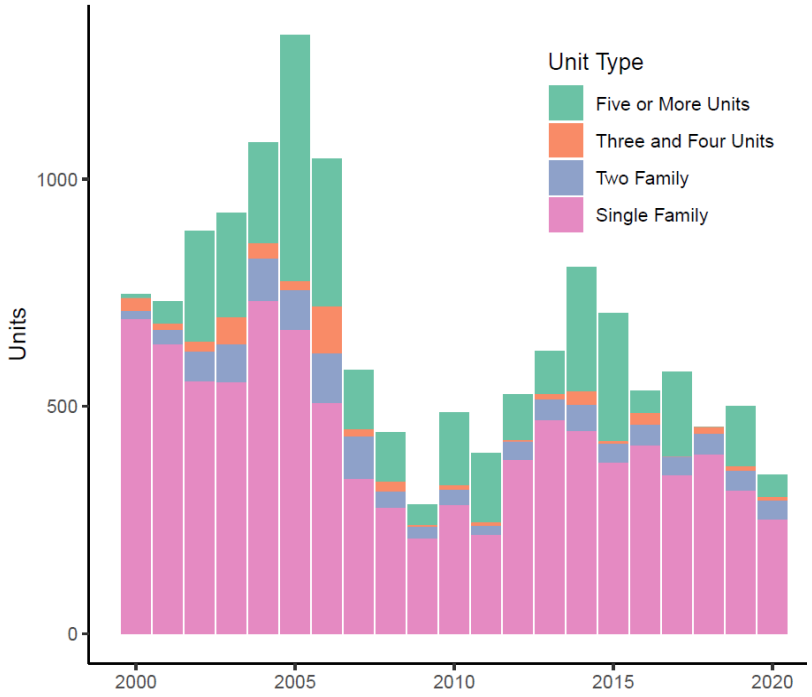


Figure 3.1 Total number of dwelling units permitted in the Merrimack Valley Region by year from 2000 to 2020 (Massachusetts Housing Data Portal, 2023)

The introduction and local promotion of housing production strategies across the Merrimack Valley is largely facilitated by municipal and regional planners, Affordable Housing Trusts, and locally led housing committees. Over the past several years, these groups have worked to spur housing production in a manner consistent with the needs of current and future populations, in accordance with a 5-year municipal Housing Production Plan (HPP). Each community in the Valley has an approved HPP (2018-2023)[7], which is

[5] Massachusetts Emergency Management Agency & Massachusetts Executive Office of Energy and Environmental Affairs. 2018. Massachusetts State Hazard Mitigation and Climate Adaptation Plan. SHMCAP-September2018-Chapter1.pdf (mass.gov)

[6] Metropolitan Area Planning Council. 2023. The Massachusetts Housing Data Portal. Housing MA

[7] Merrimack Valley Planning Commission. 2018. 2018 Merrimack Valley Regional Housing Plan. MV-Housing-Plan-full-final-version-1.pdf (mvpc.org)

currently undergoing an update, expected complete in 2024. HPPs allow communities to articulate their vision for housing production and identify strategies suited to local needs. Having an approved HPP grants communities local control over affordable multi-family housing development, further ensuring that development occurs in locations best suited to community and environmental needs. A key strategy cited in the Merrimack Valley's 2024-2029 HPP is achieving compliance with Section 3A, MBTA Communities, zoning mandate. Passed by the Massachusetts legislature in 2021, the law mandates that communities with or bordering an MBTA transit stop adopt a zoning bylaw that allows multi-family housing by-right in certain overlay districts. This is the State's hallmark response to address the state-wide housing shortage and requires included communities create zoning to support the key Smart Growth principle of higher-density development near transit.

3.1.4 Employment. The Merrimack Valley has a long history of adapting to structural changes in the economy. Prior to the industrial revolution, the region was predominantly agrarian, with a few exceptions including Newburyport's shipbuilding fame and Amesbury's prominence in manufacturing of horse-drawn carriages. At the beginning of the 19th century, however, the Merrimack Valley rapidly developed into one of New England's earliest and most important industrial regions due to the woolen worsted and footwear industries. New England textile and footwear industries declined significantly following World War II, with the Valley experiencing a net loss of nearly 18,000 jobs and a 17% reduction in employment.

Table 3.1 Summary of current (2020) population, housing, and employment for the Merrimack Valley.

Merrimack Valley Population, Housing, and Employment						
Community	**Area** (sq. mi)	**Population**	**Population Change** (2010-2020)	**Population Density** (ppl/sq mi)	**Households**	**Employment** (percent 16+)
Amesbury	12.3	17,366	6.65%	1,411.9	7,326	73.5%
Andover	30.8	36,569	10.14%	1,187.3	13,235	68.8%
Boxford	23.6	8,203	2.99%	347.6	2,867	65.8%
Georgetown	12.9	8,470	3.51%	656.6	3,223	66.9%
Groveland	8.9	6,752	4.54%	758.7	2,532	75.7%
Haverhill	33	67,787	11.35%	2,054.2	26,108	70.8%
Lawrence	6.9	89,143	16.71%	12,919.3	30,291	68.0%
Merrimac	8.5	6,723	6.07%	790.9	2,589	67.0%
Methuen	22.2	53,059	12.28%	2,390.1	18,803	68.8%
Newbury	23.4	6,716	0.75%	287.0	2,533	69.0%
Newburyport	8.3	18,289	5.01%	2,203.5	7,573	69.4%
North Andover	26.3	30,915	9.04%	1,175.5	10,971	68.0%
Rowley	18.2	6,161	5.21%	338.5	2,326	72.2%
Salisbury	15.4	9,236	11.51%	599.7	3,885	66.7%
West Newbury	13.5	4,500	6.26%	333.3	1,591	NA

In the 1960s, high tech industries supported largely by defense procurement brought another period of economic growth. However, this was short lived as sharp reductions in military spending and the national recession of 1974-1975 caused high regional unemployment (~16%). Recovery was led by a renewed expansion of the non-defense related high technology industries along the Greater Boston, Route 128 beltway. By the mid-1980s, the region was benefiting from the Massachusetts economic boom, with regional unemployment falling to 4.0%. During the latter half of the 1980s, construction was the fastest growing industry in New England, responding to the growing demand for housing and office space.

A recession in the early 1990s hit the state and the Merrimack Valley earlier and harder than the rest of the nation, but Massachusetts' economies rebounded. From 1991 to 2000, employment in the Valley grew from 133,931 to 154,482 – an increase of over 20,000 jobs. As with the rest of the country, the region took a major hit during the Great Recession of the late 2000s. From 2010-2019, Essex County experienced a steady increase in annual average employment from 358,956 (8.4% unemployment) to 418,029 (3.1% unemployment). In 2020, Essex County, along with the state and country, experienced a decrease in employment (Essex County 380,186) and paired increase in unemployment (Essex County 10.4%) due to the outbreak of the COVID-19 pandemic. In 2022, employment had recovered back to 2017 levels (Essex County 404,395 employed and 3.9% unemployment). [8]

3.2 Land Use Characteristics and Trends

The Merrimack Valley encompasses 264 square miles of land area, slightly more than half of the land area of Essex County. The region is predominantly coastal lowland and substantial portions of its eastern borders are tidal marsh, estuary, and barrier beach. Some agricultural uses remain in the more rural communities of the region – principally dairy, horse, and crop farming – but the overwhelming majority of the region's area is undeveloped forest/open land.

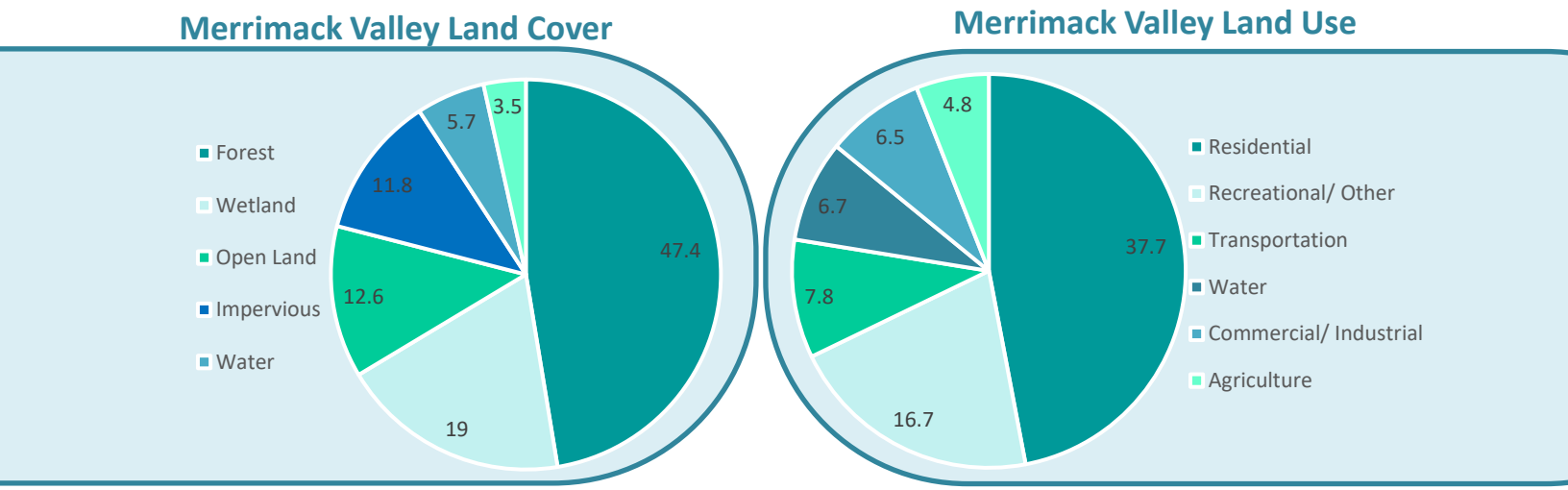


Table 3.2 presents the most recent land use and land cover information available for the 15 cities and towns in the Valley. Since the development of the first Merrimack Valley Regional Natural Hazard Mitigation Plan in 2008, the land use analysis approach has changed based on best available data. In 2008, the plan used the 2005 Land Use Data which was developed from aerial photography interpreted by the University of Massachusetts Department of Forest Resources.[9] The 2016 Land Use Dataset was developed through a combination of the NOAA Coastal Change Analysis Program raster data procured nationally, multispectral satellite imagery and lidar-based terrain elevation data, which resulted in a new 19 class raster dataset.[10] The 2016 Land Use Dataset integrated the 2005 Land Use Data but offered improvement,

[8] Mass.gov, Department of Economic Research, Essex County Laborforce, Employment, and Unemployment https://lmi.dua.eol.mass.gov/lmi/CitiesAndTowns/LmiArea?GA=04&A=000009 (April 2023).
[9] MassGIS. 2005. Land Use (2009). 2005 Land Use Data
[10] MassGIS. 2019. 2016 Land Cover/Land Use. MassGIS Data: 2016 Land Cover/Land Use | Mass.gov

as it described more detailed land cover categories due to changes in interpretation and imagery resolution. It also utilized the newly created Statewide Parcel layer and associated Massachusetts Department of Revenue land use codes.

Because the state has not released a new Land Use Dataset since 2005, the GIS analysis for the 2024 HMP reports both land cover and land use data derived from the state's most updated 2016 land cover layer. While this provides the most updated data for comparison across the land use and land cover categories, the change in methodologies means that comparison of the 2024 data to the 2008 and 2016 data is challenging.

The largest category of developed *land use* in the Merrimack Valley region is residential (37.7%). This includes all residential dwelling types, from large lot, single-family homes to multi-family apartments and condominiums. Recent development across the region has been mainly in the form of large lot, single

*Table 3.2 Land use and land cover data extrapolated from the State's 2016 Land Cover Layer (MassGIS, 2016). *Total acreage differs between land use and land cover data due to discrepancies in methodologies used to create the two*

MERRIMACK VALLEY LAND USE

	Agriculture		Commercial and Industrial		Recreation/Other		Residential		Transportation		Water		Total Acres
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	
Amesbury	1,078	12.3	554	6.3	2,950	33.6	2,633	30.0	776	8.8	793	9.0	**8,784**
Andover	77	0.4	1659	8.1	7,866	38.2	8,402	40.8	1927	9.4	646	3.1	**20,578**
Boxford	953	6.1	134	0.9	5,313	34.0	8,024	51.4	833	5.3	364	2.3	**15,621**
Georgetown	115	1.4	483	5.7	3,646	43.3	3,420	40.7	608	7.2	144	1.7	**8,415**
Groveland	77	1.3	404	6.7	2,771	46.1	2,212	36.8	268	4.5	283	4.7	**6,014**
Haverhill	1,296	5.7	1462	6.4	7,083	31.0	9,168	40.1	2368	10.4	1471	6.4	**22,847**
Lawrence	0	0.0	762	16.0	1,042	21.9	1,621	34.1	1014	21.3	315	6.6	**4,754**
Merrimac	419	7.4	90	1.6	1,778	31.2	2,816	49.4	371	6.5	224	3.9	**5,698**
Methuen	176	1.2	1070	7.3	4,357	29.6	7,214	49.0	1800	12.2	102	0.7	**14,719**
Newbury	1,137	6.9	231	1.4	10,153	61.4	4,237	25.6	528	3.2	243	1.5	**16,530**
Newburyport	393	5.7	625	9.0	3,398	48.8	1,605	23.0	723	10.4	221	3.2	**6,965**
North Andover	730	4.1	1280	7.2	6,711	37.8	7,210	40.7	1135	6.4	672	3.8	**17,738**
Rowley	566	4.4	750	5.9	7,006	54.8	3,987	31.2	381	3.0	93	0.7	**12,783**
Salisbury	581	5.3	402	3.7	6,466	58.8	2,919	26.5	461	4.2	177	1.6	**11,007**
West Newbury	877	9.3	61	0.7	3,139	33.3	4,355	46.2	339	3.6	653	6.9	**9,424**
MV Region	**8,475**	**4.7**	**9,964**	**6.5**	**73,679**	**16.7**	**69,822**	**37.7**	**13,533**	**7.8**	**6,402**	**6.7**	**181,875**

MERRIMACK VALLEY LAND COVER

	Cultivated		Forest		Impervious		Open Land		Water		Wetland		Total Acres
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	
Amesbury	608	6.9	3,786	43.2	1,109	12.6	1,283	14.6	821	9.4	1,164	13.3	**8771***
Andover	142	0.7	11,290	54.9	2,913	14.2	2,639	12.8	793	3.9	2,800	13.6	**20,578**
Boxford	340	2.2	9,830	62.9	859	5.5	1,118	7.2	513	3.3	2,960	19.0	**15,621**
Georgetown	95	1.1	4,783	56.8	721	8.6	843	10.0	199	2.4	1,775	21.1	**8,415**
Groveland	92	1.5	3,254	54.1	461	7.7	744	12.4	312	5.2	1,151	19.1	**6,014**
Haverhill	1108	4.9	10,957	48.1	3,356	14.7	3,469	15.2	1558	6.8	2,345	10.3	**22793***
Lawrence	6	0.1	1,048	22.1	2,510	52.8	777	16.4	247	5.2	165	3.5	**4,754**
Merrimac	354	6.2	3,372	59.4	466	8.2	588	10.4	234	4.1	662	11.7	**5674***
Methuen	215	1.5	6,423	43.7	2,836	19.3	2,722	18.5	416	2.8	2,098	14.3	**14710***
Newbury	922	5.6	5,943	36.0	780	4.7	1,904	11.5	780	4.7	6,201	37.5	**16,530**
Newburyport	463	6.6	2,090	30.0	1,249	17.9	1,201	17.3	1221	17.5	740	10.6	**6,965**
North Andover	476	2.7	9,208	51.9	2,107	11.9	2,013	11.4	874	4.9	3,061	17.3	**17,738**
Rowley	413	3.2	5,636	44.1	631	4.9	1,474	11.5	660	5.2	3,969	31.1	**12,783**
Salisbury	347	3.2	3,707	33.8	1,048	9.6	1,278	11.7	960	8.8	3,613	33.0	**10953***
West Newbury	795	8.4	4,887	51.9	428	4.5	842	8.9	679	7.2	1,793	19.0	**9,424**
MV Region	**6375**	**3.5**	**86,215**	**47.4**	**21,473**	**11.8**	**22,895**	**12.6**	**10267**	**5.7**	**34,497**	**19.0**	**181,722**

family subdivisions, although there have been several multi-family projects constructed under Chapter 40B and several open space residential design (OSRD) projects. OSRD projects use clustering of houses on smaller lots in order to preserve open space, in some cases keeping open as much as 50% or more of the total subdivision area. By way of example, several successful OSRD projects have been constructed in Methuen and Newbury in recent years. However, region-wide, these projects remain the exception.

A significant amount of undeveloped land remains, although it is not evenly distributed throughout the region. This undeveloped land includes land that is vacant and developable, as well as land that may be classified as undevelopable due to various development constraints, such as wetlands. Land consumption will likely continue at a high rate as long as large lot zoning remains the norm in the region's suburbs. Commercial development continues to be dispersed beyond traditional municipal centers to locations along state numbered routes and major travel corridors, such as Route 114 in Lawrence, and Route 110 in Amesbury and Salisbury. The greatest concentration of newer industrial areas tends to be in technology parks built near highway interchanges and along major corridors, such as Route 93 in Andover.

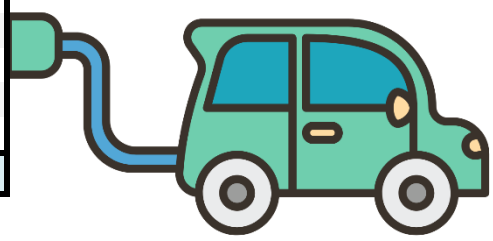
3.3 Transportation Network

3.3.1 Highways. The region's 15 cities and towns are well served by an extensive highway network that includes over 2,000 miles of roadway. Interstate highways I-93, I-95, and I-495 all traverse the region, providing convenient vehicular access to points north, south, and west. Both I-93 and I-495 link the region with Boston. I-93 extends north to Salem, Manchester, and Concord, New Hampshire. I-495 is a circumferential roadway that crosses every major highway in eastern Massachusetts, including the Massachusetts Turnpike (I-90) running west to New York state. I-95 passes through every major East Coast city from Maine to Florida. At least one of these three interstates passes through 14 of the region's 15 communities.

Table 3.3 Electric vehicle charging infrastructure within the Merrimack Valley region

Merrimack Valley EV Charging Infrastructure		
Community	**Number of Charging Stations**	**Total Number of Chargers (plugs)**
Amesbury	16	31
Andover	13	26
Boxford	3	6
Georgetown	3	10
Groveland	3	6
Haverhill	13	28
Lawrence	26	55
Merrimac	0	0
Methuen	14	28
Newbury	2	6
Newburyport	6	14
North Andover	6	21
Rowley	4	7
Salisbury	1	2
West Newbury	4	8
MVPC Region	**114**	**248**

*"Currently, there are **114** EV charging stations in the region, which contain a total of **248** individual chargers…"*



The interstate highways serve the highest numbers of vehicles, state-numbered arterial routes are the most extensive. U.S. Route 1 and Routes 1A, 28, 97, 110, 113, 114, 125, 133, and 213 are of vital importance because they link the major activity centers with other communities in the region. In addition, local roads, which make up approximately 87% of the region's highway network, are important to communities because they serve as access to residences and businesses. Virtually all 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.

3.3.2 EV Charging Infrastructure. In recent years, communities in the Merrimack Valley have begun to build out Electric Vehicle Infrastructure. Currently, there are 114 EV charging stations within the region, which contain a total of 248 individual chargers (plugs) located across the fifteen Merrimack Valley communities.[11] Chargers are currently located in all communities except for Merrimac (*Table 3.3*).

3.3.3 Public Transportation. The Merrimack Valley region receives a wide array of public transportation services from various sources, including public and private entities. At the forefront of the region's public transportation system is Merrimack Valley Transit (MeVa) formerly the Merrimack Valley Regional Transit Authority (MVRTA), which is the sole administrator of the region's local bus system. MeVa offers fixed route, demand response (Mini MeVa), and special employment transportation services within the Merrimack Valley region. Additionally, MeVa operates special services to the Boston metropolitan area to assist riders with medical appointments. Starting March of 2022, all MeVa began offering all services free of charge to riders, and increased frequency of routes in busy communities such as Lawrence.

The Massachusetts Bay Transportation Authority (MBTA), based in Boston, supplements the MeVa bus system by providing commuter rail services to the region. Seven stations along two commuter rail lines are located in the Merrimack Valley. AMTRAK (officially known as the National Railroad Passenger Corporation) offers "*Downeaster*" passenger rail service between Boston, Massachusetts and Portland, Maine. With a stop in downtown Haverhill, the *Downeaster* further connects the Merrimack Valley to the greater New England region and beyond.

3.3.4 Air Transportation. Aviation services in the Merrimack Valley region are offered at the Lawrence Municipal Airport in North Andover and at two privately-owned airports in Methuen and Newburyport. The Lawrence Airport, located on Sutton Street in North Andover, is the largest airport in the region, with five separately designated aircraft parking aprons and 37 hangar buildings. There were 200 aircrafts based at this airport in 2022, the majority of which are small, single engine private planes. Between 2000 and 2022, the airport averaged approximately 60,900 takeoffs and landings per year.[12] The Methuen Airport is a seaplane base and is located on the Merrimack River adjacent to Lowell Street. The Newburyport Airport is located along the Plum Island Turnpike in the eastern end of Newburyport and neighboring Newbury. The two airports are small facilities with 8-month operating seasons used primarily for pleasure aircraft.

MeVa Bus in Haverhill, MA

[11] National Renewable Energy labs. 2023. Electric Vehicle Charging Stations | NREL

[12] Lawrence Municipal Airport Master Plan Update, Executive Summary. October 2022. LWM-2022-AMPU-ES-web-version.pdf (lawrencemunicipalairport.com)

3.4 Water Resources and Public Water Supplies

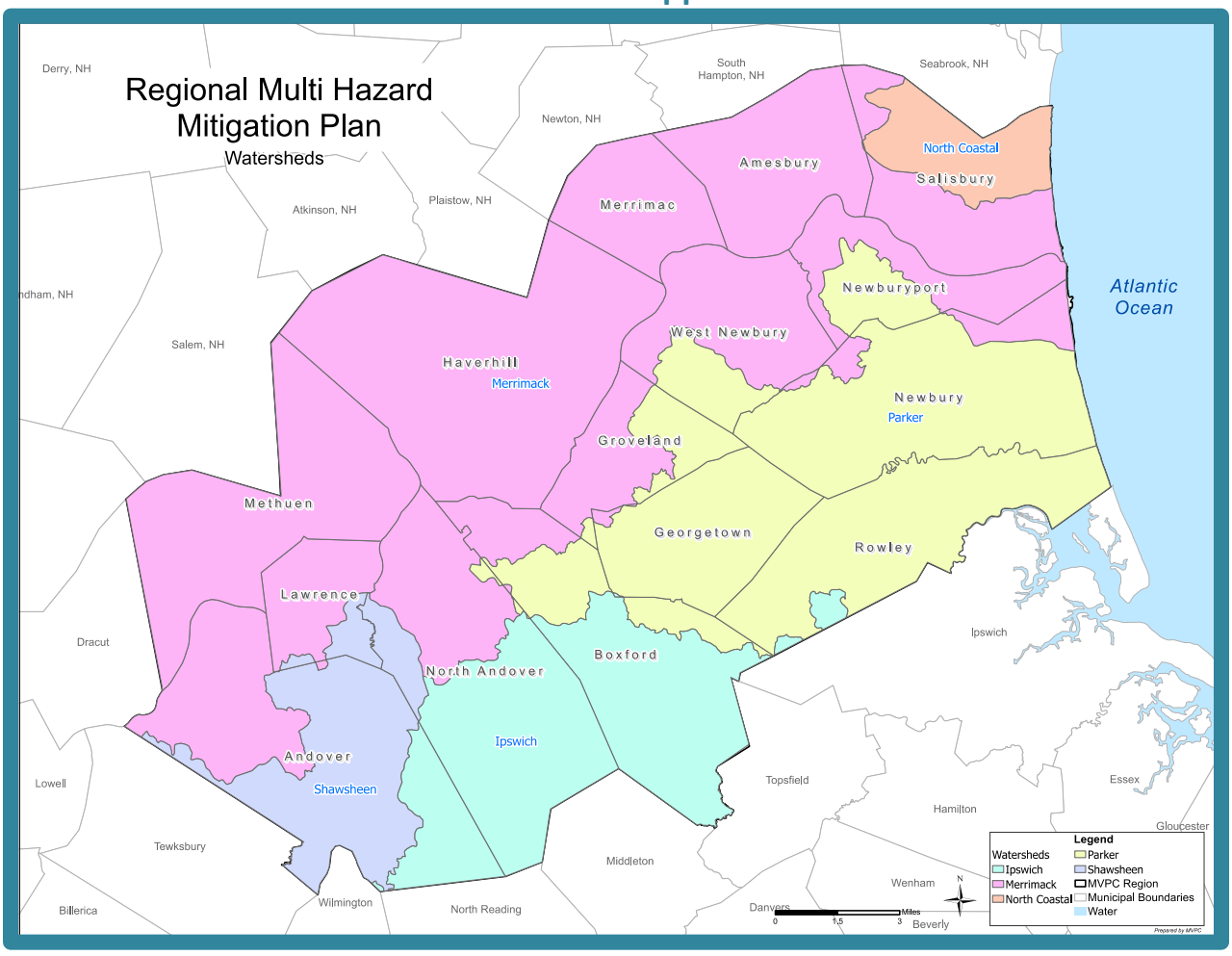


Figure 3.2 Watershed map for the Merrimack Valley region, showing five different watersheds

3.4.1 Water Resources. The Merrimack Valley region contains abundant freshwater and saltwater resources, ranging from the Merrimack River – one of the largest river systems in New England – to numerous smaller rivers and streams, lakes, ponds, wetlands, and tidal creeks. The Atlantic Ocean forms the region's eastern border in the four coastal communities of Salisbury, Newburyport, Newbury, and Rowley. Prominent estuarine waterways include Newburyport Harbor and Plum Island Sound.

The region encompasses parts of five major watersheds defined by the Executive Office of Energy and Environmental Affairs: *Ipswich River*, *Merrimack River*, *North Coastal*, *Parker River*, and *Shawsheen River*. These five cover 147 square miles, or 55% of the region. This is only a small fraction of the entire Merrimack River drainage watershed areas are shown in Figure 3.2. The Merrimack watershed area is by far the largest, encompassing basin, which begins in the White Mountains of New Hampshire and covers over 5,000 square miles. The Merrimack River has an average daily flow of 7,347 cubic feet per second (cfs) during summer months, as recorded at Lowell, MA.[13] This is greater than the average flow of all other eastern Massachusetts rivers combined. The highest flow of record, which occurred during the infamous 1936 Flood, is estimated to have exceeded *173,000 cfs*. A breakdown of each community's major watersheds is included in *Table 3.4*.

[13] Merrimack River. SNOFLO. Merrimack River Levels | 197% of Normal Streamflow - SNOFLO

Table 3.4 Detailed breakdown of each community's major watersheds by area and percentage of community

Merrimack Valley Watershed Area					
Community	**Total Area** *Acres*	**Major Watershed**	**Watershed Area Per Community** *Acres*	*Square Miles*	**Percent of Community**
Amesbury	8,783.26	Merrimack	8,779.31	13.72	99.96
		North Coastal	3.95	0.01	0.04
Andover	20,562.86	Ipswich	3,476.12	5.43	16.9
		Merrimack	6,815.73	10.65	33.15
		Shawsheen	10,271.01	16.05	49.95
Boxford	15,603.55	Ipswich	9,868.52	15.42	63.25
		Merrimack	2,067.24	3.23	13.25
		Parker	3,667.78	5.73	23.51
Georgetown	8,414.97	Ipswich	6.68	0.01	0.08
		Merrimack	130.39	0.2	1.55
		Parker	8,277.91	12.93	98.37
Groveland	6,014.06	Merrimack	3,802.10	5.94	63.22
		Parker	2,211.96	3.46	36.78
Haverhill	22,827.64	Merrimack	22,827.64	35.67	100
Lawrence	4,753.37	Merrimack	3,805.26	5.95	80.05
		Shawsheen	948.11	1.48	19.95
Merrimac	5,688.02	Merrimack	5,688.02	8.89	100
Methuen	14,705.78	Merrimack	14,705.78	22.98	100
Newbury	16,488.41	Merrimack	2,050.32	3.2	12.43
		Parker	14,438.09	22.56	87.57
Newburyport	6,961.36	Merrimack	4,521.69	7.07	64.95
		Parker	2,439.67	3.81	35.05
North Andover	17,735.20	Ipswich	10,495.86	16.4	59.18
		Merrimack	5,798.65	9.06	32.7
		Parker	155.42	0.24	0.88
		Shawsheen	1,285.27	2.01	7.25
Rowley	12,763.63	Ipswich	513.73	0.8	4.02
		Parker	12,249.89	19.14	95.98
Salisbury	10,993.03	Merrimack	5,804.43	9.07	52.8
		North Coastal	5,188.60	8.11	47.2
West Newbury	9,424.01	Merrimack	7,124.72	11.13	75.6
		Parker	2,299.29	3.59	24.4

3.4.2 Public Water Supplies. The Merrimack Valley region has a wide variety of municipal water supply sources. These range from the Merrimack River, which supplies all drinking water to the cities of Lawrence and Methuen, to smaller tributary rivers and streams, surface water reservoirs, and groundwater aquifers. Together, these sources meet the daily water supply needs of residents, institutions, and businesses throughout the Valley region, and are critically important to the region's present and future growth and prosperity. Thus, it is essential that we protect both the quantity and quality of our existing and potential water supply sources through effective land use controls.

In recent years, high temperatures and low rainfall have created regional concern around the sustained availability of potable water sources. Toward this end, most communities have adopted water supply protection district regulations consistent with Massachusetts Department of Environmental Protection (DEP) drinking water source protection requirements. These regulations prohibit high-risk commercial and industrial uses, such as gasoline stations and dry-cleaning establishments, and in some cases impose limited residential restrictions, such as amount of impervious surface cover. Primary water supply lands (Zone A and Zone II) as classified and mapped by the Water Supply Division of Mass DEP (*Table 3.5*).

Zone A - Lands that are hydrologically connected with and contribute recharge to *surface water* supplies. They consist of: (a) the land area between the surface water source and the upper boundary of the bank; (b) the land area within a 400-foot lateral distance from the upper boundary of the bank; and c) the land area within a 200-foot lateral distance from the upper boundary of the bank of a tributary stream or associated surface water body.

Zone II - Lands that are hydrologically-connected with and contribute recharge to *groundwater* supplies. They include the areas of an aquifer which contribute water to a well under the most severe pumping and recharge conditions that can be realistically anticipated. The Zone II extends upgradient to its point of intersection with prevailing hydrogeologic boundaries (for example, a groundwater flow divide, a contact with till or bedrock, or a recharge boundary).

*Table 3.5 Municipal drinking water supply zones. *Lawrence and Methuen derive their water solely from the Merrimack River, for which the MA DEP has not designated/mapped any Zone A surface water protection areas.*

Municipal Drinking Water Supply- Primary Protection Zones				
Community	**Water Zone**	**Total Acres**	**Protected Acres**	**Precent Protected**
Amesbury	Zone A	599.6	22.75	3.79
	Zone II	510.44	74.95	14.68
Andover	Zone A	1246.69	437.22	35.07
	Zone II	1595.9	484.45	30.36
Boxford	Zone A	129.15	40.66	31.49
	Zone II	2362.61	442.3	18.72
Georgetown	Zone A	0	0	0
	Zone II	1792.39	796.37	44.43
Groveland	Zone A	0	0	0
	Zone II	1615.09	558.8	34.6
Haverhill	Zone A	1818.34	487.16	26.79
	Zone II	0	0	0
Lawrence	Zone A	0	0	0
	Zone II	0	0	0
Merrimac	Zone A	1017.3	211.65	20.8
	Zone II	160.49	104.71	65.24
Methuen	Zone A	0.15	0	0
	Zone II	0	0	0
Newbury	Zone A	121.9	78.06	64.04
	Zone II	1030.36	306.41	29.74
Newburyport	Zone A	238.85	0	0
	Zone II	227.41	0	0
North Andover	Zone A	2007.54	1108.32	55.21
	Zone II	0	0	0
Rowley	Zone A	4.88	0	0
	Zone II	1277.75	704.44	55.13
Salisbury	Zone A	0	0	0
	Zone II	609.8	0	0
West Newbury	Zone A	1571.27	287.03	18.27
	Zone II	285.59	22.95	8.04
Region	**Zone A**	**8755.67**	**2672.85**	**30.53**
	Zone II	**12498.19**	**3801.77**	**30.42**

As the acreage figures in the table indicate, only about one-third (1/3) of the region's total Zone A and Zone II land area is currently considered "permanently protected" – that is, preserved from development in a largely natural state by virtue of fee simple ownership or conservation/deed restriction by a government entity or nonprofit land trust. The remaining two-thirds (2/3), although regulated, are still potentially vulnerable to impacts from some level of land disturbance and/or development activity. Land acquisition/management and regulation/enforcement measures are two tools that can be used in concert to manage these sensitive watershed and aquifer areas.

3.5 Protected Open Space and Prime Farmland

The Merrimack Valley region is blessed with an abundance of ecologically rich and visually stunning open space resources. These range from vast, interconnected salt marsh, barrier beaches, and inter-tidal zones along the coast to an intricate tapestry of forests, fields, farms, and hilltops in bordering and upland areas. Together, these rich resources provide outstanding and diverse:

- **habitat and migration corridors** for numerous wildlife species, birds, fish and shellfish, and plants;
- **surface and ground water sources** for drinking water supply, irrigation, hydropower generation, wastewater assimilation, and recreation;
- **productive soils** for agriculture, horticulture, and tree farming; and
- **natural buffers** for protection against flooding, high winds, coastal storm surges, and sea level rise.

They also serve as a major draw for tourists and vacationers, attracting thousands of visitors each year to enjoy beach combing, swimming, boating, hiking, nature observation, and sight-seeing. Regardless of their geographic setting or function, the Merrimack Valley's prime open space resources are critically important to the overall character, economic vitality, and quality of life in the Merrimack Valley region, and as such warrant vigilant protection and sustainable use.

Toward this end, the Merrimack Valley Planning Commission has worked closely with member communities and partner organizations (open space committees, watershed associations, land trusts) through the years to help identify, map, and protect some of the region's most important land and water resources. The Merrimack Valley Priority Growth Strategy (2013) recognizes the need to continue this important work and presents a series of strategies to help accomplish this. The goal is not to slow or stop growth, nor to preserve all remaining open space, but rather to help direct new development toward those areas best able to accommodate it, in the process protecting the region's most critical natural resources.

3.5.1 Existing Protected Open Space. As part of its collaborative efforts with communities to preserve vital open areas, MVPC has mapped the region's existing protected open space using data derived from both the MassGIS Office and municipal sources, including local open space and recreation plans and conversations with knowledgeable conservation officials. These existing protected lands range from several large, multi-community federal and state wildlife management areas, to non-profit land trust holdings, to individual town forests, watershed areas, and conservation lands. A description of some of the most prominent and noteworthy of these protected areas follows. While this list is by no means exhaustive, it reveals the diversity and richness of the Merrimack Valley region's natural resources.

Parker River National Wildlife Refuge. This federally-protected Refuge is the region's largest and most ecologically-rich natural area. Spanning parts of Newburyport, Newbury, Rowley, and Ipswich, it is managed by the U.S. Fish and Wildlife Service. The Refuge occupies the southern 3/4 of Plum Island, an 8-mile barrier beach, and contains over 4,700 acres of scenic tidal marsh, fresh water impoundments, bogs, and sand dunes. It is one of the few barrier beach-dune-salt marsh complexes remaining in the Northeast.

Martin H. Burns Wildlife Management Area. This state-protected wildlife management area spans the towns of Newbury and West Newbury. It consists of over 2,000 acres of small rocky hills, forest, meadows, and low-lying wetlands. Historically this area was clear-cut, but a second growth forest has returned. A series of openings and trails have been cut and are maintained to increase habitat diversity. The Little River, a major tributary of the Parker River, has its headwaters within this area.

Old Town Hill Reservation. This scenic 531-acre "half-upland, half-marine" landscape is owned and managed by The Trustees of Reservations. Old Town Hill is a glacial drumlin that rises prominently from the surrounding lowland and tidal marsh. The Reservation's upland consists of second growth forest and fields that provide habitat for nesting birds and hunting grounds for hawks and owls. The bordering salt marsh and tidal creeks are home to a variety of estuarine invertebrates.

William Forward Wildlife Management Area. This state-protected wildlife management area spans the towns of Newbury and Rowley. It consists of 2,083 acres of scenic salt marsh and upland habitat. There are approximately 60 acres of open fields that are maintained under cooperative agreements with local farmers, and another 20 acres are maintained in an early successional stage for wildlife diversity. Portions of the Parker River and two of its major tributaries – the Little and Mill River – run through or border this area.

Georgetown-Rowley State Forest. This large, 1,112-acre state forest spans the towns of Georgetown and Rowley to the west and east of Route I-95. It contains a mix of dense woodland, wetlands, and streams, and is a key headwater for Penn Brook, Mill River, and Muddy Brook. Miles of multi-use trails traverse the area, which support a variety of year-round public recreation activities.

Crane Pond Wildlife Management Area. This state wildlife area spans over 2,500 acres across the towns of Groveland, Georgetown, Newbury, and West Newbury. It consists of a series of low rolling hills and marshland. The hills were once cleared for use as pasture, but the fields were abandoned some 60 years ago, and forest has since reclaimed the land. A series of openings have been maintained by forestry operations, and a high-tension line provides additional open cover and easy access for hunters and hikers. The Parker River flows through the southern portion of the area.

Harold Parker State Forest & Wildlife Management Area. This 3,300-acre natural area spans the towns of Andover, North Andover, North Reading, and Middleton. It consists of mixed forest, and features over 35 miles of logging roads and trails. There are 11 ponds within the area, including scenic Berry Pond.

Charles Ward Reservation. The 704-acre Ward Reservation is owned and managed by the Trustees of Reservation. This visually stunning property represents the union of more than 40 separate parcels of farm and pasture land whose stone walls, when combined, extend more than 17 miles. These parcels encompass all or parts of three hills – Shrub Hill, Boston Hill, and Holt Hill – and are connected by many miles of recreational trails, segments of which are part of the Bay Circuit Trail.

Together, the above-listed properties comprise almost 17,000 acres of protected open space, or about 40% of all the protected open space in the Merrimack Valley region. The remaining protected open space acreage is divided among numerous smaller parcels that are dispersed throughout the region. A breakdown of each community's current protected open space acreage can be seen in *Table 3.6*.

Table 3.6 Detailed breakdown of protected open space within the Merrimack Valley communities

Protected Open Space In the Merrimack Valley				
Community	**Total Area**	**Protected Open Space**		
	Acres	Acres	Percent of Community	Percent of Region
Amesbury	8,783.26	939.30	10.69	0.52
Andover	20,562.86	4,611.64	22.43	2.54
Boxford	15,603.55	3,888.62	24.92	2.14
Georgetown	8,414.97	2,406.61	28.60	1.32
Groveland	6,014.06	2,049.45	34.08	1.13
Haverhill	22,827.64	2,796.52	12.25	1.54
Lawrence	4,753.37	481.75	10.13	0.27
Merrimac	5,688.02	1,044.76	18.37	0.57
Methuen	14,705.78	723.22	4.92	0.40
Newbury	16,488.41	7,679.77	46.58	4.23
Newburyport	6,961.36	1,430.20	20.54	0.79
North Andover	17,735.20	5,074.37	28.61	2.79
Rowley	12,763.63	4,553.19	35.67	2.51
Salisbury	10,993.03	1,986.08	18.07	1.09
West Newbury	9,424.01	2,522.20	26.76	1.39
Region	**181,719.15**	**42,187.68**	**-**	**23.22**

3.5.2 Prime Farmland. A number of the region's prominent farm lands – such as the Colby Farm in Newbury and the Pleasant Valley area farms in Methuen – are proximate to rivers, streams, and other water bodies. In addition to the abundant crops they produce, the farms' broad alluvial soils provide important stormwater infiltration/retention and flood storage functions. Future development of these lands would result in the loss or diminution of these functions.

Since its heyday in the 19th century, farming in the Merrimack Valley and throughout Essex County has steadily declined as a business and a way-of-life. According to the U.S. Department of Agriculture, in 1870, 47% (151,809 acres) of all land in Essex County was agricultural. By 1950, this figure had fallen to 31.2% (99,840 acres). Nevertheless, nearly one-third of County land was still being farmed. However, in the high growth decades following 1950, the loss of farmland – much of it to low-density sprawl development – greatly accelerated. By 2007, the total number of farms in Essex County had declined from 2,288 to 531 (-77%), and total farm acreage decreased from 99,840 to 27,834 acres (-72%). In 2017, the number had declined even further to 419 farms totaling 20,726 acres.[14] In the Merrimack Valley region, 8,475 acres (4.8%) were identified as "agricultural" based on the most recent land use data captured from Assessor's Data between 2012-2018.

[14] USDA Census of Agriculture. 2017. Snapshot of Massachusetts Agriculture. Agricultural Resources Facts and Statistics | Mass.gov

The Valley's shrinking farmland continues to be imperiled. 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. Due to development pressure, local farmers are finding it increasingly difficult to retain their farmland indefinitely. As important land for natural hazard mitigation, a collaborative effort is needed to implement strategies to strengthen the economic viability of farming and protect farmland in perpetuity.

3.6 Historic & Cultural Resources

The Merrimack Valley is rich in historic and cultural resources. Many historic properties 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 protection of these resources requires active stewardship and support of the whole community. *Table 3.7* provides a listing of Merrimack Valley historic districts, as recorded in the *State Register of Historic Places 2022* prepared by the Massachusetts Historical Commission.

A group actively working to protect historic and cultural resources is COSTEP-MA (Coordinated Statewide Emergency Preparedness in Massachusetts). COSTEP-MA is a collaborative of representatives from cultural and historical institutions and agencies as well as first responder and emergency management professionals from federal, state, and municipal governments. COSTEP-MA promotes proactive steps to

Table 3.7 Local and historic districts in the Region

Historic Districts in the Merrimack Valley Region	
Community	**Historic District**
Amesbury	Amesbury & Salisbury Mills Village Historic District
Andover	Academy Hill Historic District Andover Multiple Resource Area Andover Village Industrial District Ballardvale Historic District Central Street Historic District Locke Street Historic District Shawsheen Village Historic District West Parish Center Historic District
Boxford	Boxford Village Historic District Howe Village Historic District
Georgetown	
Groveland	
Haverhill	Bradford Common Historic District Hamel Leather Company Historic District Haverhill Historical Society Historic District Main Street Historic District Rocks Village Historic District Washington Street Shoe District
Lawrence	American Woolen Mill Housing District Arlington- Basswood District Arlington Mills Historic District Downtown Lawrence Historic District Jackson Terrace Historic District Mechanics Block Historic District North Canal Historic District North Common Local Historic District Prospect Hill Local Historic District
Merrimac	
Methuen	Arlington Mills Historic District Methuen Multiple Resource Area Pleasant - High Street Historic District Searles, Tenney, Nevins Historic District Spicket Falls Historic District
Newbury	Newbury Historic District
Newburyport	Central Waterfront Archaeological District Fruit Street Local Historic District Market Square Historic District Newburyport Historic District
North Andover	Machine Shop Village Historic District North Andover Center Historic District North Andover Historic District Tavern Acres Historic District
Rowley	Glen Mills Historic District Rowley Center Historic District
Salisbury	
West Newbury	West Newbury Training Field Historic District

reduce losses from natural hazards through cooperative, team-building activities in communities and through educational activities within the cultural heritage and emergency management communities. COSTEP-MA has worked to develop an Annex to the state's Comprehensive Emergency Management Plan (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, there is an opportunity for increased impervious surface, increasing the flood risk and decreasing available flood storage area. The population, household, and employment projections for the Merrimack Valley region were developed utilizing existing data[15] and projections[16] (*Table 3.8*). Over the past ten years, the region has continued to grow, albeit less dramatically than in past decades. Based upon population projections developed by the Massachusetts Department of Transportation in collaboration with the University of Massachusetts Donahue Institute and the Metropolitan Area Planning Commission, the region is expected to grow by an additional 16,595 residents (4.5%) between 2020 and 2030 and by another 17,223 residents (4.5%) between 2030 and 2050. The region, as a whole, is projected to grow by 9.1% between 2020 and 2050, which represents a slightly smaller growth rate than was experienced between 2010 and 2020 (10.9%).

Table 3.8. Current and projected population in the Merrimack Valley Region

Current and Projected Population in the Merrimack Valley Region					
Community	**Population 2010**	**Population 2020**	**Projected Population 2030**	**Projected Population 2040**	**Projected Population 2050**
Amesbury	16,283	17,366	16,727	15,450	13,842
Andover	33,201	36,569	38,830	41,448	42,743
Boxford	7,695	8,203	7,682	7,266	6,602
Georgetown	8,183	8,470	9,008	9,428	9,491
Groveland	6,549	6,752	7,031	7,142	6,818
Haverhill	60,879	67,787	69,931	70,632	70,304
Lawrence	76,377	89,143	96,484	103,093	109,125
Merrimac	6,338	6,723	6,872	6,801	6,182
Methuen	47,255	53,059	58,869	64,037	69,168
Newbury	6,666	6,716	6,311	5,504	4,511
Newburyport	17,416	18,289	17,628	16,791	15,375
North Andover	28,352	30,915	31,500	32,486	32,366
Rowley	5,856	6,161	6,208	6,012	5,610
Salisbury	8,283	9,236	9,504	9,228	8,642
West Newbury	4,235	4,500	3,899	3,428	2,928
Region	**333,568**	**369,889**	**386,484**	**398,746**	**403,707**

[15] United States Census Bureau. 2023. QuickFacts. U.S. Census Bureau QuickFacts: United States

[16] Massachusetts Department of Transportation. 2023. Socio-Economic Projections for 2023 Regional Transportation Plans. Socio-Economic Projections for 2023 Regional Transportation Plans | Mass.gov

Between 2020 and 2050, Andover (16.9%), Georgetown (12.1%), Groveland (1%), Haverhill (3.7%), Lawrence (22.4%), Methuen (30.4%), and North Andover (4.7%) are all predicted to experience population growth. Whereas Amesbury (-20.3%), Boxford (-19.5%), Merrimac (-8.0%), Newbury (-32.8%), Newburyport (-15.9%), Rowley (-8.9%), Salisbury (-6.4%), and West Newbury (-34.9%) are predicted to experience population decline. Population projections are based on U.S. Census data information including births, deaths, and migration rates. While projections may indicate anticipated trends, many factors may shape actual population change at the local level, which may deviate from projections.

According to socio-economic projections from the Massachusetts Department of Transportation, the number of households in the region is projected to increase from 136,603 in 2020 to 164,896 households in 2050, an increase of 20.7%.[17] Household projections also utilized U.S. Census data, while integrating population projections, as well as a range of additional factors including development trends, local zoning, and land-use availability. This method, which places an emphasis on available developable land, is reflected in projections outlined in *Table 3.9* below, in which the principal areas of household growth are expected in more rural communities of Rowley (51.8%), Georgetown (48.6%), Newbury (44.9%), and Boxford (39.4%); while the more developed communities of Newburyport (9.8%), Lawrence (12.2%) and Salisbury (12.4%) are predicted to experience more restrained household growth between 2020 and 2050.

When considered together, the population and household projection datasets indicate divergent outcomes, with many communities projected to experience a decrease in population paired with substantial increases in housing, and others projected to experience a substantial increase in population paired with low to moderate increases in housing. While trends in population and housing projections may hold, the emphasis on available developable land may not fully or accurately reflect local conditions, indicating possible discrepancies between projected and actual outcomes. Further, additional local factors not considered in this analysis (e.g. MBTA Communities) may further shape actual outcomes.

Table 3.9. Current and projected housing in the Merrimack Valley Region.

Current and Projected Housing in the Merrimack Valley Region					
Community	**Households 2020**	**Projected Households 2030**	**Projected Households 2040**	**Projected Households 2050**	**Percent Change 2020-2050**
Amesbury	7,473	8,475	8,841	9,012	20.59
Andover	12,948	15,089	15,811	16,157	24.78
Boxford	2,742	3,466	3,717	3,822	39.39
Georgetown	3,090	4,029	4,412	4,593	48.64
Groveland	2,519	2,747	2,877	2,931	16.36
Haverhill	26,696	29,303	30,664	31,429	17.73
Lawrence	28,955	30,356	31,757	32,485	12.19
Merrimac	2,620	3,156	3,293	3,348	27.79
Methuen	19,342	22,599	23,759	24,267	25.46
Newbury	2,697	3,410	3,745	3,907	44.86
Newburyport	7,971	8,477	8,630	8,748	9.75
North Andover	11,344	12,861	13,539	13,875	22.31
Rowley	2,328	3,029	3,356	3,534	51.80
Salisbury	4,206	4,410	4,621	4,729	12.43
West Newbury	1,672	1,864	1,998	2,059	23.15
TOTAL	**136,603**	**153,271**	**161,020**	**164,896**	**20.71**

[17] Massachusetts Department of Transportation. 2023. Socio-Economic Projections for 2023 Regional Transportation Plans. Socio-Economic Projections for 2023 Regional Transportation Plans | Mass.gov

Massachusetts also provides information on regional employment. The Massachusetts Department of Transportation projects that 10,671 jobs (7.1% increase) will be added to the Merrimack Valley region between 2020 and 2050.[18] This regional employment growth of 7.1% is expected to be fueled by robust job growth in Lawrence (4,851) and Haverhill (2,883), and by moderate job growth in North Andover (1,028), Amesbury (675), and Methuen (611). Newbury (249), Salisbury (218), Groveland (151), Rowley (98), Georgetown (79), Newburyport (54), and Merrimac (12) are also expected to see increases in employment. Among all the communities, Andover (-110), Boxford (-87), and West Newbury (-41) are expected to experience an actual loss of jobs between 2020 and 2050. Again, these projections provide an indication of expected trends, with the acknowledgement that additional factors, not considered or unforeseen, may shape actual outcomes.

3.8 Assessed Valuations by Community

The Massachusetts Department of Revenue (DOR) requires communities to value all property each year and conduct a complete recertification every three years. Both a recertification and an interim year adjustment (the two years in between the triennial re-certification) include a detailed analysis of the appropriate sales data as a basis for adjusting the property values. The goal is to keep the values as close to 100% of market value as possible and avoid an excessive swing in the assessments in one year. *Table 3.10* contains the FY 2023 Assessed Values for all property classes in each Merrimack Valley region community.[19]

Table 3.10 Assessed property values (DOR, 2023) by class in the Merrimack Valley Region.

Assessed Values by Class in the Merrimack Valley Region (FY2023)						
Community	**Residential**	**Open Space***	**Commercial**	**Industrial**	**Personal Property**	**Total**
Amesbury	2,816,128,760	0	189,286,790	117,885,083	93,910,958	3,217,211,591
Andover	9,077,872,633	0	680,896,666	827,792,800	354,008,940	10,940,571,039
Boxford	2,314,750,998	0	15,453,403	2,160,453	50,599,894	2,382,964,748
Georgetown	1,647,217,804	0	58,218,589	85,195,900	24,604,188	1,815,236,481
Groveland	1,304,227,905	0	35,018,377	28,953,300	23,625,680	1,391,825,262
Haverhill	8,435,061,505	0	571,169,034	312,047,529	346,592,101	9,664,870,169
Lawrence	5,664,430,302	0	514,125,079	336,377,951	349,910,790	6,864,844,122
Merrimac	1,113,322,113	0	24,353,736	10,041,870	9,444,044	1,157,161,763
Methuen	7,045,243,592	0	543,095,693	182,585,840	226,702,530	7,997,627,655
Newbury	2,119,375,719	0	55,093,523	3,863,600	38,602,405	2,216,935,247
Newburyport	5,459,918,769	274,300	363,260,831	223,592,200	68,709,768	6,115,755,868
North Andover	5,869,014,095	0	433,501,245	536,025,812	183,198,490	7,021,739,642
Rowley	1,297,543,105	135,400	122,785,785	55,335,910	20,935,730	1,496,735,930
Salisbury	1,961,867,252	0	278,303,564	39,596,800	82,740,210	2,362,507,826
West Newbury	1,353,610,071	0	11,333,470	2,837,100	22,662,650	1,390,443,291
Region	**57,479,584,623**	**409,700**	**3,895,895,785**	**2,764,292,148**	**1,896,248,378**	**66,036,430,634**

**Lack of reported values for Open Space within the region is likely the result of reporting in which assessor's categorize open space under the 900 series codes ("tax exempt") instead of the 200 series codes ("Open Space").*

[18] Massachusetts Department of Transportation. 2023. Socio-Economic Projections for 2023 Regional Transportation Plans. Socio-Economic Projections for 2023 Regional Transportation Plans | Mass.gov

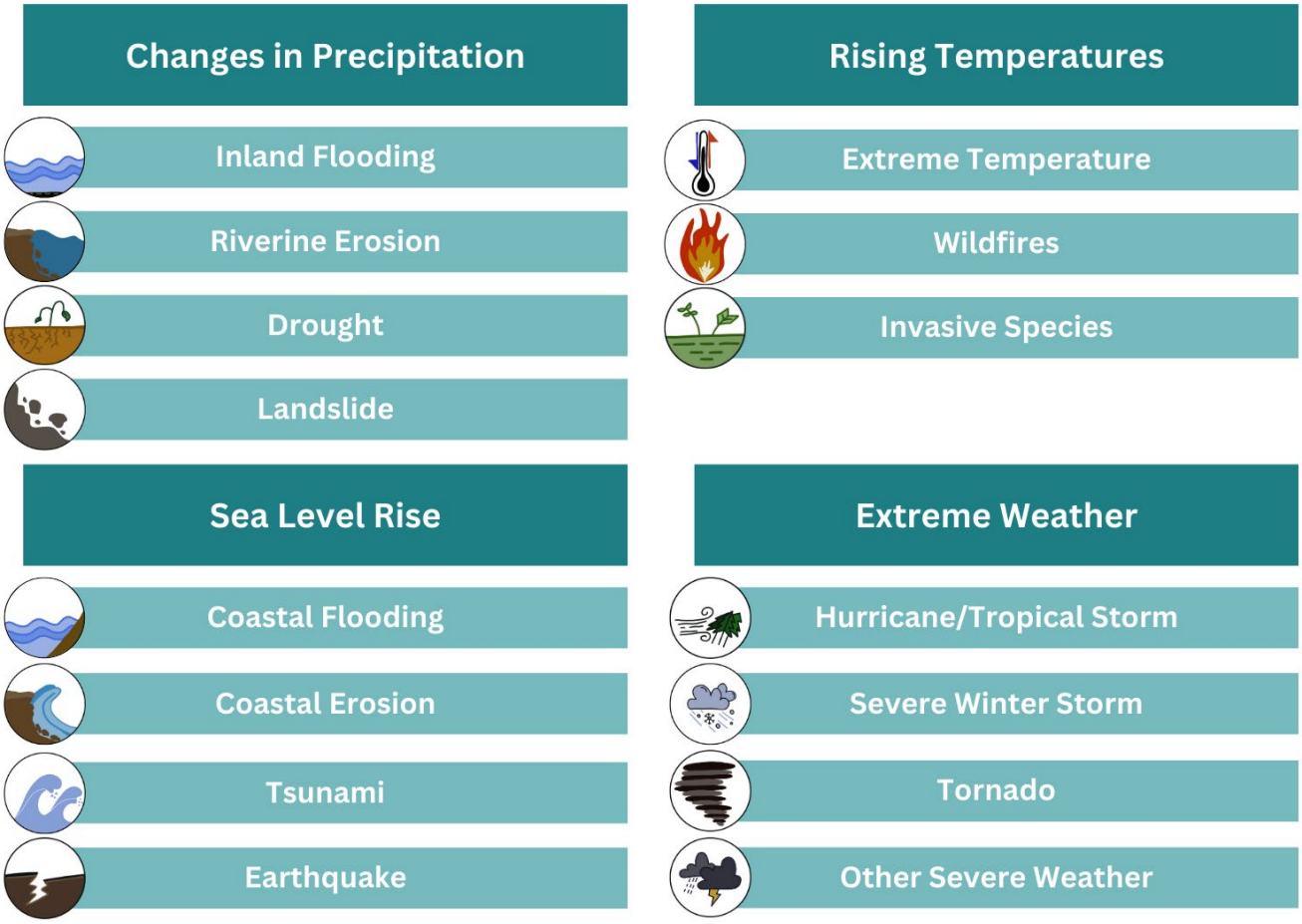
[19] Massachusetts Department of Revenue Division of Local Services. 2024. Assessed Values by Class. Assessed Values by Class (state.ma.us)

SECTION 4. NATURAL HAZARD IDENTIFICATION

This section of the Hazard Mitigation Plan identifies and describes natural hazards that are likely to occur in the Merrimack Valley Region of Massachusetts. A natural "hazard" is defined by FEMA 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 be mitigated and managed. Strategic and intentional societal behaviors, practices, and planning are important tools to bolster resiliency, helping to ensure our communities are safe, productive, and continue to thrive in the face of natural hazard and climatic events.

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

Using the natural hazards and climate change categories identified in the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 15 natural hazards were identified and assessed.



The following section describes the natural hazards that affect the Merrimack Valley region, including their historical presence and probability of recurrence, incorporating the likely impacts of climate change on each hazard. It is important to note that the above hazards and associated climate change categories are not always mutually exclusive. Indeed, they are often interrelated. For example, flooding can be the result of changes in precipitation, sea level rise, and rising temperatures.

4.1 Changes in Precipitation

Precipitation patterns in Massachusetts are becoming more intense, with greater amounts of rain falling during shorter periods of time. The wettest consecutive 10-year period on record occurred between 2005-2014, in which average precipitation was 51 inches per year, significantly higher than the long-term annual average of 45.4 inches.[20] Extreme participation is often reported as number of inches over a certain period of time, and compared to established metrics such as the 100- or 500-year storm. Changes in precipitation due to climate change are reflected in how we define these metrics. In the 1960s, a 24-hour precipitation 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 over 24 hours.[21]

While precipitation is increasing, Massachusetts is not experiencing consistent rainfall. Patterns of intense precipitation rotate with periods of equally intense drought, causing extreme differences in rainfall, water levels, and groundwater availability from year to year. This was seen firsthand in Essex County when the region experienced an "extreme" drought in 2022, followed by one of the wettest years on record in 2023. When precipitation events do occur, they are more intense. The amount of precipitation falling during very heavy events in New England has increased by 71% between 1958-2007.[22] This trend was also seen in 2023, with storms dropping several inches of rain in just a few short hours. With extreme rainfall events becoming more frequent, the severe impacts from flooding are also likely to increase.

According to NOAA's 2022 State Climate Summary for Massachusetts, projections indicate the continuation of extreme cycling, with above average and more extreme precipitation events causing more frequent flooding, while alterations in the amount, timing, and type of precipitation may intensify naturally occurring drought. By 2030, total precipitation is expected to increase by 2.5 inches per year (+6.6%).[23] This poses numerous threats to communities within our region as they navigate risks relating to changes in precipitation, including: inland flooding, riverine erosion, droughts, and landslides.

4.1.1 Inland Flooding

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 severe winter storms, heavy rainstorms, and hurricanes. While annual precipitation is expected to increase, the frequency of precipitation events is

[20] Runkle, et al. 2022. Massachusetts State Climate Summary 2022. NOAA Technical Report NESDIS 150-MA. NOAA/NESDIS, Silver Spring, MD, 5 pp.

[21] 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.

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

[23] Massachusetts EEA. 2023. ResilientMass Climate Change Projections Dashboard. MA Hydro Risk_Climate Dashboard (arcgis.com).

expected to decrease. Meaning we will experience fewer but more intense precipitation events, and likely associated flooding events. With multiple major rivers (Merrimack, Parker, Rowley) and tributaries running through the region, and nearly 25% of land cover classified as open water or wetland, flooding is a common challenge across all Merrimack Valley communities.

Flooding poses a significant and recurring risk to life and property in the Merrimack Valley. Inland flooding in Massachusetts is classified by the National Weather Service (NWS) Northeast River Forecast Center using a three-category scale: minor, moderate, or severe. Categorization is based on the types of impacts that can occur. "Minor" flooding results from a small degree of flooding in which road closures and flooding of recreational areas can occur. "Moderate" flooding can involve land with structures being impacted. "Major" flooding is categorized as widespread impacts that can significantly threaten property and even life.

According to the National Climatic Data Center, eighty-nine (89) flood events were reported in Essex County from 1950 to 2023. Of the total, 43 (48%) occurred since the 2016 update (between 2017-2023). While the Merrimack River is generally prone to minor flooding, it has experienced several significant flood events throughout its history. 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). 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 New England Hurricane of 1938, the Mother's Day Flood of 2006, and the Patriots Day Flood of April 2007 are among the region's most serious flood events.

Most recently, on August 8th, 2023 a number of communities in Essex County experienced severe flooding when over 6-inches of rain fell within the region over a 6-hour period. Widespread damage caused Mayors in Haverhill, Methuen, and Lawrence to declare states of emergency. Damage to residential homes and businesses within these communities was widespread, and municipal infrastructure was impacted. The storm resulted in millions of dollars of damage to public and private structures. *Table 4.1* below lists flood events within the fifteen Lower Merrimack Valley Communities between 1998 and 2023.[24]

Inland flooding can also occur as a result of riverine floods, which are more likely to occur in the Spring. Riverine floods result from the "overbanking" of swollen rivers and streams and are typically caused by large-scale weather events that generate an unusual amount of precipitation or by rapid snowmelt. For many communities within the Valley that border the Merrimack River, this type of hazard can pose a real threat. Stormwater floods can also occur in the region, caused by inadequate stormwater drainage in areas with a high percentage of impervious surface (rooftops, roads, parking lots, etc.) that prevents groundwater infiltration. Stormwater flooding poses a particular risk for our more developed communities with high amounts of impervious surface (such as Lawrence, Methuen, and Haverhill). 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.

Flooding Risk Assessment: 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

[24] NOAA National Centers for Environmental Information. 2023. Storm Event Database. Storm Events Database | National Centers for Environmental Information (noaa.gov)

that can be expected in specific locations, and the probability of occurrence of flood events.

The methodology for assessing the risk from flooding involved mapping the FEMA Flood Insurance Rate Maps as an overlay to critical infrastructure in each community. 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. Detailed information for each community is included in *Section 5. Risk and Vulnerability Assessment*, while a regional summary of findings is recounted below.

Table 4.1 List of flood events occurring within the Merrimack Valley Region from 1998-2023 (NOAA Storm Event Databased, 2023).

Flood Events in the Merrimack Valley 1998-2023				
Location	Event Date	Deaths	Injuries	Property Damage
Western Essex	6/17/1998	0	0	0
Western Essex	6/18/1998	0	0	0
Western Essex	4/3/2004	0	0	0
Western Essex	4/3/2004	0	0	0
Countywide	5/13/2006	2	0	7,000,000
Countywide	5/13/2006	0	0	0
Haverhill	4/16/2007	0	0	45,000
Haverhill	2/13/2008	0	0	30,000
Newbury	3/30/2010	0	2	3,270,000
Newbury	4/1/2010	0	0	0
South Lawrence	10/4/2011	0	0	5,000
Methuen	10/23/2014	0	0	0
Newburyport	12/9/2014	0	0	0
Methuen	8/18/2015	0	0	0
West Andover	4/6/2017	0	0	0
South Groveland	7/18/2017	0	0	0
Lawrence	9/6/2017	0	0	0
Lawrence	9/6/2017	0	0	0
South Lawrence	9/15/2017	0	0	10,000
Lawrence	8/11/2018	0	0	10,000
South Lawrence	11/3/2018	0	0	0
West Andover	4/15/2019	0	0	0
Newburyport	7/13/2020	0	0	0
Georgetown	7/23/2020	0	0	0
Newburyport	7/23/2020	0	0	0
Andover	7/23/2020	0	0	0
Newbury	7/30/2021	0	0	10,000
Salisbury	11/12/2021	0	0	5,000
Andover	11/12/2021	0	0	4,000
South Lawrence	10/17/2022	0	0	0
North Andover	8/8/2023	0	0	0
TOTAL		**2**	**2**	**10,389,000**

As the data in *Table 4.2* indicate, the percentage of land within a floodplain (both 100 and 500-year) ranges from 11.52% in Boxford to 48.4% in Newbury. Of the ten (10) participating communities, eight (8): Amesbury, Boxford, Haverhill, Lawrence, Methuen, Newbury, Salisbury, and West Newbury have repetitive loss structures located within their mapped flood hazard areas. Combined, there are 138 Repetitive Loss or Severe Repetitive Loss sites which have experienced a total of 425 losses. Over the years, flood damage to these structures has resulted in the payment of over $23 million in insurance claims under the National Flood Insurance Program.[25]

Table 4.2 Area within the floodplain (100 and 500-year) and NFIP claim information for ten participating communities

Merrimack Valley Floodplain Area and NFIP Claims								
Municipality	**NFIP Participant**	**Current Effective Flood Map Date**	**CRS Participant**	**Land within Floodplain (acres)**	**Land within Floodplain (%)**	**Repetitive Flood Loss Properties**	**Total Number of Losses**	**Total Amount Paid Out**
Amesbury	Yes	2012	No	2,060	23.45	6	16	1,289,152
Boxford	Yes	2012	No	1,800	11.52	1	2	15,127
Groveland	Yes	2012	No	1,242	20.65	0	0	0
Haverhill	Yes	2018	Yes- Class 9	4,476	19.59	15	33	1,258,549
Lawrence	Yes	2012	No	1,193	25.1	33	104	12,459,921
Methuen	Yes	2012	No	2,665	18.1	17	54	979,041
Newbury	Yes	2014	No	8,007	48.44	17	45	1,848,538
Rowley	Yes	2014	No	5,204	40.71	0	0	0
Salisbury	Yes	2012	Yes- Class 8	4,802	43.63	48	168	5,153,380
West Newbury	Yes	2014	No	1,761	18.68	1	3	103,188
Region	-	-	-	33,210	-	138	425	23,106,896

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. FEMA produces Flood Insurance Rate Maps, commonly known as FIRMs, to support the National Flood Insurance Program. The FIRMs depict Special Flood Hazard Areas (SFHAs), including the areas subject to inundation from the 1% annual chance flood (also known as the Base Flood or the 100-Year Flood).

All communities completing the regional HMP update participate in the NFIP program. In 2010, and again in 2012, 2014, and 2018 new FEMA floodplain maps were released for communities located in the Merrimack Valley region. Preliminary flood risk information and updated Flood Insurance Rate Maps were released again in 2023 for communities within Essex County. A letter of final determination is expected in January of 2025, with the effective date for new FIRM maps anticipated 6 months after in July 2025. Communities participating in the National Flood Insurance Program (NFIP) will be required to update their local regulations to adopt the new maps and study by this effective date. All communities have acknowledged this update and identified a pathway to adopt updated FIRM maps following the final determination.

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

[25] Massachusetts Emergency Management Association (MEMA). National Flood Insurance Program Data. Requested July, 21, 2023.

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 classes. A Class 1 rating provides the largest flood insurance premium reduction, while a community with a Class 10 rating receives no insurance. Two communities participating in the regional HMP update are part of the CRS program, Haverhill (Class 9) and Salisbury (Class 8).

In addition to threatening homes and other building structures addressed through the NFIP and CRS systems, 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.

Structural Deficient Bridges: The Massachusetts Department of Transportation (MassDOT) maintains data on bridge conditions across the Commonwealth. Information on bridge condition is pulled from state data on National Bridge Inventory Structures, and state and local municipal data on BRI structures and culverts. A "BRI" is a highway bridge that, due to its length, meets the Massachusetts General Laws (MGL) to be defined as a bridge but not the federal definition. Inspections are conducted and updated on varying timelines depending on the structure itself, and the responsible party. As part of this inspection process, bridges can be listed as being “structurally deficient”. In 2018, the Federal Highway Administration changed their definition of structurally deficient. The new definition limits the classification to bridges where “one of the key structural elements- the deck, superstructure, substructure or culverts, are rated in poor or worse condition.” During inspections, bridge conditions are rated on a scale of 0 (failed condition) to 9 (excellent condition). A rating of 4 or lower is considered “poor” condition resulting in being listed as structurally deficient.

Across the ten (10) participating communities, a total of 39 bridges are classified as Structurally Deficient (*Table 4.3)*. These bridges reside in seven (8) communities: Amesbury, Haverhill, Lawrence, Methuen, Newbury, Rowley, Salisbury, and West Newbury. Of the 39 bridges, 29 are owned by the MassDOT, with the other ten (10) owned and operated by local municipalities.[26]

Rocks Village Bridge over the Merrimack

Significant and High Hazard 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, including:

[26] Massachusetts Department of Transportation. 2024. Dataset Feature Layer: Bridges. Accessed on May 10, 2024. Bridges | Bridges | MassDOT Open Data Portal (arcgis.com)

- Overtopping caused by floods that exceed the capacity of the dam
- 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
- Deliberate acts of sabotage

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,

Table 4.3 Structurally deficient bridges across the ten participating Merrimack Valley Communities

Structurally Deficient Bridges in the Merrimack Valley						
Municipality	Bridge or Street Name	Feature Intersected	Owner	Year Built/ Improved	Structure Category	Last Inspected
Amesbury	Kimball Road	Tuxbury Pond Outlet	MUN	NA	Short Span	12/27/2022
Amesbury	495 NB	Middle Rd	MassDOT	1964	NBI	11/20/2023
Haverhill	North Ave	Snows Brook	MUN	1932	Short Span	5/26/2021
Haverhill	Rosemont Street	Little River	MUN	1934	Short Span	5/23/2023
Haverhill	Antonio Franciosa Memorial	Merrimack River NB	MassDOT	1964	NBI	11/13/2023
Haverhill	495 SB	Railroad & Little River EB	MassDOT	1961	NBI	10/30/2023
Haverhill	495 N	Railroad & Little River WB	MassDOT	1961	NBI	10/27/2023
Haverhill	495 SB	Amesbury Rd E.	MassDOT	1964	NBI	5/18/2022
Haverhill	495 NB	Amesbury Rd W.	MassDOT	1964	NBI	5/18/2022
Haverhill	495 SB	Middle Rd	MassDOT	1964	NBI	3/23/2023
Haverhill	495 SB	Amesbury Line Rd	MassDOT	1964	NBI	3/22/2023
Haverhill	Antonio Franciosa Memorial	Merrimack River SB	MassDOT	1964	NBI	11/15/2023
Haverhill	Amesbury Road	E Meadow River	MassDOT	1907/1922	Short Span	6/15/2023
Haverhill	PFC Ralph T. Basiliere	Merrimack River	MassDOT	1925	NBI	12/4/2022
Haverhill	Bridge Street	Railroad (abandoned)	MassDOT	1850/1968	NBI	2/22/2023
Haverhill	495 SB	Newton Road	MassDOT	1964	NBI	1/17/2023
Haverhill	Industrial Ave	I 495 NB	MassDOT	1961	NBI	8/15/2023
Haverhill	Industrial Ave	I 495 SB	MassDOT	1961	NBI	8/15/2023
Lawrence	Mann Bridge (Parker Street)	South Canal	MUN	1918	NBI	10/30/2022
Lawrence	Majowicz Bridge	Spicket River	MUN	1850/1938	NBI	9/19/2022
Lawrence	Mario Lucchesi Memorial	North Canal	MUN	1860/ 1939	NBI	10/12/2021
Lawrence	Charles F. Nyhan Sr Bridge	MBTA/BMRR	MassDOT	1928/1997	NBI	9/22/2023
Lawrence	Lowell Street Bridge	BMRR (abandoned)	MassDOT	1927/1987	NBI	11/27/2023
Lawrence	101 off Ramp from I495	Merrimack St & MBTA	MassDOT	1963	NBI	12/6/2021
Lawrence	Rev. James T. O'Reilly Mem.	I495 lower level	MassDOT	1962/2006	NBI	9/25/2023
Lawrence	I495 Lower Level	Merrimack River	MassDOT	1962	NBI	10/10/2022
Lawrence	I495 NB	Highway Ramps A&B	MassDOT	1962/2002	NBI	12/12/2022
Lawrence	I495 SB	Highway Ramps A&B	MassDOT	1962/2002	NBI	12/13/2022
Lawrence	Route 28 (near Stevens Pond)	Spicket River	MassDOT	1900/1949	NBI	7/4/2022
Methuen	Antonio Franciosa Memorial	I495 over 110 NB	MassDOT	1963	NBI	10/11/2021
Methuen	Antonio Franciosa Memorial	I495 over 110 SB	MassDOT	1963	NBI	10/11/2021
Methuen	213 Loop Connector	Methuen Rail Trail	MassDOT	1959	NBI	10/25/2022
Newbury	Route 1 NB	Little River	MassDOT	1922/1935	NBI	7/27/2023
Newbury	Central Street	Parker River	MUN	1968	Short Span	7/25/2022
Newbury	Sgt. Donald Wilkison	Plum Island River	MassDOT	1973	NBI	9/14/2022
Rowley	Main St./1A	Railroad MBTA	MassDOT	1907/1931	NBI	9/19/2023
Rowley	Glen Street	Mill River	MUN	1900	Short Span	6/22/2022
Salisbury	Bridge on Gerrish Road	Smallpox Brook	MUN	1850	Short Span	2/27/2023
West Newbury	T Bridge	Beaver Brook	MUN	1980	Short Span	6/22/2022

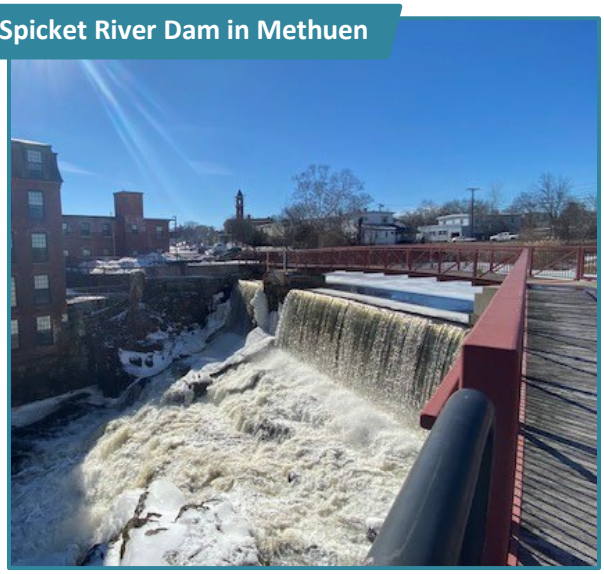
Massachusetts, a landslide destroyed a 43-foot dam on Mill Creek, a tributary of the Connecticut River, resulting in the deaths of 144 people.

Dams are classified by the Massachusetts Department of Conservation and Recreation's Office of Dam Safety (ODS) 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.

Spicket River Dam in Methuen



According to DCR Office of Dam safety records, as of March 2024, there are a total of 79 operating dams within the ten participating municipalities.[27] Of these dams, 16 are considered Significant Hazard, and three (3) are considered to be High Hazard (*Table 4.4*). The three High Hazard dams are: Lake Gardner Dam which is municipally owned and located in Amesbury; Millvale Reservoir Dam which is municipally owned and located in Haverhill; and Steven's Pond Outlet Dam which is municipally owned and located in Lawrence. All three High Hazard dams have established Emergency Action Plans (EAPs) that have been filed with the state. More information around risks related to these high hazard dams is included in *Section 5: Risk and Vulnerability Assessment.*

[27] Massachusetts Department of Conservation and Recreation office of Dam Safety. 2012. MassGIS Dams Viewer. Accessed 3.7.2024. MassMapper

Table 4.4 High Hazard dams across the ten participating Merrimack Valey Communities

High Hazard Dams in the Merrimack Valley					
Municipality	Dam Name	Year Built/ Improved	Owner	Date Last Inspected	EAP
Amesbury	Lake Gardner Dam	1872/1987	City of Amesbury	03/21/2023	Yes
Haverhill	Millvale Reservoir Dam	1898	City of Haverhill	11/15/2023	Yes
Lawrence	Stevens Pond Outlet Dam	1877	City of Lawrence	6/4/2020	Yes

Combined Sewer Overflow (CSO) Events: A major regional concern for public and environmental health related to high precipitation and flooding events are the risk of Combined Sewage Overflows (CSO). CSOs are instances in which heavy rainfall causes the volume of sewage and rain to exceed the sewage system capacity, which leads untreated stormwater and wastewater to discharge directly into the river. Unfortunately, these events are common and concerning occurrences in the Merrimack River. The presence of raw sewage within the Merrimack has a number of harmful outcomes. As a major source of drinking water for two of the highest populated communities in the valley (Lawrence and Methuen), this poses a human health threat. It also elevates risks for river users and negatively impacts wildlife and ecosystem health.

"Total CSO volume in the lower Merrimack River (MA) exceeded 2 billion gallons in 2023."

Due to the intense rainstorms experienced across the Valley, the total CSO volume in the lower Merrimack River (Massachusetts) exceeded 2 billion gallons in 2023. This amount far exceeds the previous record of 823 million gallons set in 2021. The frequent occurrence of CSOs in 2023 greatly limited access to the River due to the recommended 48-hours of "no contact" following a CSO event. Between June and July (61 days), the river was under advisory for a total of 39 days (64% of the time).

Communities along the river are actively working to reduce their CSO discharge volume, though solutions are massively expensive and technically challenging. In many cases, substantial infrastructure projects to separate combined sewage pipes, which run below key community infrastructure, are needed to fully address the problem. Communities are conducting infrastructure work, as well as exploring other solutions including building underground storage tanks to temporarily hold stormwater and expanding the capacity of wastewater treatment plants. With climate change expected to cause more intense and frequent precipitation events, CSO discharge will only become a more pressing challenge for our region.

Impact of Future Conditions: Changes in future conditions related to climate change, population patterns, and land use and development could affect inland flooding within the Merrimack Valley. As has been discussed throughout the section, climate change is expected to cause fewer but more intense precipitation events. These events will illuminate the importance of pervious undeveloped land (25% of land in the region), including water bodies and wetlands as floodwater controls. It will be critical to protect these natural resources, as we anticipate increased population growth over the next five years. With population in the Valley expected to increase by 4.5% (16,595 people) by 2030, development pressure, both for already heavily developed communities as well as more rural communities, poses a risk to exacerbate inland flooding. As more land transitions from pervious (flood storage) to developed (flood run-off) we could see greater amounts of property damage occur. Through smart growth initiates (e.g. building on already developed sites, integration of BMPs, reducing impervious cover, etc.) the region can work to minimize impacts of future population growth and development on flooding conditions. Steps towards these goals have been demonstrated through individual community projects detailed in Section 5, including high amounts of newly conserved land, culvert upgrades and dam removals, as well as green infrastructure projects.

4.1.2 Riverine Erosion

Riverine erosion is a dynamic and complex phenomenon occurring as a result of natural processes like hydraulic erosion and abrasion, as well as human activities such as development and modifications to hydrology. These factors contribute to alterations in the river's flow, affecting sediment transport and erosion rates. Development and impermeable surfaces along riverbanks can exacerbate these issues, while man-made structures like dams and channelization further disrupt the natural course of the river, influencing erosion patterns. Climate-related weather events, including heavy rainfall and storms, intensify erosion by increasing water flow and sediment transport. Impacted by numerous factors and localized conditions, the extent of riverine erosion can be assessed using the Soil Erosion Model developed by the USACE in which Total Erosion (ft) can be found by multiplying the Erosion Rate (ft/s) by Time (s).

Total Erosion (ft) = Erosion Rate (ft/s) x Time (s)

$$L_e = \dot{\varepsilon} X T$$

$$\dot{\varepsilon} = \left(k_d(\tau - \tau_c)\right) \quad (10\text{-}1)$$

(10-1)

where

$\dot{\varepsilon}$ = erosion rate
k= erodibility coefficient or detachment rate coefficient (ft^3/lb-hr)
τ= effective hydraulic stress on the soil boundary (lb/ft^2)
τ_c= critical shear stress (lb/ft^2), i.e. the shear stress at which erosion starts

Figure 4.1 Erosion Rate calculation (USACE 2017)

The Merrimack River and its tributaries experience various forms of erosion due to natural processes and human activities. Therefore, it is the Merrimack Valley communities located *adjacent* to these water bodies that experience riverine erosion and its impacts. Nearly all river-adjacent communities have or are experiencing challenges from riverine erosion. In most instances, erosion is a slow process, becoming apparent when impacts begin to threaten public or private infrastructure. While the NOAA Storm Event Database does not track riverine erosion, and no state or federal disasters for riverine erosion have been declared for Essex County, local events of erosion in the Merrimack Valley can be identified through community reports and actions. Below are key reports or projects addressing erosion in the region:

- Reports from the ACOE note erosion at the confluence of the Powwow and Merrimack Rivers in Amesbury in the 1970s due to tides and ice , leading to the construction of a 480-foot-long gabion retaining wall in 1987.
- Road closures and assessment of ongoing erosion along River Road in Merrimac which transitions into Pleasant Valley Road in Amesbury. Amesbury received grant funding from the MassDOT Complete Streets program in 2020 for infrastructure improvements along Pleasant Valley Road.
- Riverbank stabilization projects along Coffin Avenue, Railroad Avenue, and River Street in Haverhill in 2021-2023 due to at risk municipal and regional infrastructure. Funding was received through the Federal Transit Authority and MassDOT.
- West Newbury received a MVP Action Grant to assess acute locations of erosion along River Road in 2024 and is planning to seek additional funding to further study and advance findings from the report.

Efforts to mitigate erosion along the river involve various solutions aimed at stabilizing the riverbank. Approaches include the implementation of vegetation and bioengineering techniques, as well as the use of structural interventions to prevent further erosion. Additionally, land use planning and zoning regulations can play a vital role in managing human activities along the river, preserving natural buffers, and reducing the risk of erosion, and negative impacts to communities. Municipalities, in collaboration with public and private entities, have taken steps to address and minimize this hazard when possible in the Merrimack Valley region.

Riverbank Stabilization in Haverhill

Photo Credit: SumCo

Riverine erosion has been widely experienced by communities along the Merrimack River, especially those with development or infrastructure located adjacent to the river itself. As a tidally influenced river, downstream of the Lawrence Dam, climate change impacting factors such as sea level, storm events, precipitation, and temperature may continue to alter and exacerbate this natural hazard. Increased erosion may occur as a result of heightened river level, a greater volume of water, increased water flow, and changes to freezing and thawing conditions impacting factors such as ice formation and bank stability.

Impact of Future Conditions: Changes in future conditions related to climate change, population patterns, and land use and development could affect riverine erosion throughout the Merrimack Valley. As has been discussed throughout the section, climate change is expected to cause fewer but more intense precipitation events. These events are expected to intensify erosion by increasing water flow and sediment transport. With population in the Valley expected to increase by 4.5% (16,595 people) by 2030, development pressure, for communities bordering the Merrimack River and its tributaries, poses a risk to exacerbate riverine erosion. This is especially true for Haverhill, Lawrence, and Methuen which are expected to grow in population over the next five years and already have highly developed land adjacent to the river. Additional development directly adjacent to waterways could increase erosion pressure and cause more runoff directly into the river due to increased impervious cover. Through natural resource protection, and policies requiring buffering or conditions around building, the region can work to minimize impacts of future population growth and development on riverine erosion. Steps towards these goals have been demonstrated through individual community projects detailed in Section 5, including the integration of natural based solutions to address current riverine erosion, and undertaking resiliency planning projects for infrastructure bordering the Merrimack River.

4.1.3 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. Anthropogenic factors can also contribute to drought conditions, including land use changes, dams, and water supply withdrawals and diversions. 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. This five-category scale ranges from D0 “Abnormally Dry” to D4 “Exceptional Drought.”

Massachusetts is generally considered to be a water-rich state, receiving an average of 45.4 inches of precipitation each year. However, the full Merrimack Valley region can experience extended periods of dry weather, from single-season events to multi- year drought events. 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 when cumulative precipitation deficits reached 8-12 inches below normal over one year. Stream flows routinely fell below the 25th percentile of historical flows for a 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 thresholds for drought levels as well as the introduction of new and substantially updated actions for local and state government.

Since the last plan update, we have continued to experience periods of drought in the region (*Figure 4.2)*. 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”. Essex County experienced another brief but significant drought in September of 2020, and

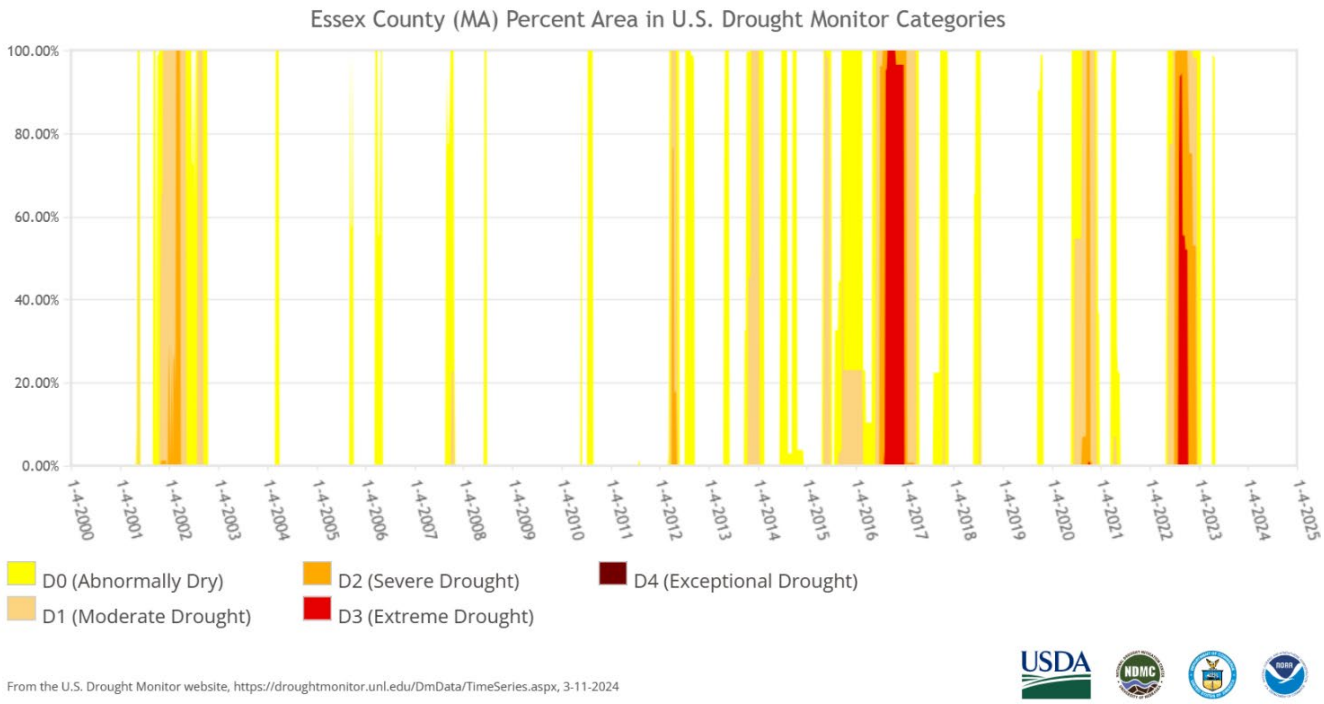


Figure 4.2 United States Drought Monitor Time Series (University of Nebraska-Lincoln).

an extreme drought from July-August of 2022.[28] May through August 2022 ranked as the driest four months on record for Boston, Massachusetts in 138 years.[29] In 2023, the Massachusetts Drought Management Plan[30] was again updated to its current form. Changes included updating the evapotranspiration index, as well as the streamflow index to the Cape Cod Drought Region, and other minor updates.

Impact of Future Conditions: Changes in future conditions related to climate change, population patterns, and land use and development could affect drought throughout the Merrimack Valley. With climate change impacting precipitation patterns, periods of drought are expected to become more frequent, longer, and more severe. Drought conditions are also expected to be impacted by increased global temperatures reducing snowpack and impacting the ability of groundwater to recharge. The extreme fluctuations between drought and flood have been identified as twin, high-risk climate threats by the state.[31] These factors can further influence local water quality and quantity in the Merrimack Valley region, providing a direct threat to communities that use local water bodies for potable water and recreational services. This will be even more impactful as the population of the region is expected to increase, and the need for potable water grows. Further, intermittent streams will cease flowing earlier in the season and some cold-water habitat will be replaced with warm water habitat, impacting the diversity, richness, and health of riparian ecosystems and associated wildlife. Development further threatens the occurrence of drought, as key groundwater recharge areas may disappear under impervious surfaces. Through protecting open space, limiting the impacts of new development, and providing opportunities to educate and inform citizens around behavior changes to conserve water, the Merrimack Valley Communities can work to reduce future impacts of drought.

4.1.4 Landslides

A landslide is the downward movement of a slope and its materials under the force of gravity. Human activity such as clearing, construction, and mining, and natural factors such as topography, geology, and precipitation influence landslide risk. Landslides often develop when water rapidly accumulates in the ground, such as during periods of heavy rainfall or rapid snowmelt. Other natural events 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. They are widespread, occurring in every state, cause an estimated 25-50 fatalities annually, and result in $1 billion in property damage each year.[32] Landslides are common throughout New England but are generally limited to steep slopes and or excess wetness in the subsurface. Certain geologic conditions also predispose landslide occurrence, including areas where there is lacustrine or marine clay and where steep slopes are underlain by glacial till or bedrock. In the Merrimack Valley region, areas with higher elevations and steep slopes, as well as locations close to the

[28] Massachusetts EEA. 2024. Massachusetts Drought Status. Accessed: Drought Status | Mass.gov

[29] United States Geological Survey. 2023. 2022 Drought in New England. 2022 drought in New England | U.S. Geological Survey (usgs.gov)

[30] Massachusetts EEA & Massachusetts Emergency Management Agency. 2023. Massachusetts Drought Management Plan 2023. Accessed: download (mass.gov)

[31] ResilientMass Plan. 2023. Massachusetts State Hazard Mitigation and Climate Adaptation Plan. 2023 ResilientMass Plan_10.10.23 508.pdf

[32] United States Department of Homeland Security, Federal Emergency Management Agency, Landslide Loss Reduction: Guide for State and Local Government Planning (1989). Landslide | Impact (fema.gov)

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

Table 4.5 Population within unstable slope areas and therefore vulnerable to landslides in Essex County (SHMCAP, 2018).

coast, are identified to be more vulnerable to landslides. The 2018 State Hazard Mitigation and Climate Adaptation Plan identifies the frequency of occurrence to be 1-3 landslides per year in the state.[33] The state plan also finds a very small portion of the population (2010 Census) in Essex County vulnerable to unstable slopes that may be more prone to landslides (*Table 4.5*).

The NOAA Storm Event Database does not track landslide occurrence, and no state or federal disasters for landslides have been declared for Essex County. The occurrence of landslides has been rare in the Merrimack Valley, and largely associated with significant precipitation events. The infamous flood of 1936 was credited with causing a landslide on the side of West Newbury's Pipestave Hill. West Newbury, which is a particularly hilly part of the Merrimack Valley, has also noted small scale erosion and mud slides across town during heavy precipitation events. Such as a recent event in August 2023, in which heavy rains caused localized flash flooding in West Newbury, leading to damage to many properties. Reports from a Conservation Commission meeting following the storm documented numerous impacts including: two small landslides, one of which caused damage to a home on Main Street; culvert failures; basement flooding; and bank erosion leading to sediment movement/deposition. Small-scale and localized mud/land slide events occur periodically in the Merrimack Valley in more hilly communities but are not well documented.

Impact of Future Conditions: Changes in future conditions related to climate change, population patterns, and land use and development could affect the occurrence of landslides throughout the Merrimack Valley. With more intense precipitation events, the risk of landslides is expected to increase due to the increased saturation of soils. Additionally, other climate factors including increased occurrence of drought and forest fires may further impact the risk of future landslide occurrence through impacting reducing vegetative cover and decreasing soil stability. While only a small percentage of land within the Merrimack Valley is susceptible to landslides, communities are reporting small-scale landslide incidents caused by development, land clearing, and intense precipitation events. This is especially true in areas with higher elevations and steeper slopes (e.g. West Newbury). As population rises and pressure for development increases, opportunities for landslide incidents may also increase. This not only poses a threat to homes and property, but also public safety as often mor remove and steeper locations are challenging to access with emergency vehicles. Through protecting open space, promoting smart growth and development, limiting the impacts of land use changes through stormwater and erosion regulations, and providing opportunities to educate and inform citizens around this risk, the Merrimack Valley Communities can work to reduce future impacts of landslides.

[33] Massachusetts EEA. 2018. State Hazard Mitigation and Climate Adaptation Plan. SHMCAP-September2018-Full-Plan-web.pdf (mass.gov)

4.2 Sea Level Rise

Rising temperatures have contributed to thermal expansion of the ocean and an influx in fresh water from melting glaciers, resulting in 11 inches of increase in Massachusetts coastal waters between 1900-2000.[34] In addition to thermal expansion and ice sheet melt, sea level is rising quicker along the Atlantic east coast than other locations 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.

For the coastal and tidally influenced communities in the Merrimack Valley region, increases in sea level rise pose severe consequences for both natural and man-made systems. Changes in sea level are measured by using data from tide stations and satellites and reported as meters/inches. Using the intermediate emissions scenario, sea level is projected to increase an additional six (6) inches by 2030 and four (4) feet by the end of the century.[35] If a high emissions scenario is used, those projections increase to 1.1 feet by 2030 and 7.7 feet by 2100 (*Figure 4.3)*. Sea level rise will increase the height and negative impacts 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. 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 our region's barrier beaches, reducing activity and decreasing economic benefits. In these scenarios, community safety will also be put at risk, as access to emergency services will be reduced for communities that are physically isolated due to high water.

2.1 Coastal Flooding

Coastal floods occur as the result of astronomical high tides, strong onshore wind events, precipitation events, or as the result of storms and storm surge. These conditions can lead to increased flood risk for coastal areas, which are defined as locations within the coastal land zones adjacent to waters, bays, and estuaries of the oceans. Coastal flooding can occur any time of year but is more common during the winter months resulting from 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 can coincide with high tides causing severe coastal flooding. The severity of coastal flooding can be measured using a number of metrics, including magnitude of flooding through water level elevation, duration of inundation, and frequency of occurrence. Flood maps and Special Flood Hazard Areas can be used to identify the extent of coastal flooding.

Bordering the Atlantic Ocean to the east, the Merrimack Valley region is highly exposed to coastal flooding along its coastal communities of Salisbury, Newburyport, Newbury and Rowley. Some inland communities bordering the Merrimack below the Lawrence dam can also be at risk for coastal flooding in extreme conditions when an incoming tide causes elevated water levels in the Merrimack. As exposed systems, the barrier beaches of Salisbury Beach and Plum Island are especially vulnerable to coastal storms, and sustain frequent wind, wave, and flood damage.

The region has experienced countless coastal flooding events over the years, with a number of notable occurrences since the last update in 2016. In March 2018, New England was impacted by the first of four significant storm systems that rode in atop a nearly 10-foot tide (9.9 feet above mean low, low water or 5.6

[34] Sweet, et al. 2022. Global and Regional Sea Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water level Probabilities Along U.S. Coastlines. NOAA Technical Report.

[35] ResilientMass.gov citing UMass Amherst Northeast Climate Adaptation Science Center Data. MA Climate Change Clearinghouse (mass.gov)

feet NAVD88[36]). 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 coastal areas across Plum Island including 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. The frequency of occurrence is only becoming more common due to heightened sea levels. Between 2006-2023, a total of 39 coastal flood events have occurred in Essex County, with 13 of those events resulting in over $7 million in property damage.[37]

In addition to substantial property damage and loss, flooding has begun to pose challenges more regularly for access to coastal communities. Both Plum Island and Salisbury Beach are served by one main access road: Plum Island Turnpike (Newburyport), and Beach Road (Salisbury). In January of 2024, severe flooding following two different storm events caused both roads to be closed. Salisbury's Fire Chief noted water levels as high as 4 feet on Beach Road. In preparation for closures, Newbury stationed emergency personnel (Police and Ambulance) on Plum Island to ensure services were available during the closure. These closures occurred during periods of moderate high tides, paired with periods of precipitation, and southeasterly winds. As significant flooding events become more common, and cause restricted access of emergency response, communities are starting to consider short-term precautions, such as acquiring rescue vehicles.

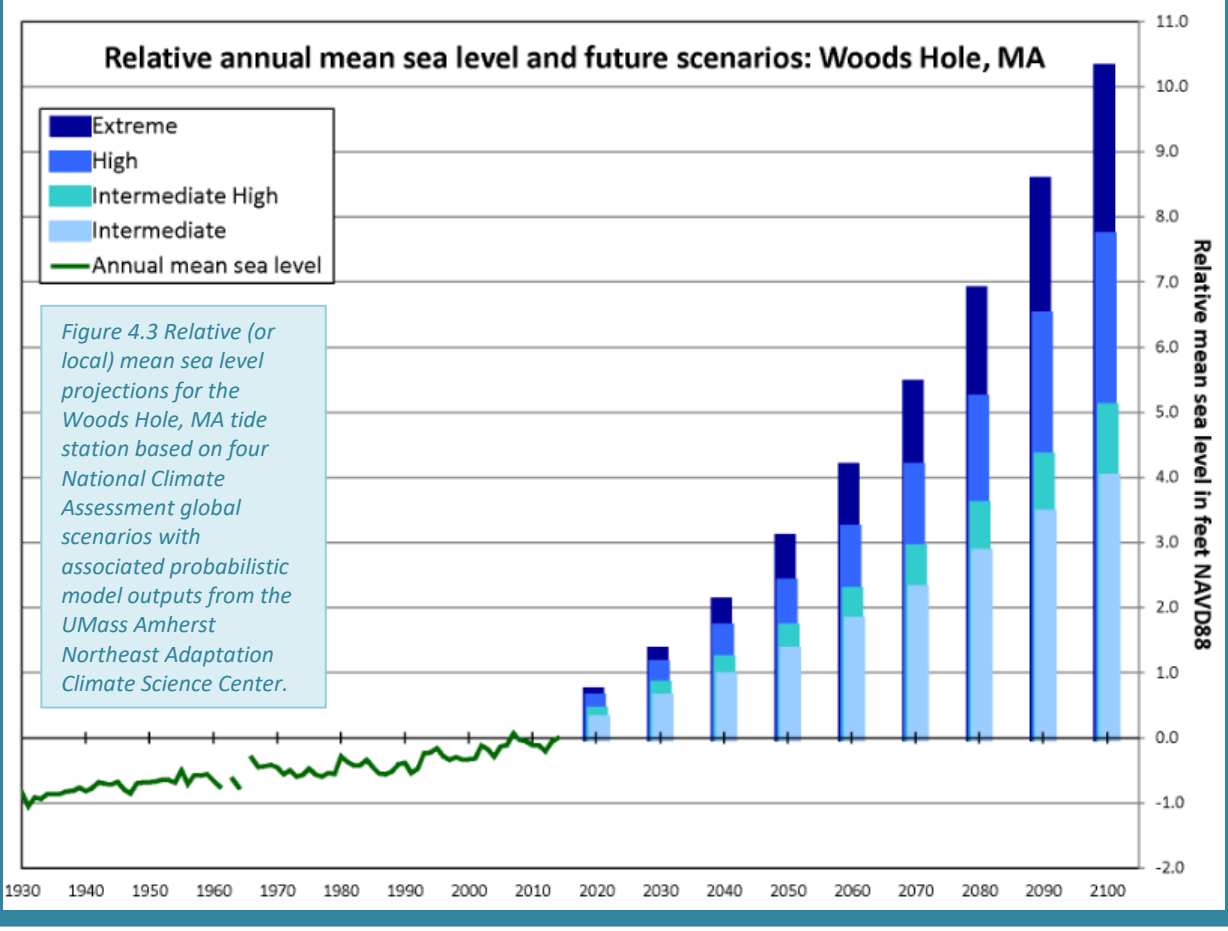


Figure 4.3 Relative (or local) mean sea level projections for the Woods Hole, MA tide station based on four National Climate Assessment global scenarios with associated probabilistic model outputs from the UMass Amherst Northeast Adaptation Climate Science Center.

[36] North Atlantic Vertical datum of 1988. North American Vertical Datum of 1988 (NAVD 88) - Vertical Datum - Datums - National Geodetic Survey (noaa.gov)

[37] NOAA National Centers for Environmental Information. 2023. Storm Event Database. Storm Events Database | National Centers for Environmental Information (noaa.gov)

Coastal Flooding Plum Island Tpke, Newbury

More long-term solutions are also being considered. A study conducted in 2021, the results of which are still considered draft, assessed the fiscal and economic risk of sea level rise on Plum Island. Results indicate that while Plum Island currently has a positive net fiscal and economic impact, the impact is expected to decline by 2050 without intervention.[38] The report highlights the positive impact that early intervention of climate investments (such as maintaining primary access across the Plum Island Turnpike) could have to keep the island accessible for numerous island homes and businesses and minimize fiscal and economic losses to the Town for as long as possible. Early investments in public infrastructure, such as access roads, could 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 the options evaluated would be expensive and would not serve as a long-term solution in the face of sea level rise, but rather would act as an option to buy time for the community and allow for a gradual adaptation to new fiscal and economic realities. To proactively pursue climate adaptation strategies to address flooding across the barrier beaches, additional collaboration, innovation, and funding will be needed.

Impact of Future Conditions: Changes in future conditions related to climate change, population patterns, and land use and development could affect the occurrence of coastal flooding throughout the Merrimack Valley. Communities are already noticing increased flooding on more common tides due to heightened sea level. With climate change bringing more intense precipitation and wind events, paired with rising water levels, this hazard is only expected to worsen. It is unclear if future population growth will impact this hazard, as population projections for the coastal communities of Newbury, Newburyport, Rowley, and Salisbury are all expected to decline, or remain comparable over the next 5-15 years. While increased populations, if they were to occur, would not directly exacerbate this problem, additional development within the coastal zone would. Increased impervious surface would reduce pervious land and put pressure on adjacent natural resources (e.g. beaches, dunes, marshes, etc.) that play a critical role in reducing coastal flooding. Due to the current and felt threat of coastal flooding, it is possible that re-wilding, migration away from the coast, or future selection of non-coastal locations will help to alleviate this hazard through reducing property and human presence within the coastal zone.

4.2.2. 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.

[38] 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

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 severity of erosion is often documented through morphological assessment and measuring loss of beach area over a certain period of time. 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

Coastal Erosion on Plum Island in 2013

Photo Credit: The Boston Globe

Sections of Salisbury Beach and 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.[39] Historically, the shoreline along the two beach systems has remained mostly stable, ranging from 0-2 feet per year of erosion; however cycles of acute and intense erosion and accretion have been observed and recorded since the 1960s.[40] Since recorded observations began, shoreline change has occurred across the barrier beach system from Salisbury to Ipswich, with different locations experiencing acute erosion/accretion depending on the given dynamics in a particular year (such as the Music Hall in Salisbury, and along Reservation Terrace and the Center Island Groin on Plum Island). Because these barrier beaches act as the first line of defense against storm surges and sea level rise for the MVPC region, understanding patterns of shoreline change and protecting natural barrier beach systems that act as buffers for coastal communities is critically important. Beachfront ownership across Salisbury is all state owned, however the shoreline behind the dune is privately owned from Atlantic Ave up to the New Hampshire border. Plum Island ranges from private to public with parcels owned at the town, state, and federal level. The Merrimack River inlet at the Northern end of Plum Island is federally maintained and repaired periodically by the US Army Corps of Engineers (USACOE). Due to the broad range of stakeholders involved and invested, monitoring and management of this system must be a collaborative process.

Over the past several decades, significant nor'easters and other storm events have caused acute erosion across both barrier beach systems. In early March of 2013, a series of powerful coastal storms combined with damaging high tides blasted a path of destruction along Plum Island in Newbury and along Salisbury

[39] MA Department of Conservation & Recreation. 2021. Upper North Shore Regional Sediment Management Study.
[40] MA Department of Conservation & Recreation. 2021. Upper North Shore Regional Sediment Management Study.

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."

Multiple nor'easter storms paired with high tides caused substantial erosion in March 2018, wiping out 12-foot-high sand dunes and causing severe property damage. The barrier beaches were hit again in January of 2024, resulting in damage to dozens of homes, and loss of thousands of tons of recently replenished sand on Salisbury Beach. Erosion has also threatened key infrastructure along the barrier beaches, such as the Department of Marine Fisheries shellfish purification plant located on Plum Island, which was closed in November 2023 due to persistent coastal erosion. As an important resource, the closure has had rippling impacts on the regional economy. These occurrences have prompted emergency shoreline protection and response efforts (rock barriers, coir bags, beach nourishment, emergency road maintenance, water/sewer repair) from the officials and local residents to protect dwellings, buildings and other infrastructure. While the efforts have provided some short-term protection to adjacent properties, they do not offer lasting protection and require regular maintenance.

In addition to natural hazards, human-constructed features across Salisbury Beach and Plum Island have been found to influence patterns of accretion and erosion along the barrier beach system. One major feature is the Merrimack River inlet jetties. Originally constructed in 1914 to improve the navigability of the channel, the jetties have been rehabilitated numerus times, only to degrade as storms erode sediment along the toe of the structure.[41] 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 in Salisbury was completed in 2015. This was the ninth time repairs had been made to the jetty system. Following the most recent repair, residents on Plum Island noticed a significant increase in erosion along the northern tip at the Reservation Terrace and Old Point neighborhoods, estimated by the Army Corps of Engineers at 53 feet of loss per year.[42] 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.).

The extreme shoreline change observed by residents is in line with historical trends observed at this location where beach sediment has alternated between accretional and erosive periods since the jetty was installed in the early 1900s (*Figure 4.4)*. 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 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.[43]

In 2023, 226,000 cubic yards of sand were dredged from the channel to allow for safe navigation and dredged material was 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 USACOE every 3-5 years from 1961-1999, but the frequency has decreased to every 10 years since that point.[44] Despite this effort, the USACOE acknowledged in their assessment that benefits of the beachfill at Plum Island Point will only offer a

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

[42] Army Corps of Engineers 2021. Section 204 Beneficial Use of Dredged Material FROM Federal Navigation Project Maintenance Detailed Project Report and Environmental Assessment.

[43] 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

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

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."[45] 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."

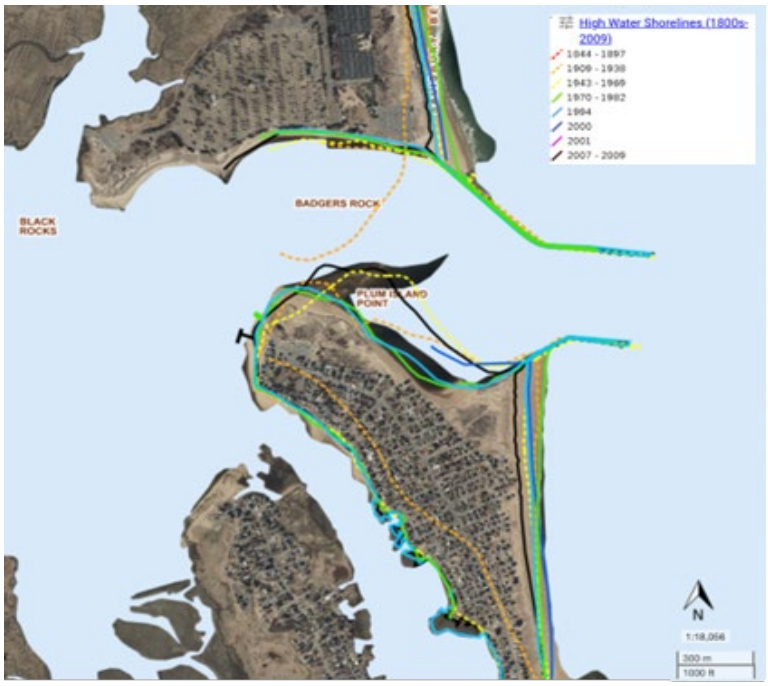


Figure 4.4 Map of the north and south jetties at the mouth of the Merrimack River with historic coastal edge data from 1909-2009. Source: Coastal Zone Management Massachusetts Shoreline Change Project.

In an effort to further assess the role that the North and South jetties are playing in causing the erosion, the City of Newburyport secured federal funding in 2022 to allow the Army Corps of Engineers (ACOE) to conduct a study. Following results of the study, the coastal communities of Salisbury, Newburyport, and Newbury along with ACOE are expected to all be involved in efforts to develop long-term solutions to sediment loss and stabilization of the barrier beach system.[46] For a successful outcome, funding and support will likely be needed to develop and implement a comprehensive and dynamic remediate plan for the barrier beach systems.

Grey infrastructure, like the jetty system at the mouth of the Merrimack, is not unique to this region. 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.[47] Armoring can successfully protect adjacent structures but can also lead to unintended long-term consequences due to the disturbance of natural systems, as experienced on Plum Island.

Impact of Future Conditions: Changes in future conditions related to climate change, population patterns, and land use and development could affect the occurrence of coastal erosion and shoreline change throughout the Merrimack Valley. The coastal communities in the Merrimack Valley region are already experiencing coastal erosion, which is likely to accelerate with climate change. With heightened sea levels and more intense and frequent storms, the barrier beaches of Salisbury and Plum Island will likely 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 lead to landward retreat of these natural systems, reducing the natural

[45] Army Corps of Engineers. 2021. Section 204 Beneficial Use of Dredged Material FROM Federal Navigation Project Maintenance Detailed Project Report and Environmental Assessment.
[46] MA Department of Conservation & Recreation (2021). Upper North Shore Regional Sediment Management Study.
[47] 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

buffer they provide to existing development and causing further risk for populations and structures in densely populated areas. It is unclear if future population growth will impact this hazard, as population projections for the coastal communities of Newbury, Newburyport, Rowley, and Salisbury are all expected to decline, or remain comparable over the next 5-15 years. While increased populations, if they were to occur, would not directly exacerbate this problem, additional development within the coastal zone could. Human-constructed features across Salisbury Beach and Plum Island have been found to influence patterns of accretion and erosion along the barrier beach system. Increased armoring or barriers could further impact future erosion. Additionally, increases in impervious surface would reduce pervious land and put pressure on adjacent natural resources (e.g. beaches, dunes, marshes, etc.) that play a critical role in stabilizing the barrier beaches. Due to the current and felt threat of coastal flooding, it is possible that re-wilding, migration away from the coast, or future selection of non-coastal locations would help to alleviate this hazard through reducing property and human presence within the coastal zone subject to this hazard.

4.2.3 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

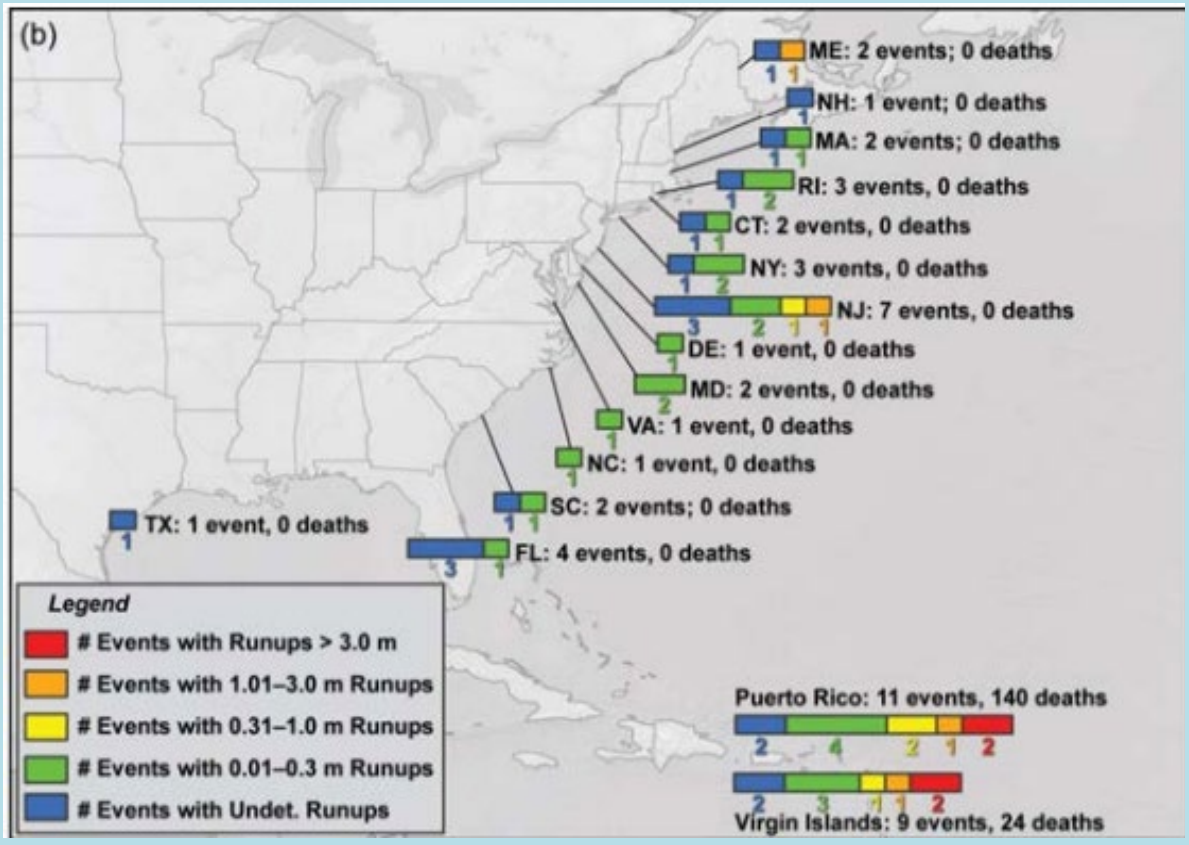


Figure 4.5 Total number of tsunami events that have occurred in the Atlantic Ocean with run-up heights of 0.01-3.0 meters (Dunbar and Weaver 2015)

communities and cause flooding in low-lying coastal areas. Tsunamis are generally measured by their height on shore and the maximum runup of waves on land. Currently NOAA's Deep-ocean Assessment and Reporting of Tsunami (DART) program provides early detection of tsunami events.

While all 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*). According to NOAA, the majority of 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.[48] 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).[49] 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 locations, the risk is considerably lower.

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.[50] 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.[51]

According to the 2018 Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP), 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 the Merrimack Valley is low to very low based on historical data and the frequency of causal activities.[52] However, while the likelihood of a damaging tsunami in Massachusetts is low compared to other hazards, the impacts could be high. The 2018 SHMCAP references a 1-mile coastal buffer which was established as part of the 2013 plan to define the geographic extent of tsunami hazards in the state. Areas of the Merrimack Valley Region (Salisbury, Newbury, and Rowley) fall within this buffer zone and are considered vulnerable locations were a tsunami to occur.

Impact of Future Conditions: Changes in future conditions related to climate change, population patterns, and land use and development could affect the occurrence of tsunamis throughout the Merrimack Valley. The effect of climate change on tsunamis is unclear, however, early studies suggest that it will contribute to increased tsunami occurrence and severity.[53] 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. While changes in population patterns and development will not directly impact the occurrence of tsunamis, it could change the impact of these events

[48] International Tsunami Information Center. Tsunami Events. Tsunami Events - International Tsunami Information Center (ioc-unesco.org)

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

[50] NOAA National Centers for Environmental Information. 2023. Storm Event Database. Storm Events Database | National Centers for Environmental Information (noaa.gov)

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

[52] Massachusetts EEA. 2018. State Hazard Mitigation and Climate Adaptation Plan. SHMCAP-September2018-Full-Plan-web.pdf (mass.gov)

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

on communities in the Merrimack Valley. If the population density and development is lower in the coastal zone in the future, the effect of tsunami occurrence on property and safety will be reduced. Whereas, if population density and development increases within the coastal zone, the negative impacts could be more substantial.

4.2.4 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 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 difficult. In Massachusetts, the most pronounced fault is the Clinton-Newbury fault zone, which consists of many faults along a line that forms a 97-mile arc extending from Newbury to Worcester and down into Connecticut.

The extent of an earthquake is referred to as "magnitude" which is an estimate of the relative size or strength of an earthquake based on the amount of seismic energy released at the hypocenter. Between 1935-1970 the Richter scale was exclusively used to measure the magnitude of an earthquake. 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 event details such as force and duration. On this scale, earthquakes under 3.5 magnitude are generally not felt, while earthquakes over 8 magnitude cause serious destruction. Because it uses a logarithmic scale, each whole number increase in magnitude represents a tenfold increase in earthquake strength. When it became apparent that the Richter scale was only valid for certain frequency and distance ranges, new magnitude scales were developed—such as the Moment magnitude scale (Mw), which as developed in the 70s and in official use by the USGS today.

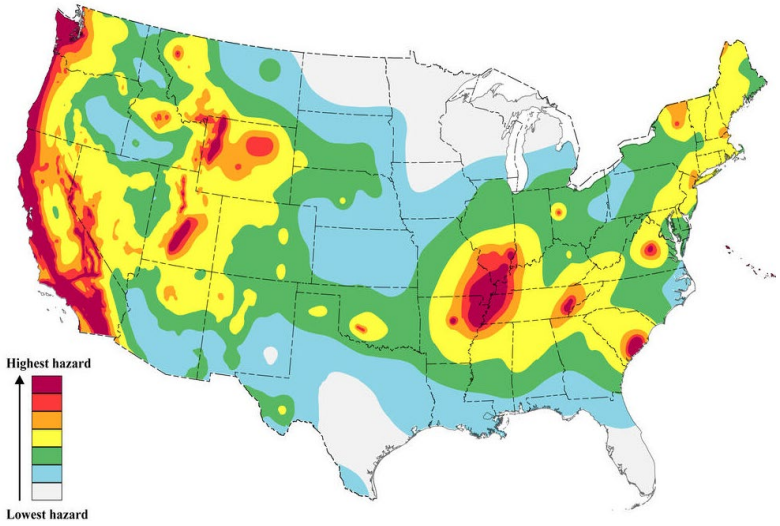


Figure 4.6 Earthquake hazard map of lower 48 states showing peak ground accelerations having a 2% probability of being exceeded in 50 years (USGS).

Because the USGS does not calculate Mw for earthquakes less than 3.5 magnitude, localized Richter scales or other scales are used to measure magnitude for smaller earthquakes. In New England, the Weston Observatory utilizes the Nuttli magnitude (MN) for North America east of the Rocky Mountains, as well as the Coda Duration magnitude (Mc), a scale based on the duration of shaking at particular stations.

While not a scientific scale, the impacts of an earthquake (intensity) are measured in the Modified Mercalli Intensity Scale, which is defined by a series of impacts based on the magnitude. The scale outlines 12 increasing levels of intensity (*Table 4.6*). A comparison of the Richter magnitude to the Modified Mercalli Intensity is shown in *Table 4.7*.

Table 4.6 Modified Mercalli Intensity Scale (USGS)

Modified Mercalli Intensity	Description
I	Not felt except by a few under especially favorable conditions
II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III	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. Vibration similar to passing of a truck. Duration estimated.
IV	Felt indoors by many. Felt outdoors by few during the day. At night, some awakened. Dishes, windows, door disturbed; walls make creaking sound. Sensation like heavy truck striking a building. Standing motor cars rock noticeably.
V	Felt by nearly everyone; many awakened. Some dishes and windows are broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	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	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	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	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI	Few if any (masonry), structures remain standing. Bridges destroyed. Rails bent greatly.
XII	Damage total. Lines of sight and level are destroyed. Objects thrown in the air.

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 country (*Figure 4.6)*. These maps show the amount of earthquake-generated ground shaking that is predicted to be 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 activity. These maps generally show that there is a 1 in 10 chance in any given fifty-year period that a potentially damaging earthquake will occur.

Table 4.7 Comparison of Moment Magnitude and Modified Mercalli Intensity Scale (USGS)

Moment Magnitude	Typical Maximum Modified Mercalli Intensity
1.0 to 3.0	I
3.0 to 3.9	II to II
4.0-4.9	IV to V
5.0-5.9	VI to VII
6.0-6.9	VII to IX
7.0 and above	VIII or higher

All of Essex County, including the Merrimack Valley Communities, is at moderate risk to the threat of an earthquake. Moderate risk means 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 (all earthquakes shown in *Figure 4.7)*.

According to the USGS, the last earthquake to hit the New England Region with a magnitude of 3.0 or greater occurred on April 5th, 2024, in the area Whitehouse Station, New Jersey.[54] New England experiences 30-40 earthquakes each year, although most are not felt. Potential earthquake losses total $14.7 billion annually in the United States, according to FEMA.[55] That 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 condition of the region's buildings.

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.

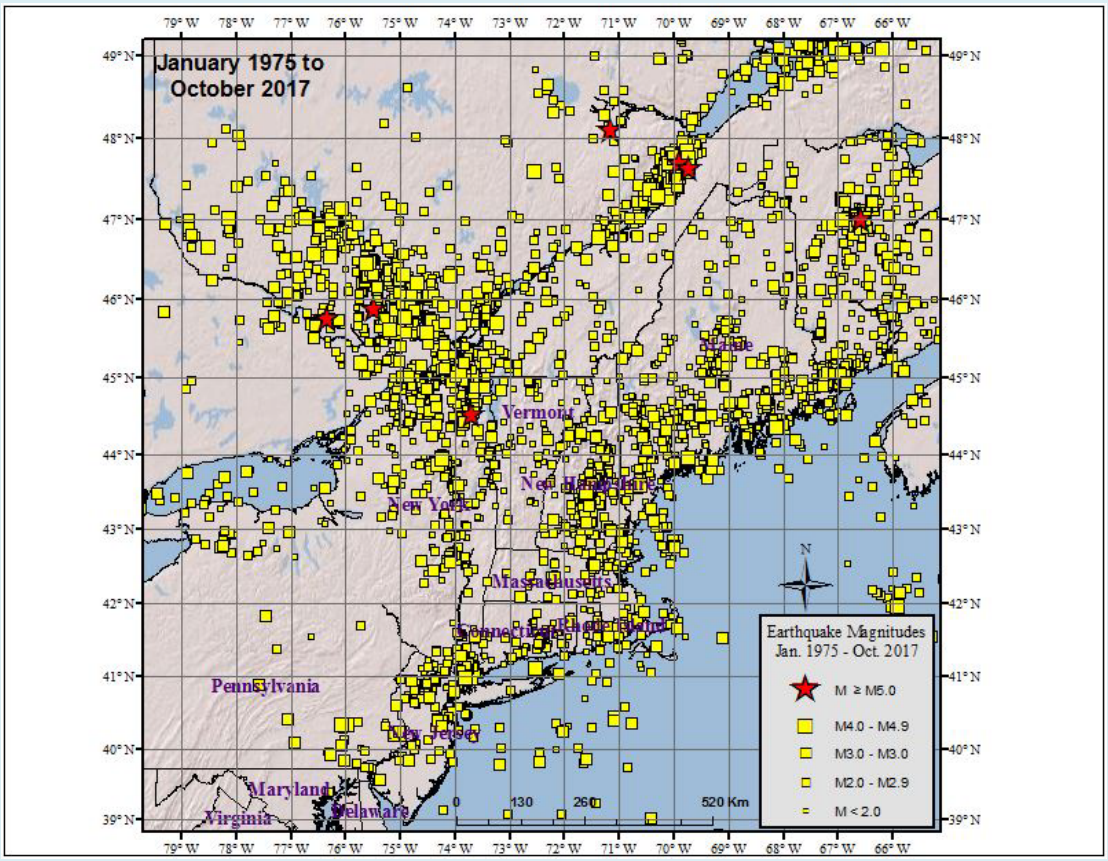


Figure 4.7 Map of Earthquakes of the Northeastern US and Southeaster Canada 1975-2017 (Northeast State Emergency Consortium)

[54] United States Geological Services. 2023. All Earthquakes- 1900 to Present. Map Viewer. Latest Earthquakes (usgs.gov)

[55] FEMA, NEHRP, USGS. 2023. Hazus Estimated Annualized Earthquake Losses for the United States. fema_p-366-hazus-estimated-annualized-earthquake-losses-united-states.pdf

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).

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. Communities within the Merrimack Valley comply with the most recent version of the Massachusetts State Building Code.

Impact of Future Conditions: Changes in future conditions related to climate change, population patterns, and land use and development could affect the occurrence of earthquakes throughout the Merrimack Valley. The effect of climate change on earthquakes is unclear, however, early studies suggest that it will contribute to increased occurrence and severity.[56] 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. While changes in population patterns and development will not directly impact the occurrence of earthquakes, it could change the impact these events have on communities in the Merrimack Valley. With population increase projected across the Valley, it is expected that additional development across the region will occur. As damage resulting from an earthquake most commonly occurs from collapsing infrastructure (collapsing walls, falling objects, and flying glass), increased development provides a greater opportunity for damage to both built infrastructure, property, and human safety.

4.3 Rising Temperatures

Massachusetts' climate is changing – nineteen of the twenty warmest years have occurred since 2001, according to the NASA climate change website. Average global temperatures have risen steadily in the last 50 years.[57] Ambient average air temperature has increased by approximately 0.5°F per decade since 1970, with winter temperatures rising at a faster rate of 1.3°F per decade.[58] 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.[59] As global emissions continue, temperatures are only set to increase (*Figure 4.7).*

Temperature variations can occur due to several factors, including increased greenhouse gas emissions from anthropogenic activity which has been linked to rises in air and water temperature across the globe. Rising temperatures are having a cascading impact on other defined hazards including extreme temperatures, wildfires, and invasive species.

[56] McGuire.2010. Potential for a Hazardous Geospheric Response to Projected Future Climate Change. Royal Society 368:119.
[57] NASA. 2021. Global Temperature. https://climate.nasa.gov/vital-signs/global-temperature/
[58] MA EEA. 2024. ResilientMass. Rising Temperatures. MA Climate Change Clearinghouse (mass.gov)
[59] 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.

4.3.1 Extreme Temperatures

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 (*Figure 4.8).* From 1971 to 2000, Massachusetts had an average of four days with temperatures above 90°F. By the end of the century, the region is projected to have 13 to 56 *more* days per year with temperatures rising above 90°F.[60]

Higher temperatures will have a negative impact 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% by 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 options.[61]

Heat can impact large regions, such as the Merrimack Valley, but its effects can be felt differently depending on local characteristics. Inland, and more highly developed areas across the region with less open/green space can hold and retain heat to a greater extent. This means more inland and developed communities such as Lawrence, Methuen, and Haverhill, and sections of Andover, Amesbury, Newbury, and North Andover are at a greater risk for impacts from this hazard due to the urban heat island effect.

With increased ambient temperatures, there is also an increased risk for heat waves. A heat wave is defined as three consecutive days during which the air temperature reaches or exceeds 90°F on each day. Temperatures that hover ten degrees or more above the average high for the region and last for several

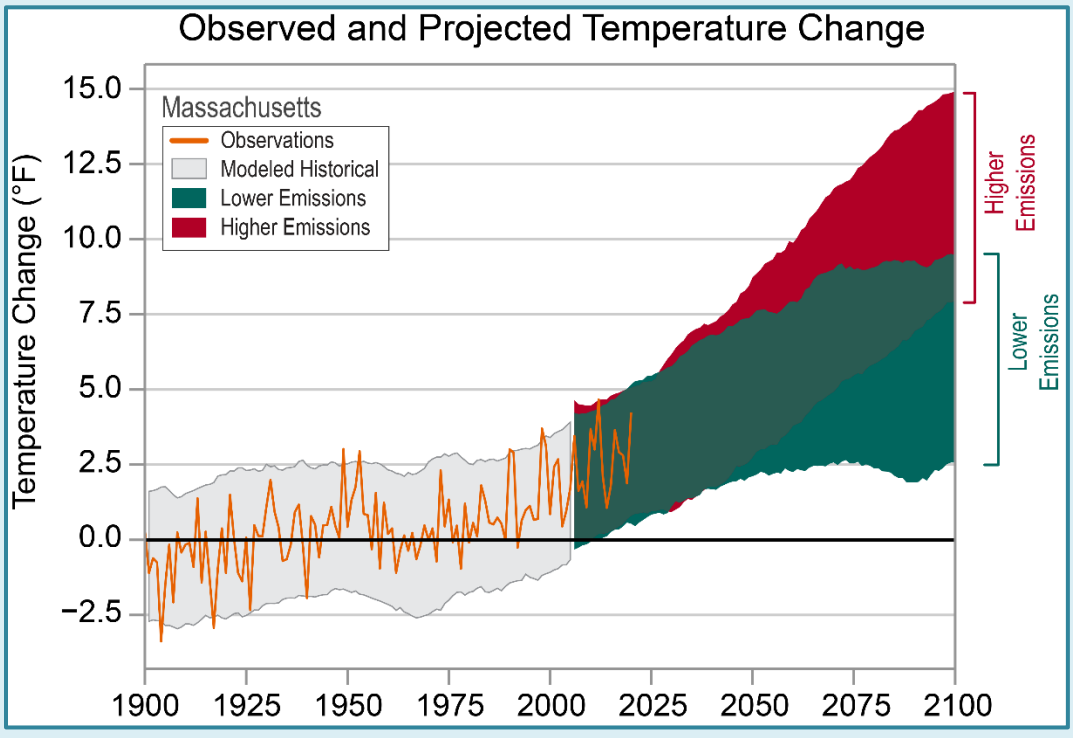


Figure 4.8 Air temperature projections under low and high emission rates (NOAA, 2021)

[60] MA EEA. 2024. ResilientMass. Rising Temperatures. MA Climate Change Clearinghouse (mass.gov)

[61] 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.

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.

Extremely hot temperatures associated with heat waves are measured through the Heat Index Scale, which combines relative humidity with actual air temperature to determine 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 two or more hours, 95°-99°F for two or more hours over two consecutive days, or 100°-104°F for two or more hours over one day. Further, the NWS defines a heat wave as three or more days of 90°F temperatures. *Figure 4.9* indicates the relationship between heat index and relative humidity.

According to the Center for Disease Control (CDC), between 1979-2018, the death rate as a direct result of exposure to heat was between 0.5-2 deaths per million people.[62] In Essex County in 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.[63] The region experienced another set of extreme high temperatures in 2021 and 2022, with 24 days reaching 90°F or greater in 2021 in Boston and record-breaking temperatures in 2022.

While localized cooling options such as air conditioning units provide a critical service for many residents, high cooling demands across the region 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 at-risk populations in the region. To reduce risk to residents during extreme heat, many communities are establishing cooling shelters across the region.

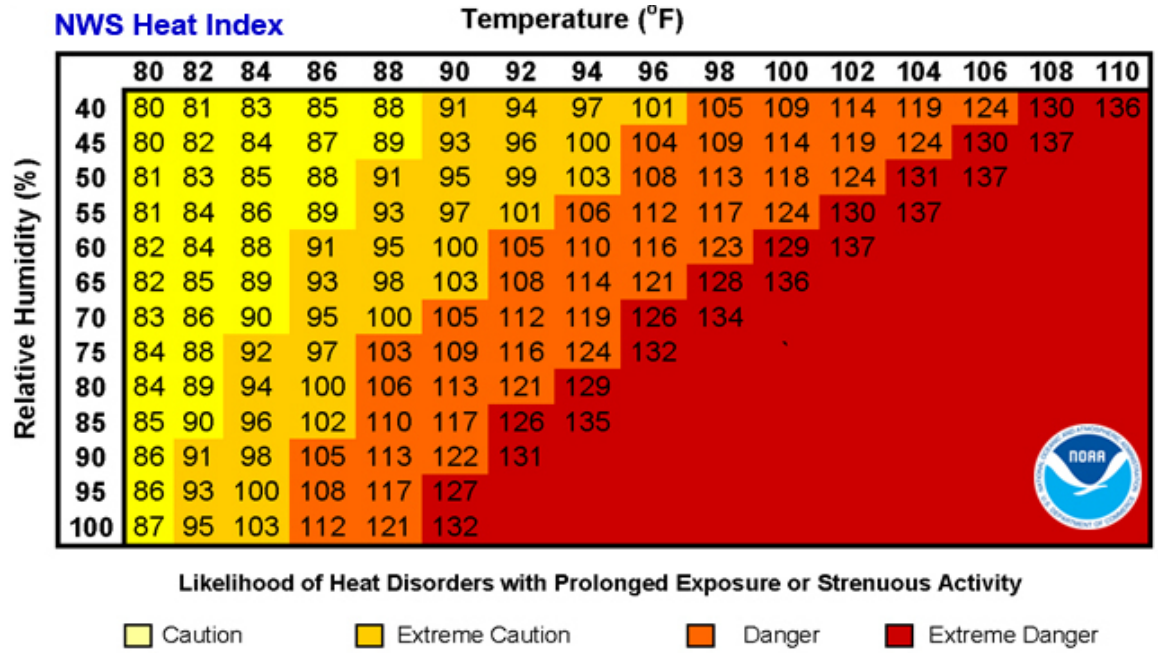


Figure 4.9 Heat Index measuring perceived heat based on air temperature and humidity levels (National Weather Service).

[62] U.S. Centers for Disease Control and Prevention. 2020. Indicator: Heat-related mortality. National Center for Health Statistics. Annual national totals provided by National Center for Environmental Health staff in July 2020. https://ephtracking.cdc.gov.

[63] NOAA National Centers for Environmental Information. 2023. Storm Event Database. StormEventsDatabase-EventDetails|National CentersforEnvironmentalInformation(noaa.gov)

Extreme heat can pose secondary risks including changes to agricultural conditions, degraded aquatic habitats, impacts to the health of terrestrial habitats and wildlife, elevated risks for droughts and wildfires, exacerbation of other natural hazards including hurricanes, and greater demands on energy systems and infrastructure. While historically, the Merrimack Valley region, along with the rest of New England, has been concerned with extreme low temperatures, the concern for high heat days is rising. The Massachusetts State Hazard and Climate Adaptation Plan recognizes extreme heat as the leading cause of weather-related fatality in the United States.

Impact of Future Conditions: Changes in future conditions related to climate change, population patterns, and land use and development could affect the occurrence of extreme temperatures throughout the Merrimack Valley. Climate change has been steadily increasing ambient air and water temperature across the globe, and its effects have, and are expected to continue, to be felt right here in the Merrimack Valley. Driven by carbon production, an anthropogenic activity, increased population may further exacerbate this hazard through heightened demand and usage of non-renewable energy sources. However, while system-wide and individual actions may act as a force to intensify extreme heat, it could also act to reduce the occurrence of this hazard. Through investment of renewable energy sources and reduced carbon consumption, we may find that increases in population within the valley do not significantly alter this hazard. Similarly, future development may pose a risk to intensify extreme heat through increased impervious cover, which reflects sunlight and heat back into the atmosphere, trapping heat in place. Cities within the region with projected population growth over the next 5-15 years may be especially susceptible to this occurrence: Andover, Haverhill, Lawrence, Methuen, and North Andover. Ensuring open space is protected, and additional development is done to minimize increased impervious surface cover, will be important to minimize the impacts of extreme heat.

4.3.2 Wildfires

Fire poses a danger to both developed and rural areas across the Merrimack Valley, as well as forested and grassland areas. Wildfire can be defined as any non-structure fire that occurs in wildland that contains grass, shrub, leaf litter, and forested tree fuels. Wildfires are often uncontrolled and spread due to the presence of vegetative fuel. These fires typically begin unnoticed and spread quickly. In this area of the country, wildfire season generally begins in March and ends in late November. In Massachusetts, 98% of wildfires are caused by humans, with other natural events/factors (e.g. lightning strikes) accounting for the remainder.[64] 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 by wildfires. The loss of ground cover materials and the chemical transformation of burned soils can make some watersheds more susceptible to erosion.

There are a number of different types of wildfires. A surface fire is the most common type of wildfire, which burns slowly along the floor of a forest, destroying or damaging trees, shrubs and other low-laying vegetation. Groundfires burn deeper, below surface fires and are typically started by lightning; 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. Forests of pitch pine, scrub oak, and oak forests have been identified as most susceptible to wildfires due to the flammable vegetation.

[64] Massachusetts EEA. 2023. ResilientMass Plan: 2023 MA State Hazard Mitigation and Climate Adaptation Plan. 2023 ResilientMass Plan_10.10.23 508.pdf

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 six years from 2017 to 2022 (most recent data available), there were 2,163 brush fires in Essex County, averaging 360 a year.[65] Over the six-year period, "other fires", defined as non-structural or non-vehicle and including brushfires peaked between April-September.

Georgetown-Rowley State Forest Fire

Photo Credit: Rowley Fire Dept

Wildfire risk is higher in areas with available vegetative fuel, such as communities with a high amount of forested land, as well as in locations at wildland/urban interface areas, which exist wherever homes and businesses are built among trees and other combustible vegetation. Such areas are becoming increasingly prevalent throughout the region, 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, leaves, 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, damaged power lines, and industrial activity all are potential ignition sources. As a highly forested region, the Merrimack Valley has identified areas in all communities that are vulnerable to wildfires, as well as specific associated assets that are at risk from this hazard (*Table 4.8).* Additional information on community-specific vulnerability to wildfires and brushfires is articulated in each community's Natural Hazard Risk Assessment Community Profile.

Table 4.8 Wildfire Prone areas across the region and the associated at-risk community lifelines and assets

Municipality	Wildfire-Prone Area	Associated at-risk Lifelines & Assets
Amesbury	Amesbury Town Forest	Elizabeth Calsey House (Assisted Living Facility)
	Bartlett Greenbelt Conservation Land	Amesbury High School
	Battis Farm	-
	Powow River Conservation Area	Telecommunication Tower, Amesbury Elementary School
	Whittier Hill Reservation	Jordan Shay Memorial Lower School, Cashman Elementary School, Merrimack Valley Health Center
	Woodsom Farm	Amesbury Water Treatment Facility (across Newton Rd.)
Boxford	Boxford State Forest	Section of I-95 runs through forested land in Boxford
	Boxford Town Forest	-
	Cleveland Farm	-
	Georgetown-Rowley State Forest	Section of I-95 runs through forested land in Boxford
	Wildcat Forest	-
	Numerous smaller wooded parcels	National Grid Power Stations, section of Maritime Northeast Piping System

[65] MA Executive Office of Public Safety and Security Department of Fire Services.2022. Fire Data and Statistics. Fire Data and Statistics | Mass.gov

Municipality	Wildfire-Prone Area	Associated at-risk Lifelines & Assets
Groveland	Center Street Greenway (150 Center St.)	Town Well, Solar Field, Highway Garage
	Crane Pond Wildlife Mgmt. Area	-
	Essex County Greenbelt Conservation Land off of Graeme Way	Adjacent to The Willows (senior housing) in Boxford
	Meadow Pond Reservation	-
	Town Forest	Groveland Water Tower
	Upper Parker River Wildlife Mgmt. Area	Salem St. and Washington St. (important transportation corridors)
Haverhill	Bailey Farm and Reservation	Chadwick Pond, Ridgerunners Fish & Game Club, rural residences (high potential for wildfire due to frequent burning at abutting Crescent Farm)
	Brandy Brow Forest	Primary public water supply watershed, J.G. Whittier Birthplace, rural residences
	Clement Farm Conservation Area	Little River, American Legion buildings, disc golf course, ballfields, Rosemont Street businesses, Main Street commercial plazas
	Creek Brook Conservation Area	Crystal Lake public water supply, rural residences
	Crystal Gorge, Crystal Shores Conservation Areas, Crystal Lake Dam Area	Crystal Lake public water supply, rural residences
	Dead Hill Reservoir Land	Johnsons Pond, Ski Bradford, rural residences
	Gale Hill Water Reservoir	Water supply infrastructure, mid-density residences
	John's Woods	Large ground-mounted solar facilities to the north, rural residences
	Lake Pentucket Conservation Area	Pentucket Lake and Whittier public schools, public water supply, dense residences
	Lake Saltonstall Conservation Area	buts Winnekenni and public water supply, municipal bath house for public swimming area, Recreation Department boat house, dense residences
	Meadow Brook Conservation Area	Millvale Reservoir public water supply, Route 495, Whittier Regional Vocational Technical High School, rural residences
	Rurak Point Conservation Area	Crystal Lake public water supply, rural residences
	Viburnum Woods	Mid-density neighborhood, upper Hilldale Avenue businesses, large ground-mounted solar facilities to south, apartments to east in Atkinson
Haverhill	Wheeler Woods Conservation Area	Chadwick Pond, rural residences
	Whittier Regional Vocational Technical High School Land	High School, Millvale Reservoir public water supply, Route 495, rural residences, large ground-mounted solar facility under construction to south
	Winnekenni Conservation Area	Kenoza Lake primary drinking water supply, Winnekenni Castle and supporting buildings, Parks Department building, Water Treatment and Maintenance Facility, Northern Essex Community College, Lake Saltonstall recreation buildings, rural residences
Lawrence	Den Rock Park	River Pointe at Den Rock Apartments and Andover Park Apartments (stem pipes and hydrants are located adjacent to the apartment due to limited access and location abutting Park)

Municipality	Wildfire-Prone Area	Associated at-risk Lifelines & Assets
Methuen	Peat Meadow IBA	Shaw's Supermarket Distribution Center, Affordable Housing
	Town Forest & Former Ski Hill Conservation Area	-
	Wooded areas of East End (Washington St. Extension, and northern sections of Howe St, and Hampstead St.)	Pump Station off of Sable Run Lane
	Wooded areas of West End (Tyler St.)	-
Newbury	Crane Pond Wildlife Mgmt. Area	Boarders Section of Main Street
	Martin H Burns Wildlife Mgmt. Area	Mass State Police Station and telecommunications tower (across from Scotland Rd.), Salter Transportation (across from Scotland Rd.), Portion of Commuter Rail Passes through area
	Old Town Hill	Highway Department Garage (across from High St./1A), Portion of Route 1A passes through area
Rowley	Georgetown-Rowley State Forest	Woodside Condominiums (along Rte 133)
	Hunsley Hills	Rowley Fire and Police Station
	Mass Audubon Rough Meadows	-
	Prospect Hill off of Haverhill Street	Water tower and communications tower
	William Forward Wildlife Management Area	Rowley Town Water Department (Central St.), Solstice Day School (Bowlery Dr.)
Salisbury	Forested land between Bridge Rd. and Ferry Road	Phragmites is a major fire hazard here
	Forest land between Bridge Rd. and Old Eastern Marsh Rail Trail	Phragmites is a major fire hazard here
	Forested Land south of Elm St.	Sewer Treatment Plant
	Forested Land south of Folly Mill Rd.	-
	Forested Land along Old Eastern Marsh Trail	Salisbury Elementary School, A segment of Route 1 also runs along this area
West Newbury	Artichoke River Woods	-
	Atherton Reservation	Rural residences
	Brake Hill and Groveland Town Forest	Nichols Village (Senior Living Community in Groveland)
	Crane Pond Wildlife Mgmt. Area	Rural residences
	Indian Hill Conservation Area	-
	Mill Pond & Pipestave Hill	Pipestave recreation area, segment of Main St./Rte 113 runs through area
West Newbury	Mullen Woods	
	Ordway Reservation	Portion of I-95 runs adjacent to area
	River Bend, Page School	Dr. John C Page School, Telecommunication Tower, Electric Power Resources (along Rte. 113)
	South Street Woodlot	Portion of I-95 runs adjacent to area
	Transmission Lines	Residences

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.

During the extreme drought conditions in 2022, the Merrimack region, similar to the rest of the state, experienced notable wildfires (*Figure 4.10)*. In August 2022, the Georgetown-Rowley State forest experienced an 11-acre fire that burned for five days. It took a regional response to contain the fire, with crews from Georgetown, Rowley, Groveland, Boxford, Newbury, West Newbury as well as the Department of Conservation and Recreation and Conservation's Bureau of Forest Fire Control all assisting in the effort.

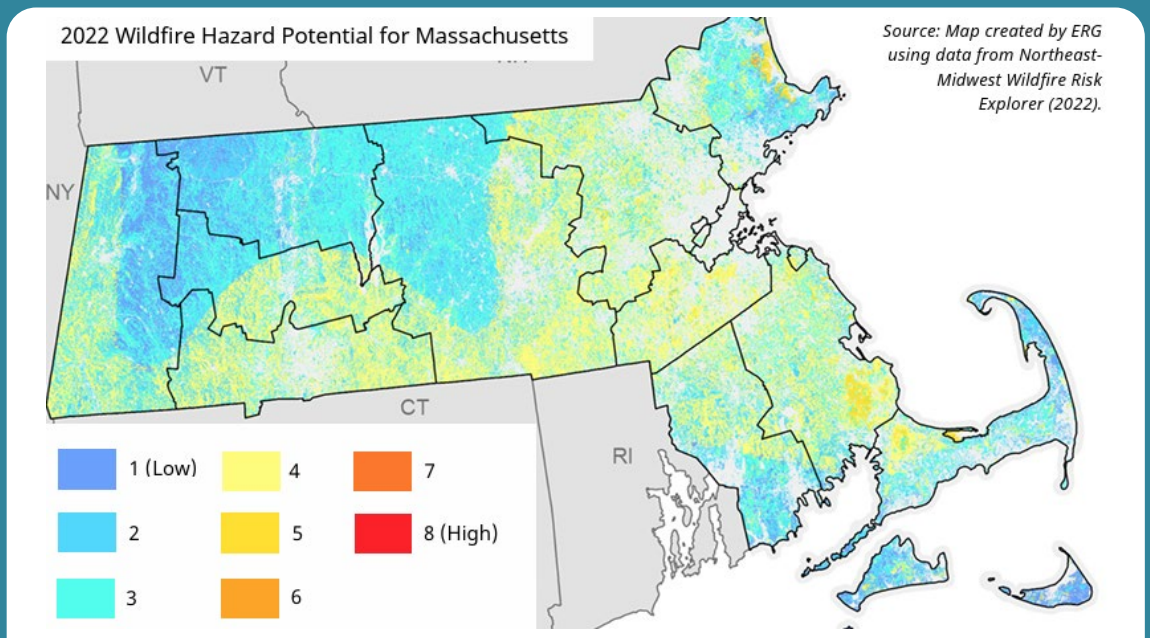


Figure 4.10 Wildfire Hazard Potential for Massachusetts during high drought year in 2022 (SHMCAP, 2023

The extent of a wildfire can be classified by physical factors or behavior, including their fireline intensity, or Byram's intensity (British Thermal Unit (BTU) per foot of fireline per second), total heat release during burnout of fuel (BTU per square foot), and even the extent of mortality/survival of wildlife above and below ground. The National Wildfire Coordinating Group uses seven (7) classes of wildfires (Class A- Class G). The categorization is defined by the size (in acres) of the fire, with Class A defined as 0.25 acres or less, and Class G defines as 5,000 acres or more (*Table 4.9*). Wildfires may have secondary impacts through degrading air quality, disrupting the local economy, threatening adjacent infrastructure, impacting local wildlife, and increasing risk of mud/landslides and erosion, and impacting water sources.

Table 4.9 National Wildfire Coordinating Group's Seven Classes of Wildfires

Class	Wildfire Size
Class A	0.25 acre of less
Class B	0.25 to 10 acres
Class C	10 acres to 100 acres
Class D	100 acres to 300 acres
Class E	300 acres to 1,000 acres
Class F	1,000 acres to 5,000 acres
Class G	5,000 acres or more

Impact of Future Conditions: Changes in future conditions related to climate change, population patterns, and land use and development could affect the occurrence of wildfires throughout the Merrimack Valley. Climate changes, including rising temperatures, alterations in precipitation patterns, drought, and increased storm events (such as thunderstorms) are expected to increase the frequency and severity of wildfires. Wildfires are expected to increase by 14% by 2030, 30% by 2050, and 50% by the end of the century.[66] As wildfires along the wildlife-urban interface pose the greatest risk to human safety and property, increases in population and subsequent demand for development of open and rural land could increase the risk and impact of wildfires within the Merrimack Valley region. This could be especially true for communities with high amounts of forested land (>50% forest land cover) such as Andover, Boxford, Georgetown, Groveland, Merrimac, North Andover, and West Newbury. Working to promote low-impact development that safeguards open space and positions housing and structures within already developed areas of the community could help to reduce the impact of population and land-use growth in the region.

4.3.3 Invasive Species

The Merrimack Valley region is susceptible to invasive species, defined as species that are non-native to the ecosystem and cause, or have the potential to cause, economic or environmental harm. Invasive species can threaten terrestrial and aquatic ecosystems. Historically, humans have played a role in both introducing (intentionally and unintentionally) invasive species into new ecosystems and allowing for their proliferation and expansion. Increased global trade and changes in climate are factors exacerbating invasive species.

The diversity of landscapes within the Merrimack Valley makes the region susceptible to a range of invasive species. Forested areas are experiencing challenges from invasive pest species such as the hemlock wooly adelgid (*Adelges tsugae*), Asian longhorn beetle (*Anoplophora glabripennis*), and emerald ash borer (*Agrilus planipennis),* which degrade native tree health. Terrestrial invasive plants including oriental bittersweet (*Celastrus orbiculatus*) and Japanese knotweed (*Reynoutria japonica*) also pose risks to native plants. In wetland areas, communities in the region have reported purple loosestrife (*Lythrum spp.)* and Eurasian milfoil (*Myriophyllum spicatum*), along with other aquatic invasive plant species. In the region's coastal communities, salt marsh and marine invasives including the common reed (*Phragmites australis*) and perennial pepperweed (*Lepidium latifolium*) as well as the European green crab (*Carcinus Maenas*) are well documented and have inspired collective regional management.

The Common Reed within the Salt Marsh

Photo Credit: MassAudubon

Invasive species management is time and resource intensive for the Merrimack Valley communities, often requiring a full suite of actions (early detection, research, rapid response, control and management, education, removal and restoration) to be successful. The extent of the challenge is generally documented through monitoring for presence and abundance of invasive species. If left untreated, secondary effects from invasive species can include increased temperatures, wildfire risk, and erosion from tree mortality, degraded habitat, and biodiversity due to loss of native species within the larger ecosystem.

[66] Massachusetts EEA. 2023. ResilientMass Plan: 2023 MA State Hazard Mitigation and Climate Adaptation Plan. 2023 ResilientMass Plan_10.10.23 508.pdf

Impact of Future Conditions: Changes in future conditions related to climate change, population patterns, and land use and development could affect the occurrence of invasive species throughout the Merrimack Valley. Climate changes, including rising temperatures, alterations in precipitation patterns, and drought, are expected to increase the presence of invasive species. This can occur in two ways. The first is that native species, which have evolved to our regional conditions, have a harder time competing as climate conditions change. Altered climate conditions also enable range expansion of non-native species who can establish a footing and excel over natives. It is possible that increases in population and development may further reduce natural habitat and cause greater stress to native species, further exacerbating the invasive problem. Alternatively, increase population may lead to better natural habitat management, actually helping to stabilize the problem.

4.4 Extreme Weather

The Merrimack Valley is susceptible to a range of extreme weather events, impacting the full region across all seasons. Extreme weather events, encompassing phenomena such as hurricanes, severe winter storms, tornadoes, thunderstorms, and high wind events, are increasingly capturing global attention due to their devastating impacts on communities, economies, and ecosystems. These events, characterized by their intensity, frequency, and/or duration, are often linked to shifts in climate patterns driven by human-induced climate change. As temperatures rise and weather patterns become more erratic, the occurrence and severity of extreme weather events are on the rise, posing significant challenges. Communities are working to understand risks from extreme weather to plan for effective mitigation and adaptation that can minimize their adverse effects on a local level.

4.4.1 Hurricanes/Tropical Storms (update all fig and table, in caption and text).

Hurricanes are defined as intense tropical weather systems with well-defined circulation and maximum sustained winds of 74 miles per hour (mph) or higher. A typical hurricane moves at an average speed of 12 mph. 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 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. While the entire region is subject to impacts from hurricanes and tropical storms, coastal areas, and specifically south-facing shores are most vulnerable.

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 classified as a Hurricane in eastern Massachusetts, storms associated with Hurricane Sandy in 2012 also left some Merrimack Valley residents without power for several days.

Hurricanes can occur along the East Coast of the United States, most often 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 (*Table 4.10*). Hurricanes reaching Category 3 and higher are considered major hurricanes given the potential for loss of life and property

damage. 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.

Table 4.10 Saffir-Simpson Hurricane Wind Scale (National Hurricane Center, NOAA)

Category	Sustained Winds	Types of Damage
1	74-95 mph 119-153 km/h	**Damaging winds will produce some damage:** Well-constructed framed homes could have damage to roof, shingles, vinyl siding, and gutters. Large branches of trees will snap, and shallow-rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph 154-177 km/h	**Very strong, damaging winds will cause widespread damage:** Well-constructed framed homes could sustain major roof and siding damage. Many shallow-rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3	111-129 mph 178-208 km/h	**Dangerous winds will cause extensive damage:** Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4	130-156 mph 209-251 km/h	**Extremely dangerous winds will cause devastating damage:** Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5	157+ mph 252+ km/h	**Catastrophic damage will occur:** A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

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 can be downed and bring with them 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.

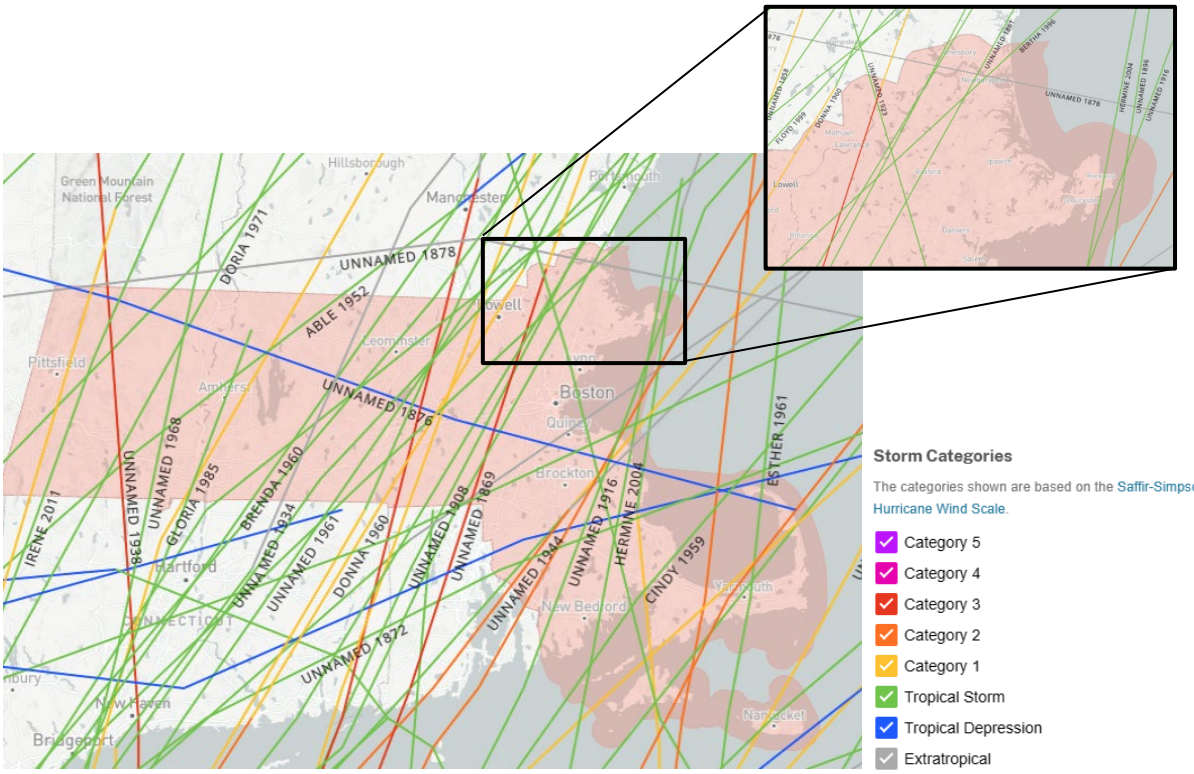


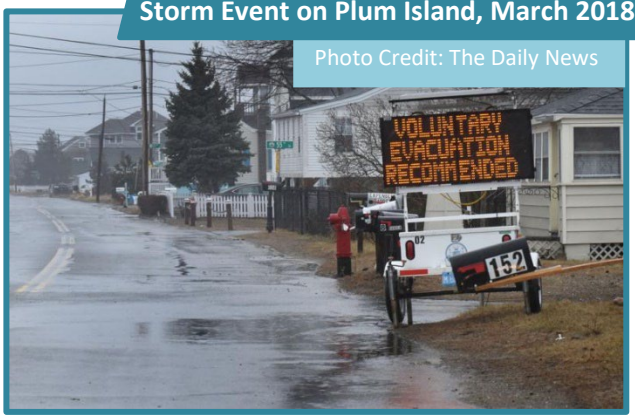
Figure 4.11 Historic hurricane tracks over Massachusetts between 1850-2023 (NOAA)

Between 1851 and 2023, Massachusetts has experienced 35 hurricane events, 60 tropical storms, and 68 tropical depressions and extratropical events (*Figure 4.11*).[67] The most recent hurricane to hit the state was Hurricane Arthur in June 2014, and most recent tropical storm was Tropical Storm Lee in September 2023—which led to a State of Emergency being declared in Massachusetts (EM-3599-MA). The three most recent storms to directly impact Essex County, in 2011, 2017, and 2020, caused 2.2 million in damage to the region. Peripheral effects from offshore hurricanes and tropical storms that track inland are also common occurrences.

In the Merrimack Valley region's coastal area, 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.

Storm Event on Plum Island, March 2018

Photo Credit: The Daily News



In the case of our barrier beaches (Plum Island and Salisbury), 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,

[67] NOAA. 2023. Historical Hurricane Tracks. Historical Hurricane Tracks (noaa.gov)

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, rendering streets impassable long after surge waters have receded.

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 to calculate a potential "worst-case" surge. This model takes data from thousands of datapoints on 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 atop a storm surge. Communities used the SLOSH model when identifying flooding risk within their communities as part of the hazard identification and evaluation process as part of this plan update.

Secondary impacts from this hazard include possible formation of tornadoes, erosion, heightened risk of landslides, and contamination of water supplies due to flooding. The 2018 Massachusetts State Hazard Mitigation and Adaptation Plan defines hurricanes as a medium frequency event, with a greater than 20% of occurrence per year.

Impact of Future Conditions: Changes in future conditions related to climate change, population patterns, and land use and development could affect the occurrence of hurricanes and tropical storms throughout the Merrimack Valley. As sea levels continue to rise and air and water temperatures warm, hurricanes are predicted to become more frequent and intense, bringing with them increased coastal flooding, and damage from wind, rain, and coastal waves. While changes in population patterns and development will not directly impact the occurrence of hurricanes and tropical storms, it could change the impact these events have on communities in the Merrimack Valley. With population increase projected across the Valley, it is expected that additional development will occur. Severe damage often occurs as a result of high winds and flooding. Therefore, increased development in coastal and tidally influenced communities, as well as forested communities susceptible to downed power lines, may result in increased damage from hurricanes and tropical storms.

4.4.2 Severe Winter Storms

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 a 12-hour period, or six or more inches over a 24-hour period. The leading cause of death during winter storms is from automobile or other transportation accidents. Exhaustion or heart attacks caused by overexertion when clearing snow are the second most likely cause of winter storm-related deaths. All of the Merrimack Valley region is considered at risk for severe winter storms, although coastal communities have been identified to be at greater risk due to the potential for increase snowfall and secondary impacts from increased sea level.

Two common systems to measure the severity of severe winter weather are the Regional Snowfall Index (RSI) and the Northeast Snowfall Impact Scale (NESIS). RSI is a regionally-specific index that ranks snowstorm impacts on a scale from 1-5 (*Table 4.11)*. The score is determined through considering the spatial extent of the storm, amount of snowfall, and the population. Whereas the NESIS preceded the RSI as a quasi-national index for large snowstorms with five categories ranging from category 1: Notable, to Category 5: Extreme.

The most severe winter storm to ever strike New England was the Blizzard of 1888. This storm, lasting four days, deposited 50+ inches of snow. A century later, the Blizzard of 1978 dumped 24-36 inches of snow on the eastern part of Massachusetts 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.

Table 4.11 RSI Scale (NOAA)

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

Since the last update, Essex County has experienced a total of 37 winter-weather related events: blizzard, extreme cold/wind chill, heavy snow, ice storms, winter storms, and winter weather.[68] Collectively, these events have resulted in $484,000 in damage. A few notable recent storms include:

- 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'easter January 10, 2024–Winds and flooding across the eastern seaboard with flooding and damage caused to coastal communities along Plum Island and Salisbury beaches.

A range of secondary effects can occur from winter storms, including loss of power, flooding, and reduced emergency access. In October 2011, a snowstorm left 640,000 Massachusetts homes and residents without power. More recently, the March 2018 storm downed trees and utility lines, resulting in power outages lasting several days across the region.

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 -25F or lower for at least three hours. The NWS Windchill Chart (*Figure 4.12*) shows three shaded areas which are associated with how long a person can be exposed to windchill before developing frostbite. Since the last plan update, Essex has experienced one extreme cold/wind chill event in February 2016.[69] Common winter weather events which spur these windchills include Nor'easters, ice storms, and ice jams.

[68] NOAA National Centers for Environmental Information. 2023. Storm Event Database. StormEventsDatabase-Event Details|NationalCentersforEnvironmentalInformation(noaa.gov)
[69] NOAA National Centers for Environmental Information. 2023. Storm Event Database. StormEventsDatabase-Event Details|NationalCentersforEnvironmentalInformation(noaa.gov)

Wind Chill Chart

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

Frostbite Times: 30 minutes | 10 minutes | 5 minutes

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

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

Figure 4.12 Wind Chill Temperature (WTC) chart (NWS)

Nor'easter: 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. Nor'easters occur in New England more frequently than hurricanes and typically have a longer duration than hurricanes. 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.

Winter Storm in Groveland, March 2024

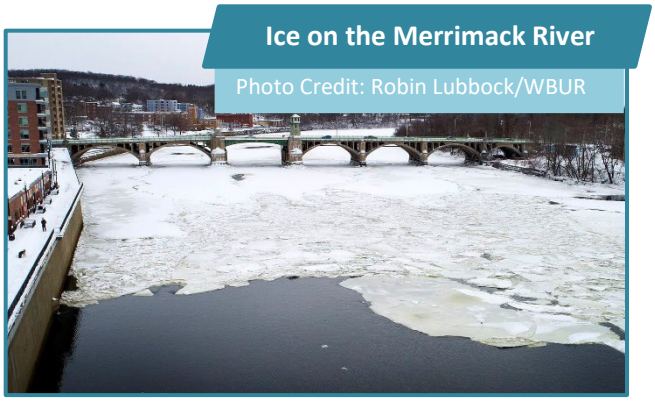
Photo Credit: Town of Groveland

Nor'easters pose a threat to infrastructure, including critical facilities. During the height of a storm, conditions can present a hazard to driving or any other outdoor activity. Nor'easters may also cause blizzard conditions, defined as 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 Winter storm 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 Methuen) and March 14, 2017, when heavy snow and strong winds combined to create blizzard conditions.

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. This can be especially concerning for vulnerable populations. The cost of snow removal, repairing damages, and the loss of business can also have severe economic impacts on local communities.

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. 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.



Ice on the Merrimack River

Photo Credit: Robin Lubbock/WBUR

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 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.[70]

Ice storms equally as severe have been recorded in New England since 1929. The U.S. Army Corps of

[70] Associated Press (AP). 2011. Report: 11/1/2011. Archive | The Associated Press (ap.org)

Engineers/Cold Regions Research and Engineering Laboratory estimates a 40 to 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.

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.

Impact of Future Conditions: Changes in future conditions related to climate change, population patterns, and land use and development could affect the occurrence of winter storms throughout the Merrimack Valley. Winter weather events are considered High frequency as defined by the 2018 Massachusetts State Hazard Mitigation and Adaptation Plan, indicating there is greater than a 20% annual chance of occurring. However, climate change may alter that prediction. The frequency and intensity of heavy precipitation events in the Merrimack Valley are projected to continue to increase throughout the 21st century. 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.[71] While more winter precipitation is likely to fall as rain/ice 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.[72] 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. While increases in regional population, and or development would not impact the occurrence of winter weather, it may further exacerbate risks to public safety and infrastructure.

4.4.3 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. 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 lasting 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 factors 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
- A forcing mechanism, such as a cold front or leftover weather boundary from a prior shower or thunderstorm activity

[71] EEOEA & the Adaptation Advisory Committee. 2011. Massachusetts Climate Adaptation Report.

[72] Massachusetts EEA. 2018. State Hazard Mitigation and Climate Adaptation Plan. SHMCAP-September2018-Full-Plan-web.pdf (mass.gov)

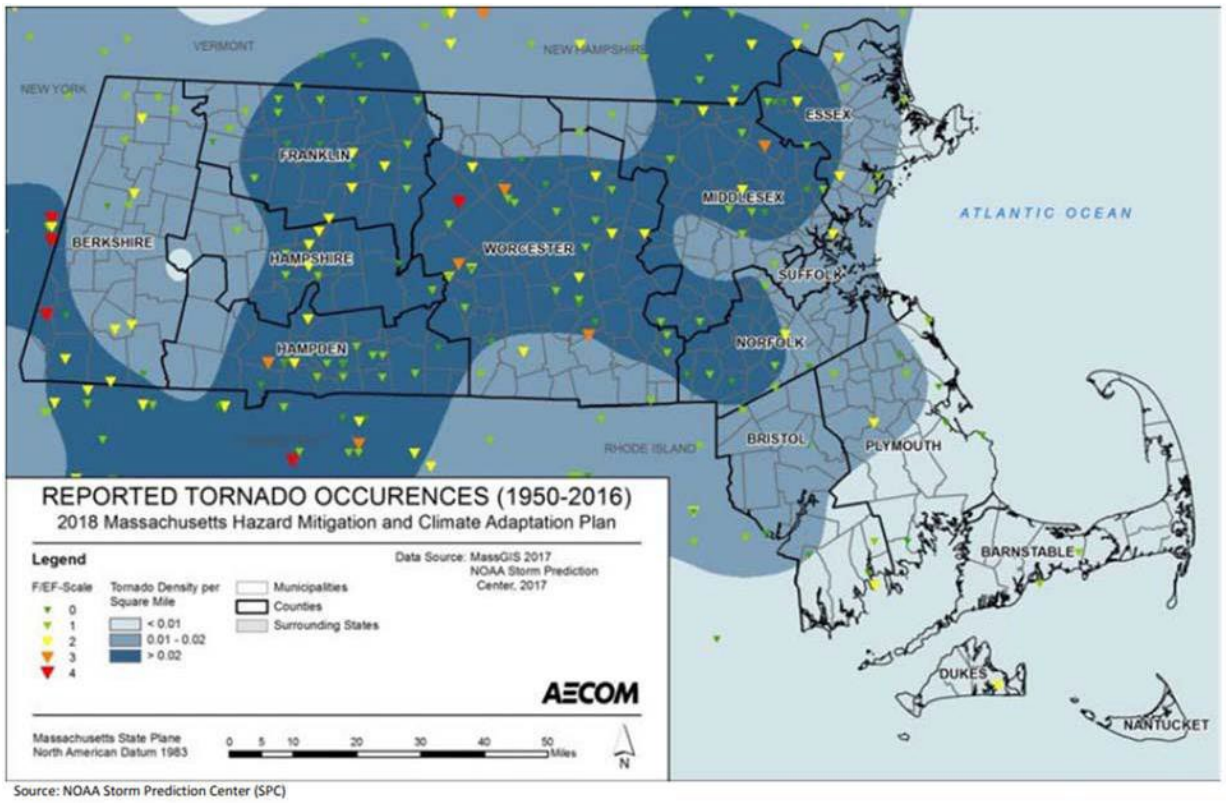


Figure 4.13 Map of tornado risk in Massachusetts based off previous occurrence (NOAA)

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 tornadoes using the Enhanced Fujita- scale (EF-scale). This scale ranges from EF0, associated with winds between 65-68 mph and minor damage, to EF5, associated with winds greater than 200 mph and massive damage(*Table 4.12)*. The Enhanced Fujita-scale is considerably more complicated than the original F-scale, and it allows surveyors to create more precise assessments of tornado severity.

Table 4.12 Enhanced Fujita Scale (National Weather Service).

EF Rating	Wind Speed	Expected Damage
EF-0	65-85 mph	Minor Damage: Shingles blown off or parts of roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.
EF-1	86-110 mph	Moderate Damage: More significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.
EF-2	111-135 mph	Considerable Damage: Roofs torn off well-constructed homes, homes shifted off their foundations, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.
EF-3	136-165 mph	Severe Damage: Entire stories of well-constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.
EF-4	166-200 mph	Extreme Damage: Well-constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.
EF-5	201+ mph	Massive/Incredibly Damage: Well-constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.

The most devastating tornado to occur in New England was the Worcester tornado of 1953, killing 90 people and injuring over 1,200. On average, six tornadoes per year touch down somewhere in New England. Those most at risk include anyone not in a secure structure, people in automobiles, and residents of mobile homes. Since 1951, there have been 131 tornado events in Massachusetts, which resulted in 105 fatalities, 1,562 personal injuries, and over 544 million in property damage.[73] Within Essex County, there have been 11 tornadoes since 1951 (*Table 4.13*). Of the events within Essex County, 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 Storm Events Database. However, the most recent tornado to occur in Massachusetts was in Bristol county in September 2023, with windspeeds of 75 mph, driving rain and flooding.[74]

Table 4.13 List of tornadoes in the Merrimack Valley region from 1951- 2023

Tornadoes in the Merrimack Valley Region (1951- Present)					
Year	**Date**	**Category**	**Injuries**	**Fatalities**	**Property Damage**
1951	8-21-1951	F2	0	0	2.5K
1956	6-13-56	9	0	0	2.5K
1956	11-21-1956	F2	0	0	25K
1956	12-18-1956	F1	0	0	0.25K
1960	7-13-60	9	0	0	0.3K
1962	7-21-1962	F1	3	0	25K
1964	5-19-1964	F1	0	0	5K
1965	8-10-1965	F1	0	0	0
1968	7-1-1968	F1	1	0	250K
1972	7-21-1972	F1	0	0	2.5K
1991	8-15-91	F1	0	0	250K

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. The damage caused by the 1953 event, relative to the State's small size, accounts for the statistical rankings previously cited. [75]

According to the Commonwealth's 2018 State Hazard Mitigation and Climate Adaptation plan on all-time initial touchdown locations across the Commonwealth, as documented in the NOAA Storm Events Database, the area of the state at greatest risk runs from central to northeastern Massachusetts including the eastern portion of the Merrimack Valley region (*Figure 4.13*).

The National Weather Service (NWS) issues tornado forecasts through each local office. In predicting severe weather, meteorologists look for the development of instability, lift and wind shear for tornadic thunderstorms. 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.

[73] NOAA National Centers for Environmental Information. 2023. Storm Event Database. StormEventsDatabase-EventDetails| NationalCentersforEnvironmentalInformation(noaa.gov)

[74] NOAA National Centers for Environmental Information. 2023. Storm Event Database. StormEventsDatabase-EventDetails| NationalCentersforEnvironmentalInformation(noaa.gov)

[75] The Disaster Center. Ranking of Tornado Risk by State. Massachusetts Tornadoes (disastercenter.com)

Tornado events in Merrimack Valley 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).

Impact of Future Conditions: Changes in future conditions related to climate change, population patterns, and land use and development could affect the occurrence of tornadoes throughout the Merrimack Valley. Climate researchers have found that while the yearly number of tornadoes is relatively the same, the number of large tornado outbreaks is increasing, resulting in more days with multiple tornadoes occurring.[76] We are also seeing shifts in when tornadoes are occurring, with more events happening in the fall and winter and less happening in the spring and summer.[77] Changes in air temperature are believed to be driving these patterns and are expected to intensify as climate change continues. This may result in tornadoes occurring more commonly when they are not expected, and the public is not prepared for them. While changes in population patterns and development will not directly impact the occurrence of tornadoes, it could change the impact these events have on communities in the Merrimack Valley. With population increase projected across the Valley, it is expected that additional development could increase the opportunity for damage to both built infrastructure, property, and human safety.

4.4.4 Other Severe Weather

High Winds. High winds pose a risk to the communities of the Merrimack Valley region and can cause considerable damage to structures, infrastructure, and trees. 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 are measured by speed (mph or knots) and associated characteristics. A common scale for measuring wind is the Beaufort wind scale. For non-tropical events over land, sustained winds of 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." For non-tropical events over water, a small craft advisory is issued by the National Weather Service for sustained winds of 25 to 33 knots), a gale warning is issued for sustained winds of 34 to 47 knots, a storm warning is issued for sustained winds of 48 to 63 knots, or a hurricane-force wind warning is issued for sustained winds 64 knots or more. For tropical systems, the National Weather Service issues a tropical storm warning for any areas expecting sustained winds from 39 to 73 mph, and a hurricane warning for sustained winds of 74 mph.

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. The entire Merrimack Valley region is susceptible to high winds, although coastal areas can be

[76] Tippett, M.K., C. Lepore, and J.E. Cohen, 2016: More tornadoes in the most extreme U.S. tornado outbreaks. 37 Science, 354 (6318), 1419-1423. http://dx.doi.org/10.1126/science.aah7393

[77] Moore, T.W., 2018: Annual and seasonal tornado trends in the contiguous United States and its regions. 34 International Journal of Climatology, 38 (3), 1582-1594. http://dx.doi.org/10.1002/joc.5285

especially hard hit, as can communities with significant forested areas in which high winds may cause downed trees and powerlines.

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. Three basic factors are required for a thunderstorm to form: moisture, rising unstable air, and a lifting mechanism to provide the impetus.

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. Massachusetts experiences 20-30 thunderstorm days per year, with high wind events happening more frequently.[78] The entire Merrimack Valley region is susceptible to thunderstorms, and it is not unusual for the region to experience a few moderate-to-severe thunderstorms throughout the spring and summer. The severity of thunderstorms is often measured by their associated impacts: flooding, hail, and winds.

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 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." 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 (DR-1224-MA) for the Individual Household Program (Individual Assistance) on June 23, 1998.[79]

Tree Damage in Andover, September 2023

Photo Credit: Melrose Police Dept.

According to the NOAA Storm Events Database, Essex County experienced 26 days of Thunderstorm Wind events resulting in nearly $300,000 in property damage since 2016. The most recent of these events occurred in September 2023 across Boxford, Middleton and Rowley, resulting in an estimated $12,000 of property damage.[80] Severe thunderstorms are considered high frequency events the Merrimack Valley. 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).

[78] Massachusetts EEA. 2018. State Hazard Mitigation and Climate Adaptation Plan. SHMCAP-September2018-Full-Plan-web.pdf (mass.gov)

[79] FEMA. 2024. Disaster Declarations for States and Counties. Disaster Declarations for States and Counties | FEMA.gov

[80] NOAA National Centers for Environmental Information. 2023. Storm Event Database. StormEventsDatabase-EventDetails| NationalCentersforEnvironmentalInformation(noaa.gov)

Impact of Future Conditions: Changes in future conditions related to climate change, population patterns, and land use and development could affect the occurrence of severe weather throughout the Merrimack Valley. Climate researchers have found that average wind speed increased in the last decade from 7 mph to 7.4mph.[81] As winds are directly influenced by temperatures and temperature differentials, it is not clear exactly how continued climate warming will impact winds. Some areas may see increases in gust and average wind speed, while others may see decreases. With regard to thunderstorms, climate change conditions are expected to create more favorable conditions for severe storms. Because warmer air holds more moisture, thunder storms are expected to become more intense across the globe. While shifts in population patterns and development within the Merrimack Valley region is not expected to alter the occurrence of severe weather, it could increase the opportunity for damage to both built infrastructure, property, and human safety.

Conclusion

Through reviewing the previous occurrence, geographic location, extent/severity, and the future probability of fifteen different natural hazards occurring within Massachusetts, the Merrimack Valley communities considered their current and future risk. With this knowledge, a more comprehensive risk assessment was done on a regional and local level (*Section 5: Risk and Vulnerability Assessment*) to identify acute incidents of risk and pinpoint specific hazards and locations.

[81] Zhenzhong, Z. et al. 2021. A reversal in global terrestrial stilling and its implications for wind energy production. Natural Climate Change: 9 (979-985). A reversal in global terrestrial stilling and its implications for wind energy production | Nature Climate Change

SECTION 5. RISK AND VULNERABILITY ASSESSMENT

This section of the Hazard Mitigation Plan identifies and assesses the natural hazard risks in each of the 10 participating communities. The section is organized into individual community subsections that provide information, as applicable, on each communities' current demographics, key services, recent development and land use changes, community lifelines, critical infrastructure including structurally deficient bridges and High Hazard Potential Dams, and community specific natural hazards.

5.1 Natural Hazard Risks for the Merrimack Valley Region

In preparing the risk assessments, a database was developed of each municipalities' Community Lifelines. FEMA defines Community Lifelines as "the most fundamental services in the community that, when stabilized, enable all other aspects of society to function." These lifelines can take the form of critical infrastructure, services, and resources. This is an expanded definition from the 2016 plan that considered "Critical Facilities and Infrastructure." The full breadth of each communities' lifelines are dynamic, expansive, and vital for day-to-day operation.

Each Local Hazard Mitigation Planning Team, comprised of key personnel including Emergency Managers and Public Works staff, reviewed and updated the list of critical facilities from the 2016 plan to reflect the most current information. Additionally, new lifeline categories (denoted by *) were added to the 2024 plan following FEMA's expanded definition. The list of Community Lifelines inventoried for each community includes the following:

Community Lifeline Categories

- Emergency Operation Centers
- Municipal Offices
- Police Stations
- Fire Stations
- Emergency Shelters
- Food Service locations (food pantries/soup kitchens)*
- Public Works Garages
- Water Treatment Plants
- Water Pumping Stations & Storage Tanks
- Sewage Treatment Plants
- Sewage Pumping/Lift Stations
- Solid Waste Transfer/Disposal Facilities
- Transportation Hubs (Bus, Train, Air)
- Electric Power Plants and Substations
- Communication Facilities
- Grocery Stores*
- Hospitals and Clinics
- Elderly Housing/Senior Centers
- Subsidized Housing Locations*
- Community centers
- Nursing Homes
- Schools and Colleges
- Daycare Facilities
- Courts
- Historical/Cultural Assets
- Evacuation Routes
- Additional locations of concern/interest

Once reviewed and finalized, each municipalities' list of updated community lifelines was entered into MVPCs electronic database and integrated into a set of hazard maps. Hazard maps were developed as a tool for communities to identify current hazard risk and associated local vulnerabilities, as well as future hazard projections. A set of three hazard maps were developed for each community and can be found in Appendix B of this plan.

- **Current Hazard Map**: Integrated data layers for mappable current natural hazard conditions identified in Massachusetts. Including: Earthquake locations[82], tornado locations[83], hurricanes tracks and surge inundation[84], landslide susceptibility[85], slope stability[86], floodplains[87], land surface temperature[88], 100-year storm winds[89], average annual snowfall[90], and drought[91].
- **Composite Hazard Map**: Overlayed hazards occurring within each community to develop a composite hazard map. Locations were assigned a Hazard Score based on the number of overlapping hazards occurring, with areas experiencing just one hazard assigned a "very low" hazard risk and areas experiencing 5 hazards assigned a "critical" hazard risk. Risk rankings are reflected by color on composite hazard maps.
- **Projected Hazard Map:** To ensure future climate projections were also considered in the risk vulnerability assessment, a projected hazard map was developed and integrated future climate projections for flooding (sea level rise, storm surge, and coastal flooding)[92], heat, and precipitation[93,94].

Using the set of hazard maps, as well as best available data on natural hazards for the region, each community conducted a relative risk assessment for each of the 15 natural hazards identified with Massachusetts (Appendix C: Module 2). The assessment consisted of evaluating the following categories for each hazard:

- *Location:* Area of potential impact within the community (Negligible= >10%, limited= 10-25%, significant= 25-75%, extensive= <75%)
- *Severity/extent:* The extent or magnitude of a hazard measured against an established indicator (Weak, Moderate, Severe, Extreme)
- *Previous occurrence:* Frequency of occurrence within community (Rare= 1x in last 100 years, Occasional= 1x in last 10-99 years, Often= 1x every 10 years, Very Often= 1x per year)
- *Future probability:* Likelihood of hazard occurring within community in future (Unlikely= 1x every 100 years+, Occasional= 1x in next 10-100 years, Likely= 1x every 10 years, Highly Likely= 1x per year)

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[82] USGS. 2023. Earthquake Map. Latest Earthquakes (usgs.gov)
[83] NOAA. 2023. Tornado Tracks. Tornado Tracks | Tornado Tracks | FEMA Geospatial Resource Center (arcgis.com)
[84] MassGIS. 2013. Hurricane Surge Inundation Zones. MassGIS Data: Hurricane Surge Inundation Zones | Mass.gov
[85] Tennessee Geographic Alliance. 2018. Landslide Susceptibility and Incidence. Landslide Susceptibility and Incidence | Landslide Susceptibility and Incidence | ArcGIS Hub
[86] UMass Amherst Massachusetts Geological Survey. 2013. Slope Stability Map of Massachusetts. Slope Stability Map of Massachusetts | The Massachusetts Geological Survey (umass.edu)
[87] MassGIS.2023. FEMA National Flood Hazard Layer. MassGIS Data: FEMA National Flood Hazard Layer | Mass.gov
[88] Massachusetts EEA. 2023. Land Surface Temperature Index. Land Surface Temperature Index MVPC - Overview (arcgis.com)
[89] Draxl, C., B.M. Hodge, A. Clifton, and J. McCaa. 2015. "The Wind Integration National Dataset (WIND) Toolkit." *Applied Energy* 151: 355366. Accessed: Wind Resource Maps and Data | Geospatial Data Science | NREL
[90] NOAA National Centers for Environmental Information. 2004. The Northeast Snowfall Impact Scale. The Northeast Snowfall Impact Scale (NESIS) | Regional Snowfall Index (RSI) | National Centers for Environmental Information (NCEI) (noaa.gov)
[91] National Drought Mitigation Center & University of Nebraska-Lincoln. 2024. U.S. Drought Monitor. GIS Data | U.S. Drought Monitor (unl.edu)
[92] Massachusetts EEA. 2022. MC-FRM. Massachusetts Coast Flood Risk Model (MC-FRM) 1% Annual Exceedance Probability - Overview (arcgis.com)
[93] NOAA National Centers for Environmental Information. 2022. State Climate Summaries. Massachusetts - State Climate Summaries 2022 (ncics.org)
[94] Massachusetts EEA. 2022. Massachusetts Climate and Hydrologic Risk Project. Massachusetts Climate and Hydrologic Risk Project (Phase 1) – Stochastic Weather Generator Climate Projections Dataset - Overview (arcgis.com)

After assessing each of the 15 hazards, each community assigned an Overall Risk Rating of "Low", "Moderate" or "High" to each hazard. Overall risk represents the cumulative risk that a hazard poses for each community. Risk ratings were assigned based on the following scale:

- *Low:* Two or more criteria fall in lower classifications, or the event has a minimal impact on the planning area. *This rating is sometimes used for hazards with a minimal or unknown record of occurrences or for hazards with minimal mitigation potential.*
- *Moderate:* The criteria fall mostly in the middle ranges of classifications and the event's impacts on the planning area are noticeable but not devastating. *This rating is sometimes used for hazards with a high extent rating but very low probability rating.*
- *High:* The criteria consistently fall in the high classifications and the event is *likely/highly likely to occur* with *severe/extreme strength* over a *significant/extensive portion* of the planning area.

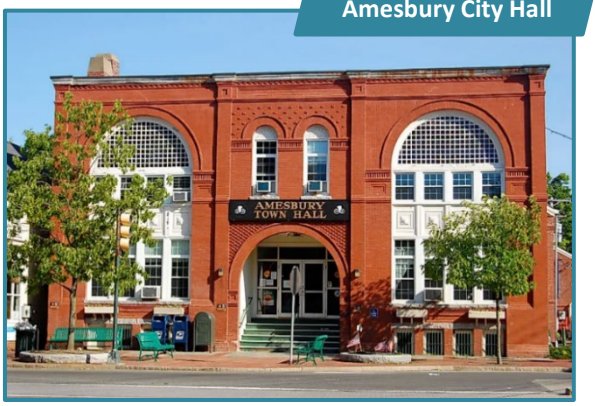
5.2 Natural Hazard Risks by Community

An overview of natural hazard risk for each of the ten (10) communities participating in the Hazard Mitigation update is provided in the following section. Each Community Profile details current demographics, key services, recent development and land use changes, community lifelines, and critical infrastructure including structurally deficient bridges and High Hazard Potential Dams. At the end of each profile is the Overall Risk Rating table for the 15 natural hazard risks considered in this plan. For communities that are experiencing specific local challenges related to natural hazards, detailed information has been included within the Community Profile.

The information in this section provided a critical foundation for Local Hazard Mitigation Planning Teams to identify specific challenges occurring within their communities (*Section 6: Natural Hazard Challenge Statements)* and establish long-term Mitigation Action Plans (*Section 8: Mitigation Strategies)* to manage and mitigate risk and vulnerability.

5.2.1 City of Amesbury Natural Hazard Risk Assessment

Community Profile



Amesbury City Hall

The City of Amesbury, settled in 1637, is one of the oldest municipalities in the United States. The City is located approximately 33 miles north of Boston, along the Merrimack River, on Massachusetts' North Shore. The City provides a unique feature for its residents in that it is quaint, rural New England in character, but provides a suburban feel due to its proximity to the Metro-Boston area.

According to the 2020 US Census, Amesbury has a resident population of 17,366 people.[95] Amesbury experienced an increase of 1,083 people (6.7%) between 2010 and 2020. Population projections for the City from the UMass Donahue Institute forecast the 2030 population will be 16,727 people, a decrease of 3.7% from 2020.[96] The public school system includes two elementary schools (Sgt. Jordan Shay Memorial Lower Elementary School and Cashman Elementary School), one Middle School (Amesbury Middle School), and two High Schools (Amesbury High School and Amesbury Innovation High School). Total student enrollment across all public schools K-12 is 1,787 students.

Amesbury is home to one environmental justice (EJ) population. The "Income" EJ Block Group is defined by the State as "at least 25% of households have a medium household income 65% or less than the state median household income." Two block groups within Amesbury are identified as EJ. According to the Massachusetts Executive Office of Energy and Environmental Affairs, Income EJ block groups in Amesbury range from $40,326-45,250 median household income.

The City of Amesbury spans 14.3 square miles. The GIS analysis for the 2024 HMP reports both land cover and land use data derived from the state's most updated 2016 land cover layer[97]. Predominant *land cover* in Amesbury is forest (43%), followed by open land (15%), wetland (13%), developed impervious land (13%), water (9%), and agricultural land (7%). According to the assessor's data, *land use* in Amesbury is primarily recreational/other (34%) and residential (30%), followed by agricultural (13%), water (9%), transportation (9%), and commercial/ industrial (6%). Commercial development continues to be dispersed beyond traditional municipal centers to locations along state numbered routes and major travel corridors, such as Interstates 95, 495, and U.S. Route 110, which characterize the major throughway that is Amesbury's primary business district.

The City provides public drinking water from the Powwow River, Lake Attitash, and two wells (Well #1 and Well #2). Both wells are located in the northwest corner of the City near the New Hampshire border and are mainly used to meet peak water needs in summer months. Total daily average water usage for Amesbury in 2021 was 1.2 million gallons per day, with average residential usage totaling 54 gallons per person per day. Sewer is operated by the City through the Amesbury Wastewater Treatment Plant (WWTP). The WWTP has been upgraded to treat an average daily flow of 2.4 million gallons per day, and a peak hourly flow of 8.4 million galls per day. Electricity and gas are provided to residents through National Grid.

[95] United States Census Bureau. 2023. QuickFacts. U.S. Census Bureau QuickFacts: United States
[96] UMass Donahue Institute. 2022. Massachusetts Population Projections. UMass Donahue Institute | Population Projections
[97] MassGIS. 2019. 2016 Land Cover/Land Use. MassGIS Data: 2016 Land Cover/Land Use | Mass.gov

Recent Development and Land Use Change

In recent years, Amesbury's population has increased due to the development of wooded areas and new development of the City's business districts has led to an influx of industry. Although the City has a variety of industries and businesses, it is considered primarily a residential community. In recent years, the community has looked to adopt smart growth strategies to concentrate development across Amesbury. For example, growth in the South Hunt Road area has been encouraged through a targeted, multi-phase infrastructure program intended to support the economic development and expansion of the South Hunt development area. The improvements are designed to increase capacity for higher traffic volumes for the full build-out of the development area, and to facilitate complete streets improvements that balance growth from housing and economic development. Amesbury was awarded a $2 million MassWorks grant in 2019 for the second phase of the infrastructure program, known as the South Hunt Road Corridor Improvements Project. The City has also seen concentrated growth on Elm Street, a gateway to downtown. Since 2016, the City of Amesbury has initiated 16 major developments: 6 commercial, 9 residential, and 1 mixed use (*Table 5.2*).

Amesbury has also had ten zoning changes since the 2016 update: two (2) base changes and eight (8) overlay changes. These include two (2) changes increasing open space conservancy, two (2) establishing renewable energy development districts, three (3) establishing marijuana overlay districts, and three (3) expanding water resource protection districts.

Table 5.2 Major development projects in Amesbury initiated since 2016

Amesbury Major Development Projects 2016-2023			
Facility Type	**Street Address**	**Square Feet / Total Housing Units**	**2023 Status**
Residential-Amesbury Heights	Haverhill Rd	240	Complete
Residential-Baileys Pond	Granville Ln	100	In Process
Residential- Baileys Pond	Cutters Ln	24	In Process
Residential - Hatters Point Phase II	Merrimac St	45	Complete
Mixed Use-Maple Crossing	24 South Hunt Rd	410,000 s.f.	In Process
Commercial-Hampton Inn	284 Elm St	65,000 s.f.	Complete
Commercial- Amesbury Animal Hospital	277 Elm St	6,500 s.f.	Complete
Commercial-Amesbury Dental Associates	282 Elm St	7,560 s.f.	Complete
Commercial-Hotel	295-297 Elm St	54,00 s.f.	Complete
Commercial- Munters	14 South Hunt Rd	450,000 s.f.	In Process
Commercial-Coastal Connections	35 Water St	22,000 s.f.	Complete
Residential	Brielle Way	7	Complete
Residential	Colonial Dr	7	Complete
Residential	Market St	3	Complete
Residential	130 Market Street	10	In Process
Residential	140-142 Main Street	18	Complete

While the City has been experiencing growth and development in recent years, Amesbury is also committed to protecting its natural resources and preserving open space. In 2016, Amesbury established its Amesbury Open Space, Natural Resources and Trails Committee to support the maintenance, update, and

implementation of the City's Open Space and Recreation Plan (OSRP). Currently, Amesbury has over 1,000 acres of open space, two lakes, and over eight square miles of meandering waterways including four miles of the Merrimack River. A significant amount of undeveloped land remains, although it is not evenly distributed throughout the region. This undeveloped land includes land that is vacant and developable, as well as land that may be classified as undevelopable due to various development constraints, such as wetlands. Since 2016, six new parcels and multiple tax taking properties have been protected totaling 630 acres of land (*Table 5.3)*.

Table 5.3 Newly conserved or preserved land in Amesbury since 2016

Amesbury Newly Conserved or Preserved Land 2016-2023				
Property Name	**Address/ Parcel ID**	**Area**	**Land Owner**	**Year Completed**
Heron Pond Farm	South Hampton Road	17.3	CR held by Greenbelt	2019
Woodsom Farm	Lions Mouth Road	379	City of Amesbury	2018
Point Shore Meadows	Point Shore Drive	7.1	City of Amesbury	2019
Horton Street	13 Horton Street	0.5	City of Amesbury	2018
Quinn Farm	110-116 Whitehall Road	8.54	Amesbury ConCom	2021
Town Forest Parcels	Kimball Road (60/5, 60/1, 48/14, 62/2, 62/1, 61/7, 62/3, 74/2)	123.07	Amesbury ConCom	2021
Various- 31 tax taking properties	Multiple Locations	94.36	Amesbury ConCom	2021

Since the last plan update, changes in development and land use in the City have increased Amesbury's risk to natural hazards. While the City has made considerable strides to increase conservation space and incentivize Smart Growth and development since 2017, the preservation of open space has resulted in increased growth in already developed areas of the City, including hazard prone locations along the Merrimack River, its tributaries, and other flood prone locations. This has ultimately put a greater number of residents at risk to natural hazards. While the City's actions have led to the preservation of open land, bringing benefits for flood storage and extreme heat and drought mitigation, a changing climate and increasing population are continuing to increase natural hazard risk in Amesbury.

Community Lifelines

A select list of Community Lifelines (emergency operations centers, hospitals/healthcare centers, public shelters) is shown in *Table 5.4* and was originally derived from the City's Comprehensive Emergency Management Plan (CEMP) and updated from conversations with the LHMPT. The locations of these and other community lifelines in Amesbury were entered by MVPC into an Excel database and subsequently incorporated into MVPC's ArcGIS for use in digital mapping. As part of the plan update, the full list of community lifelines was reviewed and amended to reflect current conditions, as well as to incorporate new facilities and resources. The critical facilities are depicted in the Amesbury map series that is presented in Appendix B.

Table 5.4 Select list of Amesbury's community lifelines (Emergency operation centers, hospitals, and shelters

Amesbury Emergency Operation Centers, Hospitals, and Shelters						
Facility Type	**Common Name**	**Street Address**	**Health Facility Type**	**Maximum Capacity**	**Feeding Capability**	**Emergency Generator**
Emergency Operations	Elm Street Fire Station	124 Elm St	N/A	N/A	N/A	Yes
	Amsbury Emergency Management Agency	124 Elm St	N/A	N/A	No	Yes
Hospitals and Healthcare Centers	Beth Israel Lahey Health Care	24 Morrill Pl	Hospital	78	Yes	Yes
	Milltown Health and Rehab	22 Maple St	Nursing Home	124	Yes	Yes
	Genesis Health Care-Maplewood	6 Morrill Pl	Nursing Home	120	Yes	Yes
	Hillside Rest Home	29 Hillside Ave	Assisted Living	28	Yes	Yes
	Elizabeth Calsey House	15 Elizabeth St & 286 Lion's Mouth Rd	Assisted Living	40	Yes	Yes
Emergency Shelters	Amesbury Council on Aging	68 Elm St	N/A	100	Yes	No
	Amesbury High School	5 Highland St	N/A	1,000	Yes	Yes
	Amesbury Middle School	220 Main St	N/A	200	Yes	Yes
	Jordan Shay Memorial School	193 Lion's Mouth Rd	N/A	1,090	Yes	Yes
	Cashman Elementary School	193 Lion's Mouth Rd	N/A	500	Yes	Yes
	Fairfield Inn Marriot	Clark's Rd	N/A	150	Yes	Yes
	Educational Childcare, Inc.	36 Sparhawk St	N/A	169	No	Yes
	All Saints' Anglican Church	67 Friend St	N/A	300	Yes	Yes
	St. Andre Bessette Parish	2 School St	N/A	350	Yes	No
	Main St. Congregational	145 Main St	N/A	531	Yes	-
	Market St Baptist Church	37 Market St	N/A	647	Yes	No
	Union Congregational	350 Main St	N/A	260	Yes	-
	St James Episcopal Church	120 Main St	N/A	192	Yes	-
	Rock Church	58 Macy St	N/A	166	No	No
	Seventh Day Adventist	171 Main St	N/A	80	Yes	-
	Public Works Center	39 So Hunt Rd	N/A	100	No	Yes
	Hampton Inn	284 Elm St	N/A	114	Yes	Yes
	Friends Meeting House	120 Friends St	N/A	85	Yes	Yes
	Rocky Hill Meeting House	4 Old Portsmouth Rd	N/A	100	No	No

Bridges: The City of Amesbury has 41 bridges within its municipal borders.[98] Of these bridges, 14 are municipally owned, with the remaining 27 bridges owned and maintained by MassDOT. Over half (23) of the 41 structures are categorized as waterway bridges, with the remaining intersecting roadways or other features. There are currently two bridges classified as structurally deficient in Amesbury, the bridge on Kimball Road over the Tuxbury Pond Outlet, owned by the City and the I495 E overpass over Middle Road, owned by MassDOT. This number is far smaller than the eight (8) structurally deficient bridges reported in the 2016 plan. This is in large part due to upgrades made since 2016, such as the John Greenleaf Whittier Bridge update which was completed in 2018.

Amesbury identified an additional three bridges that are not listed on the State registry but are of high concern for the City based on local conditions. These are the R street Bridge, the Birch Meadow Bridge, and Main Street Downtown Bridge. The R street bridge was significantly damaged during the Mother Day Flood in 2006. Sufficient repairs were never conducted due to complications with adjacent private property. The bridge is still in need of comprehensive repairs. The Birch Meadow bridge is located in a high flood zone. During periods of high flow, the culvert under the bridge has experienced extreme flooding leading to structural damage to the culvert. The City has identified the need for long-term culvert repair and bridge updates at this site. The Main Street Bridge runs under the entire downtown over the Powow river. The City has noted local long-standing concerns around the structural integrity of the bridge and the need for repairs.

Dams: The Department of Conservation and Recreation (DCR) Office of Dam Safety (ODS) includes 14 Amesbury dams on its dam hazard classification list.[99] Eleven (11) of these dams are municipally owned, with three (3) dams, Bailey Pond Dam, Scenic Dam, and Patten Pond Outlet Dam, privately owned. Two of these dams, the Millyard Dam 2 and Mill Street Dam have been listed as "breached" by the DCR Office of Dam Safety and are no longer operational. A total of two (2) dams are classified as a "significant hazard" dam, with one additional dam classified as "High hazard" (*Table 5.5*). The City has an Emergency Action Plan (EAP) for the Lake Gardner Dam, which was originally developed in 1996 and last updated in August 2019.

Table 5.5. List of Amesbury's Significant and High Hazard Dams as identified by the Massachusetts Office of Dam Safety

Amesbury Significant and High Hazard Dams				
Dam Name	**Impoundment Name**	**Year Completed**	**Hazard Class**	**Last Inspection Date**
Tuxbury Pond Dam	Tuxbury Pond	1929 (updated 2022)	Significant	10/19/2020
Bailey Pond Dam	Bailey Pond	1912	Significant	5/09/2023
Lake Gardner Dam	Lake Gardner	1872 (rebuild 1987)	High	3/21/2023

Tuxbury Pond Dam: The Tuxbury Pond Dam is municipally owned and was built more recently in 2002. The dam holds back water from Tuxbury Pond and was primarily built to service the drinking water supply for the City. The Channel is 10 feet deep, and the dam's gates and stop-lock bays can be opened for flood control as needed. The dam is considered to be in satisfactory condition, but is listed as a Significant hazard dam due to its potential impacts to the City if the dam were to fail.

[98] MassDOT. 2024. Bridges. Bridges | Bridges | MassDOT Open Data Portal (arcgis.com)
[99] MassGIS. 2012. Dams. MassGIS Data: Dams | Mass.gov

Bailey Pond Dam: Bailey pond Dam is the only private dam that is listed in significant or high hazard condition in Amesbury. In Amesbury's Water Body Assessment (2022), they note that the current condition of the dam and outlet piping has become a concern and the DCR Office of Dam Safety has issued an Order to Repair to the reported property owner. The ownership of the dam and the outlet piping were in question since the original Hat Factory Development Project in the late 90's early 2000's. The condition of the dam sometimes causes road flooding.

Lake Gardner Dam: Because the Lake Gardner Dam is classified as a High Hazard Dam by the DCR Office of Dam Safety, it must be inspected every two years. As the dam owner, the City of Amesbury coordinates directly with the ODS office to ensure timely inspections are conducted and the dam is maintained. The City has an established Emergency Action Plan (EAP) in accordance with the Commonwealth of Massachusetts general Laws, M.G.L. 253, Section 44-49, Chapter 302 CMR. 10.00, "Dam Safety." This plan formalizes the response to an emergency condition at the Lake Gardner Dam site. The EAP also includes downstream inundation maps and a dam break analysis to further assess local and regional risk.

For the Dam Break analysis, the National Weather Service (NWS) DAMBRK model was employed. Two separate model runs were considered: A Fair Weather or Sunny Day condition, where normal daily flows are present in the river; and a ½ Probable Maximum Flood (1/2PMF) scenario with breaching of Lake Gardner Dam during the ½ PMF. Rainfall estimates for the ½ PMF scenario were taken from Hydrometeorologic Report No. 51 (HMR 51) and were oriented and arrayed according to the NWS methodology and program from Hydrometeorologic Report No. 52 (HMR 52). Once the rainfall has been computed, the hydrograph analysis for the ½ PMF was completed using the Hydrologic Engineering Center's Hydrograph computation model (HEC-1).

The EAP identifies a number of natural hazards that may impact the dam. These include:

- Increased precipitation (water volume and flow rate) causing washout of spillways and gate structures, undermining of riprap or concrete slope protection, washout of soil foundation material below dam causing, flow erosion along embankment, dam overtopping undermining, shifts in foundation/embankment or abutment slopes.
- Severe cold/winter storms causing freezing and thawing resulting in gross deformation of dam or outlet structures.
- Severe wind (can be paired with precipitation) causing uprooted trees on and near the embankment resulting in scours and cracks of the embankment and washouts.
- Earthquakes causing shifting of structures, cracking, or settlements, which may lead to leakage/dam deformation/seepage/sliding/overtopping/ catastrophic failure.
- Landslide causing the displacement of large volumes of water and creation of waves leading to possible leakage, deformation, seepage, sliding, overtopping or catastrophic failure.

The Lake Gardner Dam is located in a mixed residential/commercial area, as such there are economic, environmental, and societal impacts associated with dam failure. The development downstream of the dam includes downtown Amesbury, roads, utilities, residential, commercial, and public safety structures. In Amesbury's Water Body Assessment (2022) the inundation map for dam failure is noted as including most of downtown. The EAP identified the area "between Lake Gardner and the Merrimack River along the Powwow River; as far east as the base of Mundy Hill and as far west as Patterns Pond and the junction of Main Street and Rt. 110" as the land subject to evacuation or notification. This includes a total of 430 properties (along 32 roadways) during a fair-weather breach event, and an additional 766 properties (total of 1,196 properties) along 75 roadways to be notified during a maximum flood scenario.

The City is committed to ensuring general maintenance and inspection of the Lake Gardner Dam is conducted, and that emergency plans and policies remain updated and in place to reduce vulnerability from High Hazard dams in Amesbury.

Millyard Dam: While not listed as a significant or high hazard dam, the Millyard Dam (referred to as the Crib Dam) located in the Upper Millyard has been identified as a dam of concern by the Local Hazard Mitigation Planning Team. This crib-style dam is a leftover as a relic from Amesbury's industrial past when it was used to power textile mills. This was the main dam that failed during the 2006 Mother's Day flood, causing significant downstream flooding.

Hazardous Sites

In additional to community lifelines and critical facilities, Amesbury has hazardous sites that are important to consider for hazard mitigation planning:

Brownfields: The City of Amesbury has historic contaminated brownfields, modern contaminated brownfields, and asbestos and lead contamination in older homes that may release hazardous materials into the environment due to a significant flood event. Historic manufacturing and industrial sites are generally located where mill buildings and railroads exist - the Lower Millyard, Upper Millyard, Cedar Street, Oak Street, Mill Street, Patton's Hollow, and the Hat Factory on Merrimac Street.

Historic uses include tar, creosote, coal power, mercury, and other chemicals in the tanning of hide, pressing felt, and weaving of rope. The majority of these chemicals lie in soils below the buildings associated with the use. The Massachusetts Department of Environmental Protection (DEP) only lists sites where a release of oil or hazardous material has been reported to them. Seventy-four (74) sites of record have been listed for Amesbury, with tier 1 sites denoted as the most contaminated, then tire 1B, and finally tire 2, which are considered the least contaminated. The former Microfab property at 106 Haverhill Road, which is an Environmental Protection Agency (EPA) identified Superfund Site, is Amesbury's only Tier 1 site. The City is actively working with the EPA and their consultants to plan remediation of the Microfab site. Amesbury has two Tier 1B sites: the Bailey Pond parcel at 77 Merrimac Street, and Bartley Machine 35 Water Street. Finally, Amesbury has numerous tire 2 sites at Nichols Yard on Railroad Avenue, Titcomb Landfill, the former Manufactured Gas Plant and Murphy Brass Foundry at 33 Mill Street, and Cumberland Farms at 241 Main Street. Currently the Amesbury Heritage Park, 31 Water Street, the former DPW 25 & 27 Water Street and the former DPW salt shed at 22 Water Street are in the pre-tier stages.

Emergency Planning Zone (EPZ): Amesbury is part of the Seabrook Station 10-mile EPZ. This identifies a Plume Exposure Pathway - a circular geographic zone, centered on the nuclear power plant to protect the public against exposure to radiation. Amesbury is also part of the 50-mile EPZ; and an Ingestion Pathway - a circular geographic zone, centered on the nuclear power plant to protect the public from ingestion of contaminated water or foods. The Amesbury Radiological Emergency Response Plan and Massachusetts Radiological Emergency Response Plan cover planning and procedures for any potential incident at the Seabrook, New Hampshire facility. Currently the Amesbury Comprehensive Emergency Management Plan is being updated by the City. As part of this update, Amesbury's Radiological Emergency Response Plan will also be updated and reviewed.

The Seabrook Nuclear Power Plant is significant to Amesbury due to the effects an evacuation related to an incident at the site would have on the adjacent region. The Emergency Management Director for the Seabrook Nuclear Power Plant has indicated the plant maintains the Amesbury Radiological Emergency Response Plan and Massachusetts Radiological Emergency Response Plan, as mentioned previously.

Community Specific Hazards

Amesbury's LHMPT reviewed the full range of natural hazards that impact Massachusetts, as identified through the State Hazard Mitigation and Climate Adaptation Plan. The majority of the natural hazards considered impact the Merrimack Valley Region in a similar way. For those that have a different or locally-specific impact on the City of Amesbury, additional information has been supplemented in this section.

Flooding

Amesbury is a water-rich community, lying almost completely within the Merrimack River Watershed and containing an abundance of water resources. The Merrimack River system supports a variety of uses, including water supply, recreation, and wetland and aquatic habitat (including freshwater, brackish and salt water). In Amesbury, Lake Gardener and the Powwow and Back Rivers drain the eastern parts of the City, while Lake Attitash, Tuxbury Pond, Goodwin's Creek, and the Great Swamp drain the western parts of the City. The major water bodies are highlighted in greater detail below as described in Amesbury's Open Space and Recreation Plan (2020):

The Merrimack River and Powwow River: Both rivers are tidally influenced and contain some limited estuarine habitat. The Merrimack River provides a scenic shoreline along the southern border of Amesbury, and many water-related uses and historic settlement areas are located along the river. The Powwow River has its headwaters in New Hampshire and then flows through Tuxbury Pond in the northwest corner of Amesbury, emerging as a narrow winding stream that meanders through the northern part of Amesbury passing near the water treatment plant and then through Woodsom Farm. The river reenters New Hampshire briefly and then flows southeast to widen into Lake Gardner. As it flows through the City center, the Powwow River transitions to falls that were historically used to power industrial uses through a series of dams created in the 19th century. It then joins with the Back River to form a wide slow-moving river that flows south into the Merrimack. Both the Merrimack River and the Powwow River are Category 5 listed waterbodies in EPA's 303(d) list. Sections of the Merrimack River located in Amesbury are impaired by Enterococcus and Polychlorinated biphenyls (PCBs) in fish tissue. The Powwow River is impaired by E. Coli. The section of the Powwow River by Tuxbury Pond is also impaired by total suspended solids and turbidity.

Clarks Pond: Located near downtown Amesbury, Clarks Pond was formed by a small, 88-foot-long dam on the Back River, which flows down from New Hampshire through a wooded area leading up to the pond. After flowing over the dam, the Back River continues, eventually merging with the Powwow River at the Lower Millyard. Clarks Pond itself is about seven acres. With extensive construction in Amesbury and in Southern New Hampshire runoff has led to silt filling in the pond. Algae and weeds have also posed an issue for the pond. There is no dedicated public access to Clarks Pond, but several smaller residential streets surround it that do allow for access. The Clarks Pond Watershed Association (CPWA) is an association of residents formed in 2015 to advocate for the Clarks Pond watershed and the Back River from Clinton Street to the Powwow River in Amesbury.

Lake Gardner: A long, narrow lake formed by a dam on the Powwow River, Lake Gardner is a prominent surface water body. It stretches from the center of Amesbury north to the New Hampshire border and is currently used for passive recreation. Homes line its western shore, which are supported by the public sewer system. Lake Gardner Beach, a sandy public swimming beach with canoe and small boat access, is at the southern end. The beach is very popular as it is one of the few freshwater public beaches in the area. The eastern and northern shores are undeveloped conservation land made up of woods and other open space, including the Powwow River Conservation Area. The City's Battis Farm protects over a half mile of Lake

Gardner's shoreline. The Lake Gardner Improvement Association (LGIA) is a group of Amesbury residents that advocates for Lake Gardner, its beach, and the surrounding Powwow Conservation Area. The LGIA provides essential services such as water testing and organizes community activities on the lake and beach. The LGIA is currently collaborating with the City on improvements to Lake Gardner beach, in the effort to reduce the run-off of surface water and sediment into the lake. In 2019, a retaining wall with a French drain was installed along the beach towards the conservation area.

Lake Attitash: Serving as a recreational resource and fishery in Amesbury, as well as a Class B backup water supply for the City, Lake Attitash is an important resource. The lake covers 360 acres in Amesbury and Merrimac. The main tributary is the Back River, entering from the west-northwest, with a much smaller secondary tributary entering from the Tuxbury Pond southwest, and additional direct drainage around the lake. The shore of Lake Attitash was developed over the years as a summer cottage community that was made permanent through private home improvement investment, the provision of more convenient access, and the construction of public sewer to serve the area. The lake has a public boat ramp and is heavily used by shoreline residents as well as visitors. Lake Attitash is listed as a Category 5 impaired waterbody in the EPA's 303(d) list, which is a state's list of impaired and threatened waters. Lake Attitash is impaired by harmful algal blooms and mercury in fish. The Lake Attitash Association (LAA) has been undertaking efforts to protect the lake and its tributaries from pollution. Annual monitoring of vegetation in the lake has been conducted since 2010. In conjunction with the City of Amesbury, the LAA has secured grants for public education and invasive control efforts. In recent years, Lake Attitash has experienced significant cyanobacteria (blue-green algae) blooms and an increase in invasive or non-indigenous aquatic plants. The LAA has spearheaded the implementation of an aquatic management plan including the application of Diquat and Alum treatments, as well as non-chemical control strategies for invasive species.

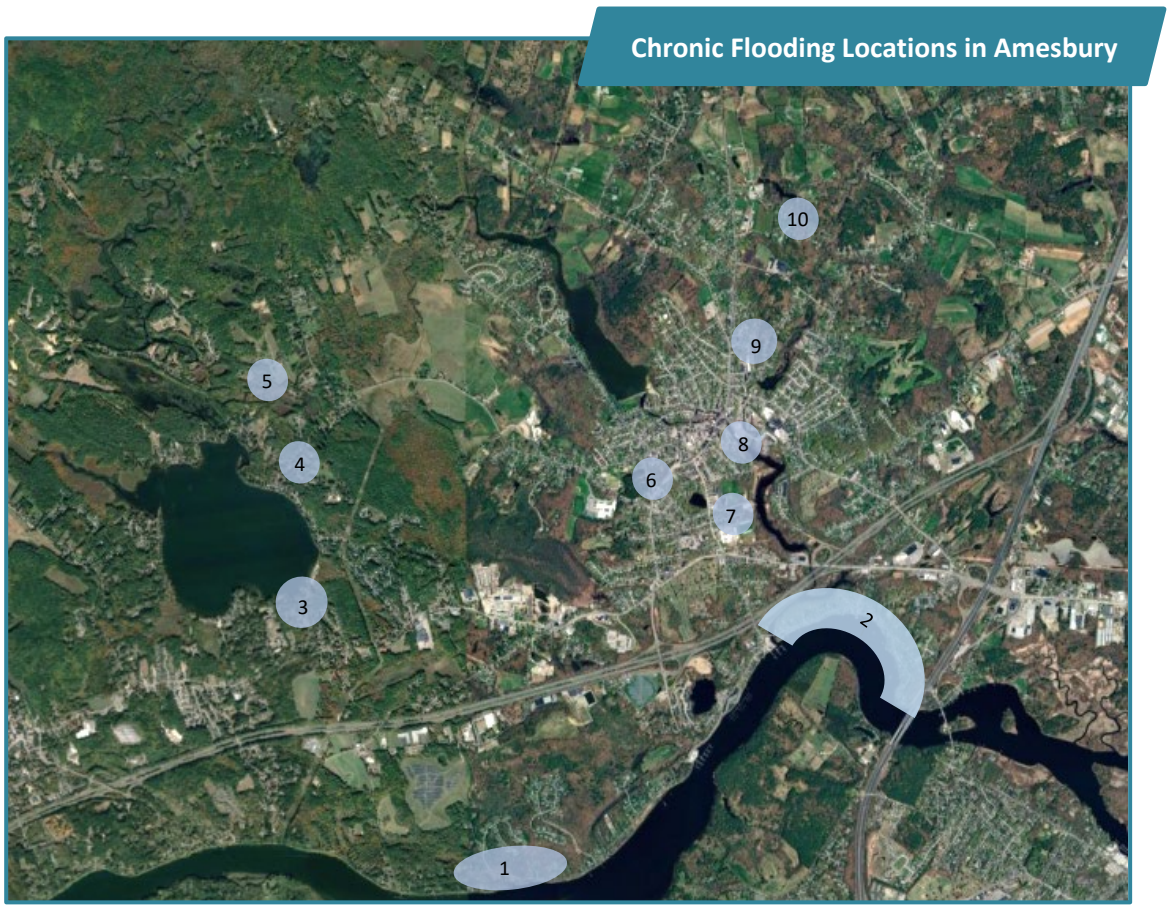


Figure 5.1 Chronic flooding locations identified across Amesbury by the LHMPT

Areas of Common Flooding: While flooding is a common experience in Amesbury, a few key events stand out over the years. Community members still remember the 1936 flood, which caused extensive flooding and required evacuation of homes along Point Shore. More recently, the Mother's Day flood of 2006, caused overtopping of rivers and major flooding in the community. During the 2006 storm, Amesbury felt the effects of the 14 inches of rain on their dams and water infrastructure. The Powwow dam was a major concern and in danger of collapsing during the 2006 storm, which would have caused cascading effects throughout downtown. Flooding of the Powwow River and Merrimack River inundated key areas of the City, shutting down commercial establishments and forcing the evacuation of numerous residences and businesses. Roadways were also closed for days, seriously impacting access across Amesbury.

The Local Hazard Mitigation Planning Team has identified the following areas of chronic flooding within Amesbury along major waterways and in more densely developed areas, 1: Pleasant Valley Road; 2: Main Street and Lower Main street; 3: 4th Street and Lakeshore Drive; 4: Lake Attitash Way and Kimball Road; 5: Newton Road; 6: Greenleaf Street; 7: East Greenwood Street/Childs Avenue/ Noel Street; 8: downtown locations including Water Street, Mill Street, and the Upper and Lower Millyard; 9: California Street; and 10: Fern Avenue/ Congress Street/Pinewood Road (*Figure 5.1)*.

To manage these water resources, and address flooding concerns across the City, Amesbury has developed and actively uses its Watershed Management Plan, the Lake Attitash Watershed-Based Plan and Lake Gardner Watershed-Based Plan. These plans aim to assess impacts and identify management strategies and proposed solutions to minimize flooding, improve water quality, and manage hydrological flow throughout the region. Additionally, Amesbury has put regulatory policies in place to enhance protection of watersheds, surface waters, and aquifers, leading to the protection of water quality as well as protecting key habitats that regulate flooding. These include the creation of the Water Resources Protection District in 2000, the Cluster Residential Special Permit, enactment of Neighborhood Conservation Districts (NCD), and Smart Growth Overlay District.

Amesbury is also working to complete hydrological infrastructure projects in the City, including upgrading and replacing culverts. Nearly a dozen culvert projects have been identified or initiated since the last plan update. These include culverts on Middle Road, California Street, Congress Street, Friends Street, Poplar Street, Clinton Street, Pleasant Valley Road, Kimball Road and along Route 110. It also includes two emergency point repairs on Oakland Street and Sparhawk Street (Route 150).

Flood Vulnerability Assessment: A GIS analysis of Amesbury's FIRM flood hazard area maps by MVPC has determined that 1,761 acres (2.75 sq. mi.) of land area within the City is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 299 acres (0.5 sq. mi.) lies within the 500-year floodplain. Together, these two flood zones constitute 23% of the total area of the community. With nearly a quarter of Amesbury designated in the 100 or 500-year floodplain, ensuring any "potentially developable" land within the floodplain remains undeveloped will help to prevent increases in impervious surface cover and reduce flooding within Amesbury.

As part of the mapping analysis, MVPC also identified the buildings and critical facilities located within the City's 100-year and 500-year floodplains and thus are at risk of future flood damage or loss. A total of 279 buildings (3.9% of all buildings in the City) are located within a floodplain, collectively valued at $294 million. A total of five (5) of these have been identified as community lifelines, valued at $9.2 million (*Table 5.6)*. The number of critical facilities identified within floodplains in this plan update is higher than the 2016 update (176 buildings). This reflects the 2023 update considering both 100- and 500-year floodplains, as well as the expanded definition of "community lifelines" used, which include a broader range of services compared to the 2016 plan.

NFIP Information: Amesbury actively participates in the National Flood Insurance Program (NFIP). The City's initial Flood Hazard Boundary Map (NHBM) was identified in 1974, and the initial Flood Insurance Rate Map (FIRM) was identified in 1980. The latest effective FIRM was adopted in 2012. The Flood Hazard Management Program Is expecting a new FIRM and Flood Insurance Study (FIS) will be ready for adoption in 2024. Amesbury intends to update their local regulations to adopt the new maps and study ahead of the effective date, anticipated in summer of 2025. This will require updating Amesbury's Zoning Bylaw, in which minimum floodplain management criteria appears. Amesbury implements and enforces local floodplain management regulations to regulate and permit development in Special Flood Hazard Areas (SFHAs) through their Planning Board. Amesbury's Inspectional Services Department ensures compliance with the NFIP requirements. Following an event, substantial improvement/substantial damage assessments are conducted by the Inspectional Services Department. Due to recent staff turnover, Amesbury does not have an official Floodplain Administrator. The City has identified this gap as a high priority action to reduce vulnerability for their community.

The Massachusetts Emergency Management Association (MEMA) reports a total of 139 properties with flood insurance policies in place in Amesbury as of July 2023. Of these, 83 are within flood hazard areas and total $23,460,000, while the remaining 56 are within Special Flood Hazard Areas and total $15,116,000. According to data provided by MEMA, there are five (5) properties in Amesbury that have sustained repetitive flood losses since 1978. Four of the sites are classified as single-family residential and one as non-residential. In total, these five properties have resulted in the payout of 13 National Flood Insurance claims totaling $767,066 since 1979. Amesbury also has one single-family residential property classified as a severe repetitive loss site with 3 recorded losses and claims totaling $522,086.[100] Based on the frequency, extent, and severity of historic flooding as well as the probability of future flooding in Amesbury, City officials consider the community to be at ***high risk*** from flooding.

Table 5.6 List of Community Lifelines located in Amesbury within the 100 and 500-year floodplain

Amesbury Community Lifelines within Floodplain 100-Year Floodplain		
Facility Type	**Name**	**Generator**
Housing Location	Harbor Schools group Home	No
Housing Location	Powow Villa	No
Housing Location	Lofts at Clark's Pond	No
Community Resource	Amesbury Village Center	No
Fuel Station	AL Prime	No

Riverine Erosion

Another major challenge stemming from intensive precipitation and storm events is riverine erosion. Amesbury has experienced bank erosion during flood events along the Powwow and Merrimack Rivers. Over the years, the City has taken steps to manage and minimize this hazard. For example, Amesbury along with the Army Corps of Engineers (ACOE) completed the Amesbury Shore and Bank Protection Project back in 1978, building a 480-foot-long gabion retaining wall along Alliance Park. In more recent years, locations along Lower Main Street, Merrimack Street, and Pleasant Valley Road have been locations of concern due to bank erosion. The erosion may impact nearby infrastructure including buildings and roads. Climate change is only expected to further exacerbate this problem with more frequent and intense rainfall. Amesbury has recently received funding from the Massachusetts Department of Transportation in 2020 as part of the Complete Streets funding program to assess and address erosion along Pleasant Valley Road.

[100] Massachusetts Emergency Management Agency. 2023. *NFIP Summary Data Report* – 7/25/2023.

Based on the frequency, extent, severity, and probability of historic and future erosion along the Merrimack River in Amesbury, City officials consider the community to be at ***moderate risk*** from riverine erosion.

Invasive Species

With an abundance of freshwater and tidally influenced water bodies and a diversity of natural landscapes, Amesbury has a range of habitats that are at risk from invasive species. Efforts to control invasive species such as perennial pepperweed (*Lepidium latifolium*) and the common reed (*Phragmites australis*) have been underway for nearly two decades. Removal and treatment for both invasives have been conducted across the region through partnerships with federal, state, and local entities. Efforts have been substantial to reduce and manage monocropping of these invasive vegetative plants across Amesbury, allowing for native plant species to thrive, which in turn support critical wildlife species.

In addition to these two prolific invasive species, Amesbury has also identified a range of other aquatic vegetation impacting freshwater bodies including bladderwort, water shield, variable milfoil, Eurasian milfoil, pickerelweed, hedge hyssop and purple loose strife. In Lake Gardner, there are many spots in which plants densely cover the surface, making recreational activities extremely difficult. While Amesbury mainly draws water from the Powwow River as a potable water source for the City, secondary sources include Tuxbury Pond. Drawing from this source becomes very difficult if not impossible during summer months due to blooms of invasive species.

Based on the frequency, extent, severity, and probability of historic and future invasive species challenges in Amesbury, City officials consider the community to be at ***moderate risk*** from invasive species.

Natural Hazard Management and Response

The Amesbury Fire Department has a total of 44 personnel led by Chief James Nolan. The Police Department has a total of 36 personnel led by Chief Craig Bailey. The Amesbury Department of Public Works, responsible for overseeing the operations and maintenance of critical community lifelines, is supported by 32 full-time equivalent employees.

Amesbury also operates a town-wide emergency alert system called Smart911, a free service that allows residents to receive notifications from local authorities to stay informed on hazardous or emergency situations.

Amesbury's Office of Emergency Management is responsible for various duties to ensure public safety in the community. Led by Deputy Directors Paul Bernier and David Olson, the office provides assistance during catastrophic events working with Amesbury's Public Safety Department and first responders.

Natural Hazards Risk Assessment

Through using the City of Amesbury's previous Hazard Mitigation Plan, in association with other planning documents including Amesbury's Comprehensive Emergency Management Plan, and Municipal Vulnerability plan, natural hazards for the City were considered. On the basis of this analysis, Amesbury considers itself to be at ***high risk*** from inland flooding, extreme temperatures, severe winter storms, and high winds/thunderstorms; ***moderate risk*** from invasive species, coastal flooding, riverine erosion, drought, and hurricane/tropical storms; and ***low risk*** from wildfires, earthquakes, tornadoes, tsunamis, and landslides.

Table 5.7 Amesbury's risk rating for the 15 natural hazards experienced in the Commonwealth

Amesbury Natural Hazard Risk Chart	
Natural Hazard	**Community Risk Rating**
Inland Flooding	High
Extreme Temperatures	High
Severe Winter Storms	High
High Winds/ Thunderstorms	High
Invasive Species	Moderate
Coastal Flooding	Moderate
Coastal/Riverine Erosion	Moderate
Drought	Moderate
Hurricane/Tropical Storm	Moderate
Wildfires	Low
Earthquake	Low
Tornadoes	Low
Tsunami	Low
Landslide	Low

Continue to page 193 of the Plan to review Amesbury's next section: ***City of Amesbury Natural Hazard Challenge Statements***

5.2.2 Town of Boxford Natural Hazard Risk Assessment

Community Profile


Boxford Town Hall

The Town of Boxford is located in north-central Essex County and covers approximately 24 square miles. The landscape is characterized by gently rolling hills and stream valleys interspersed with wetlands and ponds.

The Town's population, according to the 2020 U.S. Census is 8,203 and the population density is 348.2 people per square mile.[101] The total number of housing units is 2,853, and the average household size is 2.86 people. The average age of Boxford residents is 46.1, with 17.8% of residents over the age of 65, and 24.5% of residents under the age of 18 . A total of 2,281 Boxford students are enrolled in one of Boxford's two elementary schools (Spofford Pond and Harry Lee Cole), or the Masconomet Regional Middle or High School.

Until the construction of Interstate 95 in the 1950s, Boxford was primarily a farming community. However, with the growing Metro Boston job centers situated within commuting distance, the Town experienced decades of rapid population growth (more than 100% each decade in the 1950's and 1960's). After 26% growth in the 1990's, Boxford's population stabilized in the early 2000 as development slowed and housing costs escalated. From 2010-2020, Boxford's population grew 2.9%, an increase of 238 people. Population projections for Boxford from the UMass Donahue Institute forecast 2030 Town population of 7,682 people, a decrease of 6.4% from 2020.[102]

The Town is not served by either a municipal water supply system or a centralized sewage treatment plant, but instead relies on individual on-site wells and septic systems. There are 18 public water-supply wells in Town.[103] According to the Town's Open Space and Recreation Plan (OSRP, in draft 2023), all of the potable water used by Boxford residents is obtained from wells. The water supply for private residences is derived almost exclusively from private wells located on each individual residential property. Private wells in Town rely primarily on the Ipswich River watershed, which supplies 350,000 homes as of 2019. The Parker River (Fish Brook) and Merrimack River (Johnson Creek) are also significant sources for private well users. In the summer of 2022, the region experienced a severe drought, causing low flow in the Ipswich and Parker Rivers and raising concern for citizens utilizing private wells. In addition to drought, anthropogenic groundwater contamination has occurred in Boxford along the I-95 highway corridor because of poorly considered or improper road salt storage, management, and application practices by MassDOT. To date, fifteen wells within this corridor have exhibited chloride concentrations that exceed either the Secondary Drinking Water Standard of 250 mg/L, or the Drinking Water Advisory standard for sodium of 20 mg/L for individuals on a salt restricted diet. MassDOT has conducted a controversial well replacement program in Boxford to provide replacement wells for selected residences in return for a waiver of liability from the affected homeowner. In total, fifteen replacement wells have been installed under this MassDOT program.


Boxford State Forest

The 2024 HMP reports both land cover and land use data derived

[101] United States Census Bureau. 2023. QuickFacts. U.S. Census Bureau QuickFacts: United States
[102] UMass Donahue Institute. 2022. Massachusetts Population Projections. UMass Donahue Institute | Population Projections
[103] MassGIS. 2024. Public Water Supplies. MassGIS Data: Public Water Supplies | Mass.gov

from the State's most updated 2016 land cover layer.[104] Predominant *land cover* in Boxford is forest (63%) and wetlands (19%), followed by open land (7%), developed impervious land (5.5%), open water (3%), and agricultural land (2%). *Land use* in Boxford is primarily residential (51%) and recreational (34%), followed by agricultural (6%), transportation (5%), open water (2%), and commercial/industrial (1%). Commercial/ industrial activity is limited to 30 acres concentrated in the Town's two village centers – Boxford Center and West Boxford Center – and a small commercial development in the north-central section of Town near the Georgetown line. In the western and northwestern sections of Town, there still exists significant agricultural activity which, combined with extensive conservation open space, gives the area its rural character. In central and east Boxford, the open lands are mostly conservation properties.

Recent Development and Land Use Change

Boxford is a small rural community with historically slow development patterns favoring single-family homes on large parcels. Since the 2016 update, Boxford has initiated one large development, the Willows, which is currently in the construction phase. This 66-unit multi-family 55 and over housing development is helping reconcile the community's need for smaller housing options for their growing elderly population. To support this development, Boxford conducted one zoning change since 2016, the development of an elderly housing overlay of 127 acres. Beyond this development, the Town is also looking to construct a new Department of Public Works facility as the old facility is inadequate for the Town's needs. Boxford is also actively working to preserve and conserve open space within the Town. Since the 2016 update, one parcel of 35.58 acres was purchased by the Town in the fall of 2023 for open space, public access and recreation.

Since the last plan update, changes in development and land use in the Town have not impacted Boxford's risk to natural hazards. While the Town has experienced one significant new development, impacts have not increased and perhaps slightly decreased the risk to resident safety or property damage. Risk has been mitigated through actions to ensure the design meets or exceeds the WPA and MA-DEP Stormwater Standards for development. These 10 standards among other things, ensure that the development will not have any adverse downstream impacts with respect to runoff rate and volume, ensuring groundwater recharge is realized, minimizing Total Suspended Solids and other pollutants from entering resource areas, and ensuring proper construction and post construction stormwater Best Management Practices, etc. Further, the town replaced a culvert in the direct vicinity of the development. The culvert was sized and replaced to exceed MA Stream Crossing Standards which promotes stormwater resiliency and allows for better stormwater mitigation. Additionally, efforts to counteract impacts from development through the conservation of open space has allowed the Town to minimize further development and preserve natural open space.

Community Lifelines

A list of selected community lifelines (emergency operations centers, hospitals/healthcare centers, public shelters) is shown in *Table 5.8* and was originally derived from the Town's Comprehensive Emergency Management Plan (CEMP) and updated from conversations with the LHMPT. The locations of these and other community lifelines in Boxford were entered by MVPC into an Excel database and subsequently incorporated into MVPC's ArcGIS for use in digital mapping. As part of the plan update, the full list of community lifelines

[104] MassGIS. 2019. 2016 Land Cover/Land Use. MassGIS Data: 2016 Land Cover/Land Use | Mass.gov

was reviewed and amended to reflect current conditions, as well as to incorporate new facilities and resources. The critical facilities are depicted in the Boxford map series that is presented in Appendix B.

Table 5.8 Select list of Boxford's community lifelines (Emergency operation centers, hospitals, and shelters)

Boxford Emergency Operation Centers, Hospitals, and Shelters							
Facility Type	**Common Name**	**Street Address**	**Health Facility Type**	**Average Daily Capacity**	**Maximum Capacity**	**Feeding Capability**	**Emergency Generator Available**
Emergency Operations	Boxford Emergency Operations Center	285 Ipswich Rd. (Housed in PD)	N/A	N/A	N/A	N/A	Yes
Hospitals and Healthcare Centers	None						
Emergency Shelters	Cole Elementary School	Middleton Rd.	N/A	NA	319	Yes	Yes
	Masconomet Regional High School	20 Endicott Rd., Topsfield	N/A	NA	2,000	Yes	Yes
	Lincoln Hall	565 Main St.	N/A	100	100	Yes	Yes

Bridges: Boxford has a total of 19 bridges within its municipal borders.[105] The Town owns seven (7) of these bridges, with the Massachusetts Department of Transportation (MassDOT) owning the remaining 12. The majority of bridges in Boxford (12) provide passage over water features including the Fish Brook and Ipswich River. The other seven (7) intersect roads including I-95 and Fuller Lane. No bridges in Boxford are listed as structurally deficient, and all have been regularly inspected.

Dams: Boxford has a total of 13 dams within its municipal borders.[106] The Town owns four (4) of these dams: Stiles Pond Outlet Dam, Baldpate Pond Dam, Spofford Pond Outlet Dam, and Lockwood Dam. The remaining nine (9) dams are privately owned. Two of these privately owned dams, while listed on the state registry,

Table 5.9 List of Boxford's Significant and High Hazard Dams identified by the Massachusetts Office of Dam Safety

Boxford's Significant and High Hazard Dams				
Dam Name	**Impoundment Name** (maximum capacity in acre-feet)	**Year Completed**	**Hazard Class**	**Last Inspection Date**
Stiles Pond Dam	Stiles Pond (260 acre-feet)	1920 (major repair completed Fall 2014)	Significant	6/1/2020
Howes Pond Dam	Howes Pond (40 acre-feet)	1800 (major rebuild in 1960)	Significant	3/6/2017

[105] MassDOT. 2024. Bridges. Bridges | Bridges | MassDOT Open Data Portal (arcgis.com)
[106] MassGIS. 2012. Dams. MassGIS Data: Dams | Mass.gov

have been identified as breached by the Town: Morss Farm Pond Dam and Fish Brook Dam. None of the dams in Boxford are categorized as High Hazard Dams. However, two of the dams – Stiles Pond Dam (municipally owned) and Howe Pond Dam (privately owned)– are classified by the state as "significant" hazard dams. These dams are listed in *Table 5.9* below.

Stiles Pond Dam: The Stiles Pond Dam, owned by the Town, is a 170-foot earthen embankment with a reinforced concrete wall forming the center 100 feet. The spillway of the dam is a reinforced concrete block culvert. Inside this culvert there are stoplogs which establish normal operating levels in the pond. Stiles Pond forms the headwaters of Fish Brook. The dam's flashboards cause adverse flow conditions downstream. Significant improvements were made to the dam by the Town DPW in Fall 2014 with the addition of clay and rip-rap to the areas that were seeping or eroding. An Emergency Action Plan (EAP) for the dam was completed and submitted to the Office of Dam Safety in 2022.

Howes Pond Dam: Howe Pond Dam, off Mill Road, is a privately owned structure that was originally built in the 1700s. It has been repaired many times over the years. The dam consists of three channels, which include the main dam (in the center) approximately 100 feet across, and two spillways to the left and right of the main structure. The dam and surrounding areas are well maintained by the homeowner.

Lowe Pond Dam: While not considered a significant or high hazard dam, the Lowe Pond Dam is a privately owned dam created in the 1950's that the Town felt important to highlight. The dam was rebuilt in the 1970's and is comprised of two structures, an earthen dam and a concrete weir. The earthen portion of the dam is 137 feet long and the concrete weir is 53 feet long. Maintenance of this dam consists mostly of controlling erosion and vegetation management. This dam constricts water flow downstream in Pye Brook in the summer months. Floodwaters have been known to threaten the earthen part of the dam, requiring emergency assistance from the Town to prevent overtopping. To ameliorate this hazard, Town officials, acting under emergency powers, have at times stored floodwaters upstream of Four Mile Pond during large storms. This emergency action unfortunately increases the risk of flooding to property bordering Four Mile Pond and along Pye Brook.

Boxford is working to reduce vulnerability surrounding their significant hazard dams through ensuring regular monitoring, inspections, and maintenance, and by working with private dam owners to notify them of their responsibilities. Boxford is also working to alleviate flooding in this area and others by addressing barriers to flow through culvert restoration projects across the Town. Since 2016, the Town has partnered with the Ipswich River Watershed Association to complete a barrier assessment, and identify priority culverts for replacement and replacement. As of October 2023, six (6) culverts and one (1) bridge are in in the permitting phase, with an additional bridge, the Endicott Bridge, designed and awaiting MassDOT review. Funding through ARPA and MVP Action Grants are being used to support this work.

Community Specific Hazards

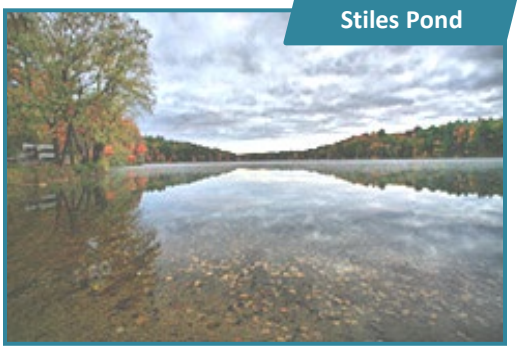
Boxford's LHMPT reviewed the full range of natural hazards that impact Massachusetts, as identified through the State Hazard Mitigation and Climate Adaptation Plan. The majority of the natural hazards considered impact the Merrimack Valley Region in a similar way. For those that have a different or locally-specific impact on the Town of Boxford, additional information has been supplemented in this section.

Flooding

Boxford lies within three major drainage basins: the Merrimack, Parker, and Ipswich River watersheds. The Merrimack basin occupies a small part of northwest Boxford and consists of Hovey's, Johnson's, and Chadwick Ponds and their associated wetlands and intermittent streams. Much of this area is a protected public water

supply watershed. The Parker River originates in West Boxford in wetlands west of Sperry's Pond, and flows northeast into Groveland, Georgetown and on through Newbury to Plum Island Sound. The Boxford portion of the basin contains Baldpate Pond and some small tributaries of the Mill River in central Boxford. In Boxford Village, Fish Brook and Pye Brook are the principal sub-drainage systems, eventually flowing into the Ipswich River mainstem in Topsfield. These two brooks and their associated wetlands and tributaries drain many of the larger ponds in Boxford, including Four Mile, Spofford, Stiles, Lowe, and Kimball Ponds.

Areas of Common Flooding: Areas in the community that experience occasional flooding include lands bordering the Parker River, Pye Brook, and Fish Brook, as well as lands on the perimeter of numerous ponds and wetlands. Of particular concern to local emergency management personnel are selected areas in the vicinity of Four Mile Pond and Lowe Pond. Four Mile Pond off Georgetown and Herrick Road flows into Lowe Pond, where there is an earthen dam that has required sand-bagging on multiple occasions. Lawrence Road, downstream from the outlet of Stiles Pond, floods with regularity and has been closed to traffic on numerous occasions. Portions of Main Street near Mortimer Road have also been noted as locations of common flooding. Lastly, sections of Wildmeadow Road, Baldplate Road, and low-laying sections adjacent to Woodcrest Road have more recently been identified as problematic locations due to beaver activity which clogs culverts, leading to flooding.


Stiles Pond

Flood Vulnerability Assessment: A GIS analysis of the Town's FIRM flood hazard areas by MVPC has determined that 1,723.35 acres (2.7 sq. mi.) of land area in Boxford is located within the 100-Year floodplain and thus is vulnerable to flooding. An additional 76.39 acres (0.12 sq. mi.) lies with the 500-Year floodplain. Together, these two flood zones constitute almost twelve (11.5%) of the total area of the community. Local wetland bylaws restricting development and other activity within wetlands as well as within the buffer zone around them (100 feet) act to further protect these natural spaces and reduce community vulnerability to flooding. Potential development within these zones would be subject to restrictions under the Wetland Protection Act and Local Wetland Bylaw, as overseen by the Conservation Commission.

As part of the mapping analysis, MVPC also investigated the presence of any "critical" facilities at potential risk of future flood damage or loss. No such facilities were identified in the mapped FIRM flood zones, nor, according to Town officials, are there plans to site any future critical facilities in these zones. MVPC also examined *non*-critical facilities in flood hazard areas. According to GIS analysis, 101 structures lie within the floodplains, accounting for 2.5% of Boxford's infrastructure. The total value of these residential & institutional properties is $62.6 million.

NFIP Information: Boxford actively participates in the National Flood Insurance Program (NFIP). The Town's initial Flood Hazard Boundary Map (NHBM) was identified in 1974, and the initial Flood Insurance Rate Map (FIRM) was identified in 1991. The latest effective FIRM was adopted in 2012. The Flood Hazard Management Program anticipates a new FIRM and Flood Insurance Study (FIS) will be available for adoption in 2024. Boxford intends to update their local regulations to adopt the new maps and study ahead of the effective date, anticipated in summer 2025. This will require updating Boxford's Zoning Bylaw (Article V Use Regulations, 196-22.1 Floodplain District), where minimum floodplain management criteria appear. Boxford implements and enforces local floodplain management regulations in Special Flood Hazard Areas (SFHAs) through their Planning Board and Zoning Board of Appeals through the Town's Zoning Bylaw section 196.22-1. In Boxford, the Building Inspector is the Town's Zoning Code Enforcement Officer. The Building Inspector is empowered to enforce the zoning code. Any violations can be taken to the Zoning Board of Appeals. Currently, the Town's Bylaw does not specifically address substantial improvements/substantial damage

provisions after an event. Therefore, following an event, the Town Administrator's officer with the aid of the Town Council, acting through the Select Board, would coordinate assessment and compliance.

According to data provided by the Massachusetts Emergency Management Agency (MEMA), there is currently one repetitive flood loss site in Boxford. This site has experienced a total of two losses totaling $15,127 in claims (July 2023). Town-wide, there are 12 flood insurance policies in place for properties located in flood hazard areas, and one policy for a property located in a special flood hazard area. The combined insurance value for these properties is $4,006,000.[107] Based on the frequency, areal extent, and severity of historical floods in dispersed locations in Boxford, Town emergency management officials consider the community to be at ***moderate risk*** from flooding.

Wildfires

Boxford is a small town with two-acre zoning and extensive protected forested. As such, nearly two-thirds of land in Boxford (61%) is forested, according to GIS analysis by MVPC. Almost every household in Boxford has woodland area that can be threatened by wildfires. Boxford also contains over 1,000 acres of state forests, including Georgetown-Rowley and Boxford State Forest which are in addition to local properties such as Wildcat and Cleveland Farms. Emergency Response officials report they respond to brush fire incidents each year in peak months though these are infrequent. Boxford reports a total of 59 brushfires since the last update was conducted in 2016 (Averaging 8.4 per year). Based on this record and given the low-density settlement in proximity to Boxford forest lands, officials still assigned a ***moderate risk*** rating to the hazard of wildfire/brush fire.

Invasive Species

The Town of Boxford has noted impacts from a range of invasive species in recent years. As a heavily forested community, Boxford is susceptible to invasive species including Oriental Bittersweet, Japanese knotweed, Glossy Buckthorn, as well as a range of invasive insect species that rely on this habitat such as the Asian Longhorned beetle and Hemlock Woolly Adelgid. For example, the Town experienced an infestation of Japanese Hops in a wetland restoration area within the Boxford Commons in 2018 and 2019. Due to the Town's susceptibility to invasive plant and insect species, and the challenge of managing these invasives, they have assigned a ***high risk*** to the hazard of invasive species.

Natural Hazards Management and Response

Boxford has an Emergency Management Planning Committee that provides a unified command structure. The Committee, currently led by Lt. Robert D. Hazelwood, is made up of the Town Administrator, Director of Public Health, Police Department, Fire Department, Department of Public Works, Council on Aging and Planning/Environmental Protection Department.

The Boxford Fire Department operates out of two stations, East Station and West Station. The Department is led by a full-time Chief, one full-time Captain and three full-time Firefighters. The department employees work a 40-hour week staffing the department Monday through Friday. In addition, the department has 34 call firefighters who respond as needed. The department has one Deputy Chief, one Captain and five Lieutenants. All members train two hours on Monday nights throughout the year to maintain and acquire skills and knowledge required in the fire service. Members are encouraged to attend further training such as

[107] Massachusetts Emergency Management Agency. 2023. *NFIP Summary Data Report* – 7/25/2023.

Emergency Medical Technician Certification, Firefighter I/II, and many specialized trainings offered by the Massachusetts Fire Academy.

The Boxford Police Department is led by the Chief, one Lieutenant and three sergeants with eight full-time officers and 11 reserve officers. Police officers are the only Town employees who are working in Town on a 24/7 basis. As such, the Police Department is the first responder in virtually all emergency situations. The Police are responsible for deploying other on shift patrols as necessary and calling the emergency into the Communications Department and DPW. They assist in any emergency by securing the area and/or helping residents in need if possible until other units arrive.

The Boxford Communications Department serves Boxford as the 911 and Public Safety Communications Center. Department staff provide 24-hour 911 communications and dispatch service for Public Safety Police & Fire departments. All Dispatchers are required to complete a minimum of 16 hours of continuing education during each fiscal year as per State requirements which include, but are not limited to, training in Emergency Medical Dispatch (EMD) and CPR.

The Boxford Department of Public Works is led by the Superintendent and has eight full-time personnel, and one part-time admin. In addition to providing roadwork, culvert and public facility maintenance, the DPW provides vehicles and equipment used in emergencies including barriers, generators and pumps.

Natural Hazards Risk Assessment

Through using the Town of Boxford's previous Hazard Mitigation Plan, in association with other planning documents including Boxford's Comprehensive Emergency Management Plan, and Municipal Vulnerability plan, natural hazards for the Town were considered. On the basis of this analysis, which incorporated the judgment of local emergency management and project planning team personnel, Boxford considers itself to be at ***high risk*** from winter storms (blizzards/snow/ice storms) drought, extreme temperatures, and invasive species; ***medium risk*** from inland flooding, high winds/thunderstorms, and hurricanes/tropical storms; and ***low risk*** from earthquakes, wildfires, landslides, and tornadoes. As an inland community, Boxford does not consider itself to be at risk from: Coastal/Riverine Erosion, Coastal Flooding, or Tsunamis.

Table 5.10 Boxford's risk rating for the 15 natural hazards experienced in the Commonwealth

Boxford Natural Hazard Risk Rating	
Natural Hazard	**Community Risk Rating**
Severe Winter Storms	High
High Winds/ Thunderstorms	High
Inland Flooding	High
Invasive Species	High
Wildfire	Moderate
Drought	Moderate
Hurricane/Tropical Storm	Moderate
Earthquake	Low
Extreme Temperatures	Low
Landslide	Low
Tornadoes	Low
Coastal/Riverine Erosion	NA
Coastal Flooding	NA
Tsunami	NA

*Continue to page 194 of the Plan to review Boxford's next section: **Boxford's Natural Hazard Challenge Statements**.*

5.2.3 Town of Groveland Natural Hazard Risk Assessment

Community Profile

Groveland Town Hall

The Town of Groveland is located 31 miles north of Boston along the south bank of the Merrimack River. State Routes 97 and 113 traverse the Town and Interstate Highways I-95 and I-495 are located nearby. The Town covers 8.9 square miles and has a population of 6,752.[108] The population density is 760.4 people per square mile and the average household size is 2.66 people. Residents are the under the age of 18 make up one-fifth of the population (21.5%), with residents 65 and older accounting for 16.5%. Population projections for Groveland from the UMass Donahue Institute forecast the 2030 Town population of 7,031 people, an increase of 4% from 2020.[109]

Groveland has one elementary school, Dr.Elmer S. Bagnall Elementary School, with a current enrollment of 473 students. Groveland is also part of the Pentucket Regional School District which serves middle and high schoolers from the communities of Groveland, Merrimac, and West Newbury.

Groveland provides public drinking water to 70% of the Town from three municipal wells. One well is located in the Center Street Greenway near Argilla Brook and the other two are located near the Merrimack River behind River Pines Drive. Sewer service is provided to 30% of the Town, mostly within more densely-developed areas, which the remaining portion of the community relying on individual on-site septic systems for their wastewater disposal. Sewage is piped to the regional wastewater treatment plant in neighboring Haverhill where the wastewater is treated prior to its discharge to the Merrimack River. Electricity is provided to residents through the Groveland Municipal Light Department, and National Grid provides gas to the Town.

The topography of Groveland ranges from low-lying vales marked by streams, ponds, and wetlands to gently rolling hills composed of glacial deposits. The northern, more heavily developed section of the Town is made up of undulating terrain with scattered hills that rise to a height of approximately 250 feet above mean sea level. The terrain for the rest of the Town tends to be flatter and includes sizable areas of freshwater wetlands.

The GIS analysis for the 2024 HMP reports both land cover and land use data derived from the state's most updated 2016 land cover layer.[110] Predominant *land cover* in Groveland is forest (54%) and wetlands (19%), followed by open land (12%), developed impervious land (8%), open water (5%), and agricultural land (2%). *Land use* in Groveland is primarily recreational (46%) and residential (37%), followed by commercial/industrial (7%), open water (5%), transportation (4%) and agricultural (1%).

Recent Development and Land Use Change

Groveland Town Center, designated a local priority growth area in the Merrimack Valley Regional Land Use Plan (2015), is approximately 101 acres and is zoned business, limited business, and Residential Zone 3. A mix of uses is allowed in this area including medium density residential, offices, service establishments, business in single-family units, and retail establishments. The Town's Master Plan (2023) identifies a few key focus areas, including enhancing community connectivity, addressing vacant and underutilized buildings, and

[108] United States Census Bureau. 2023. QuickFacts. U.S. Census Bureau QuickFacts: United States
[109] UMass Donahue Institute. 2022. Massachusetts Population Projections. UMass Donahue Institute | Population Projections
[110] MassGIS. 2019. 2016 Land Cover/Land Use. MassGIS Data: 2016 Land Cover/Land Use | Mass.gov

providing accessible housing options. Over the past several years, the Town of Groveland has experienced significant increases in development and population. Since the 2016 update, Groveland has initiated ten major developments: one affordable housing development, one senior living community, five subdivisions, and three commercial developments (*Table 5.11*).

Table 5.11 Major development projects in Groveland initiated since 2016.

Groveland Major Development Projects 2016-2023			
Facility Type	**Street Address**	**Total Housing Units**	**2023 Status**
Affordable Housing	Salem Street/Sewell St	192	In process
Commercial: Storage Facility Expansion	15 Nelson Street	NA	In process
Subdivision	Billis Way (off Main St)	9	Near complete
Subdivision	Oakland Ter (off Salem St)	3	Near complete
Subdivision	Katie Ln (off King St)	9	30% complete
Subdivision	Atwood Ln (off Center St)	8	Complete
Senior Living Community	1 Nichols Way	115	Complete
Subdivision	Graeme Way (off Etsy Way)	7	Complete
Commercial: Storage Facility	441 Main Street	NA	Complete
Industrial Warehouse	10 Federal Street	NA	Complete

Groveland is also actively working to preserve and conserve open space within the Town. Since the 2016 update, three parcels totaling 19.2 acres have been conserved, with an additional five parcels totaling 25.2 acres currently in the planning, permitting, or design phase (*Table 5.12)*. Groveland has also taken regulatory approaches to encourage conservation, such as their Conservation Subdivision Design (CSD) Bylaw which incentives developers to conserve open space in new subdivisions. In their 2023 Master Plan, Groveland also elevates the idea of developing an Open Space District, something that is becoming more common for communities like Groveland who have significant natural resources.

Table 5.12 Newly conserved or preserved land in Groveland since 2016

Groveland Newly Conserved or Preserved Land 2016-2023				
Property Name	**Address/ Parcel ID**	**Area**	**Land Owner /CR Holder**	**Year Completed**
Wood St Town Forest Addition	08-004-L	7.7 Acres	Town of Groveland	2019
Town forest addition	05-002-F	10.9 Acres	Town of Groveland	2020
Veasey Park addition	52-003-A	0.6 Acres	Town of Groveland/ Groveland ConCom	2023
Veasey Park addition	39-068-M	3.5 Acres	Town of Groveland	2023
Seven Star Rd CA addition	13-014-A	2 Acres	Town of Groveland/ Groveland ConCom	2023
Sewell St CR	53-004-A & 47-029-0	10 Acres	CR held by Groveland ConCom	Planning
Turtle area/Center St Greenway CR	40-009-0, 33-006-0, 33-010-0 & 33-009-0	8 Acres	Town of Groveland	In process
833 Salem St CR	47-034-0	1.7 Acres	CR held by Groveland ConCom	In process

Since the last plan update, changes in development and land use in the Town have not impacted Groveland's risk to natural hazards. While the Town has experienced development, impacts have not increased or decreased the risk to resident safety or property. Risk has been mitigated through actions to promote smart growth strategies through the Town's updated Master Plan, and require Best Management Practices (BMPs) through the Town's Stormwater Management and Land Disturbance Bylaw. Additionally, with more than one-third of land in Groveland publicly or privately protected, the Town has counteracted impacts from development through conserving open space which provides flood storage, reduces drought and high heat impacts, and benefits air quality.

Community Lifelines

A list of selected community lifelines (emergency operations centers, hospitals/healthcare centers, public shelters) is shown in *Table 5.13* and was originally derived from the Town's Comprehensive Emergency Management Plan (CEMP) and updated from conversations with the LHMPT. The locations of these and other community lifelines in Groveland were entered by MVPC into an Excel database and subsequently incorporated into MVPC's ArcGIS for use in digital mapping. As part of the plan update, the full list of community lifelines was reviewed and amended to reflect current conditions, as well as to incorporate new facilities and resources. The critical facilities are depicted in the Groveland map series that is presented in Appendix B of this Plan. While the Groveland Public Safety Building (Police and Fire) serves as the Town's Emergency Operations Center, an aging generator at the Police Department poses risk for emergency response. Ensuring emergency centers are well-equipped and have up-to-date equipment is essential to having comprehensive and timely response capacity.

Table 5.13 Select list of Groveland's community lifelines (Emergency operation centers, hospitals, and shelters)

Groveland Emergency Operation Centers, Hospitals, and Shelters							
Facility Type	**Common Name**	**Street Address**	**Health Facility Type**	**Average Daily Capacity**	**Maximum Capacity**	**Feeding Capability**	**Emergency Generator Available**
Emergency Operations	Groveland Public Safety Building (Police & Fire)	181 Main Street	N/A	N/A	N/A	N/A	Yes
Hospitals and Healthcare Centers	None						
Emergency Shelters	Groveland Town Hall	183 Main Street	N/A	20	50	No	Yes
	Elmer S Bagnall Elementary School	253 School Street	N/A	150	300	Yes	Yes

Critical Infrastructure

Bridges: The Town of Groveland has one bridge within its municipal borders.[111] The Bates Bridge on Routes 97/113 over the Merrimack River had previously been listed as structurally deficient by MassDOT Highway,

[111] MassDOT. 2024. Bridges. Bridges | Bridges | MassDOT Open Data Portal (arcgis.com)

and in fact, the American Association of State Highway and Transportation Officials (AASHTO) Bridge Rating for the structure in May 2007 was only 2.0 (out of 100), at the time the *lowest rating* of any bridge in the Merrimack Valley region. For many years MassDOT had to periodically close the bridge, also known locally as the Groveland Bridge, to traffic to perform short-term repairs that were the result of the structure's continued deterioration. This deterioration eventually resulted in MassDOT posting the bridge with a weight limit. Work was completed in October 2013 on construction of a new Bates Bridge, located 50-60 feet downstream from the 1950 span. Like the prior bridge, the new structure includes a functioning draw mechanism that allows larger watercraft to proceed upstream as far west as downtown Haverhill. Currently no bridges are classified as "structurally deficient" within Groveland.

Dams: The DCR Office of Dam Safety includes eight (8) Groveland dams on its statewide dam classification list.[112] These include four privately owned: Dyes Pond Dam, Small Pond Dam, Mill Pond Dam (off Rollins St.), and White Pond Dam (breached); and four municipally owned: Johnsons Creek Dam, Johnsons Pond Dam, Mill Pond Dam, and Pleasure Pond Dam. Of these, two dams – Johnsons Creek Dam and Johnsons Pond Dam – are classified as significant hazard dams (*Table 5.14*).

Table 5.14 List of Groveland's Significant and High Hazard Dams as identified by the Massachusetts Office of Dam Safety

Groveland Significant and High Hazard Dams				
Dam Name	**Impoundment Name** (maximum capacity in acre-feet)	**Year Completed**	**Hazard Class**	**Last Inspection Date**
Johnsons Creek Dam	Johnson's Creek (220 acre-feet)	1913	Significant	11/1/2023
Johnsons Pond Dam	Johnson's Pond (1,080 acre-feet)	1930	Significant	5/10/2023

Johnsons Creek Dam: The Johnsons Creek Dam is located near Salem Street and regulates flow in Upper Johnsons Pond. Originally constructed in 1913, Johnsons Creek Dam is an earthfill dam with a vertical downstream masonry wall. The dam is ~100 feet in length, with a maximum height of 16 feet. The dam is classified in the "small" size and "significant" hazard categories. As the dam owner, the Town of Groveland works with the ODS to ensure timely inspections every five years. Groveland is actively pursuing funding for dam and culvert repair and reconstruction at the site. The Town applied for an EEA Dam and Seawall grant for permitting and design and is also working to get the project listed on the TIP for construction funding.

Johnsons Pond Dam: The Johnsons Pond Dam is located along Washington Street and regulates flow from Johnsons Pond. Originally constructed in 1930, the existing impoundment is an earthen embankment with a six-foot span concrete weir that discharges to a downstream culvert structure. The dam outlet is considered to be in fair condition, while constant beaver activity in the area poses ongoing flooding risk. The Town received funding through an MVP Action Grant in FY2022 to study flood resiliency across the Johnson Creek Watershed including the Johnsons Pond Dam. Although located in Groveland, this dam is owned by the City of Haverhill. As such, the City works with ODS to ensure timely inspections every five years. Due to local concerns, Groveland is actively pursuing funding for dam and culvert repair and reconstruction at the site and has submitted a Small Town Road Assistance Program (STRAP) grant.

Groveland is also working to address barriers to flow through culvert restoration projects across the Town. In 2023, the Town received a $1 million MassWorks grant through the Small Town Road Assistance Program (STRAP) to replace a deteriorating culvert pipe with a precast concreate box culvert along Uptack Road. The

[112] MassGIS. 2012. Dams. MassGIS Data: Dams | Mass.gov

work greatly improved hydrological flow under Uptack Road and bolstered Groveland's climate resilience. Groveland also received funding through the Municipal Vulnerability Preparedness (MVP) Program in 2023 to advance the Johnson Watershed Flood Resiliency Project. This funding will address flood mitigation projects at several locations in the watershed, including funding the design and permitting for another culvert on lower Center Street. The Town will be looking for additional funding for construction of hydrological barriers identified through the MVP grant.

Community Specific Hazards

Groveland's LHMPT reviewed the full range of natural hazards that impact Massachusetts, as identified through the State Hazard Mitigation and Climate Adaptation Plan. The majority of the natural hazards considered impact the Merrimack Valley Region in a similar way. For those that have a different or locally-specific impact on the Town of Groveland, additional information has been supplemented in this section.

Flooding

The Town of Groveland is located within the Merrimack River watershed and the Parker River watershed. Approximately 63% of the Town area lies within the Merrimack River watershed, with the remainder (37%) in the Parker River watershed. The Merrimack River collects most of the drainage from the northern and southeast sections of the Town, while the Parker River drains most of the south-southeastern sections. Within the two basins, there are a number of smaller sub-drainage areas that contain an abundance of tributary streams, ponds, and wetlands.

Flooding within Groveland occurs from two main pathways: Riverine flooding from the Merrimack and Parker Rivers, and inland flooding from numerous interior creeks, brooks, streams, and ponds. Flooding can occur from all these sources following intense or prolonged precipitation events.

Merrimack River: The Merrimack River is the major waterway in the region running from New Hampshire through northern Massachusetts where it discharges into the Atlantic. It is tidally influenced and navigable above Groveland and forms the Town's 2.2-mile northern border with the City of Haverhill. The Merrimack and its tributaries have experienced flooding on numerous occasions throughout the years. The flood of record occurred in 1936 with a water surface elevation in Groveland of about 25.0 feet above mean sea level (msl). Since 1936, the construction of a series of upstream flood control structures (in NH) by the Army Corps of Engineers has alleviated some of this flooding along the Merrimack mainstem. However, flooding continues to occur along parts of the south bank of the river, most notably along Main Street from the downtown area by the Bates Bridge west (upstream) to Washington Street.

The Merrimack River and Bates Bridge

Parker River: The Parker River enters and leaves Groveland in two locations, and a significant portion of the Town (3.4 sq. miles) lies within its drainage area. About 900 feet of the river crosses the Town at the very southern tip near the Boxford-Georgetown line. The river enters again in the eastern part of Groveland from Georgetown, flows into Crane's Pond, and then emerges from the pond continuing in an easterly direction. A total of 1.25 miles of the Parker River flows within Groveland. Most of the Parker River watershed area in

Groveland lies within the Crane's Pond Wildlife Management Area, owned by the Massachusetts Division of Fisheries and Wildlife. Flooding occurs along the Parker River mainstem and the perimeter of Crane's Pond, but the extent and impact are significantly mitigated by the expansive bordering wetlands that offer substantial flood storage.

Various Ponds and Creeks: There are four major ponds in Groveland. These include Johnsons Pond, New Mill Pond, Meadow Pond, and Crane Pond. These ponds range in size from 225 acres (Johnsons Pond) to 4.5 acres (Crane Pond) and serve a range of functions within the community from municipal water sources to locations for recreation. Additionally, a number of creeks and brooks run through the Town, including Johnson's Creek, Brindle Brook, and Argilla Brook. These waterways contribute flow to the larger ponds and rivers cited above. Their proximity to more densely developed residential and commercial areas in Town pose flooding risks.

Areas of Common Flooding: Flooding has been cited as a common concern along Washington Street, Center Street, Main Street, Salem Street, and Seven Star Road. Flooding occurrences in Groveland have frequently been attributed to insufficient drainage and undersized infrastructure. In their Open Space and Recreation Plan (2020-2027) Groveland cites the importance of wetlands in their community, which have minimized flooding in the interior parts of Groveland and prevented significant damage. The Town has strengthened its Wetland Protection bylaw, which extends the buffer zone for building near wetlands to a 100-foot setback from the high-water mark of record.

Flood Vulnerability Assessment: A GIS analysis of the Town's FIRM flood hazard areas by MVPC has determined that a total of 1,044 acres (1.6 sq. mi.) of land area in Groveland is located within the 100-Year floodplain and thus is vulnerable to flooding. An additional 198 acres (0.31 sq. mi.) lies with the 500-Year floodplain. Together, these two flood zones constitute over twenty percent (20.7%) of the total area of the community. Zones within the floodplain which are open and "potentially developable" under the Town's current zoning scheme are areas of vulnerability. Development of open spaces within the floodplain would increase the impervious surface cover and stormwater runoff volumes in the flood zones, thereby exacerbating the existing flooding problems. It is recommended that the Town looks to protect/conserve areas within the floodplain to increase environmental and community resilience to hazards such as flooding and drought.

Table 5.15 List of Community Lifelines located in Groveland within the 100 and 500-year floodplain.

Groveland Community Lifelines within Floodplain		
100-Year Floodplain		
Facility Type	**Name**	**Generator**
Power Substation	Electrical Substation	No
Water Supply/Pumping/Storage	Well #1	Yes
Water Supply/Pumping/Storage	Well #3 and #4	Yes
Sewage Pumping Station	Main Street Sewer Pump Station	Yes
Sewage Pumping Station	Pentucket H.S. Sewer Pump Station	Yes
500-Year Floodplain		
Facility Type	**Name**	**Generator**
Electric Power Plant	Power Generation-Solar Field	No

As part of the mapping analysis, MVPC also investigated the presence of any "critical" facilities at potential risk of future flood damage or loss. Six (6) critical facilities were identified within flood zones, collectively valued at $8.26 million (*Table 5.15*). MVPC also examined *non*-critical facilities in flood hazard areas. This analysis revealed the presence of 173 residential, commercial, and industrial structures, collectively valued in 2023 at $89.5 million.

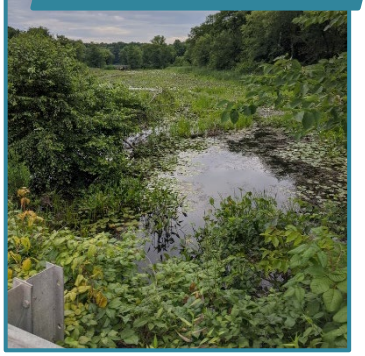
NFIP Information: Groveland actively participates in the National Flood Insurance Program (NFIP). The Town's initial Flood Hazard Boundary Map (NHBM) was identified in 1974, and the initial Flood Insurance Rate Map (FIRM) was identified in 1980. The latest effective FIRM was adopted in 2012. The Flood Hazard Management Program anticipates a new FIRM and Flood Insurance Study (FIS) will be available for adoption in 2024. Groveland intends to update their local regulations to adopt the new maps and study ahead of the effective date, anticipated in summer 2025. This will require updating Groveland's Zoning Bylaw (Section 50-5.6), where minimum floodplain management criteria appear. Groveland implements and enforces local floodplain management regulations in Special Flood Hazard Areas (SFHAs) through complying and enforcing their Town Bylaw, the State Building Code (780 CMR), and the NFIP Standards. Groveland's Building Commissioner, who also acts as the Zoning Enforcement and Floodplains Administrator, ensures local enforcement. Following and event, substantial improvement/substantial damage provisions are addressed through post-event surveys, which are completed by the Building Commissioner to assess the level of damage, allowable cost, and compliance at the time of permitting.

According to data compiled by the Massachusetts Emergency Management Agency there are currently no repetitive flood loss sites in the Town of Groveland. Town-wide, there are 10 flood insurance policies for properties located in FIRM flood hazard areas, and 6 located within special flood hazard areas (SFHA). The combined insurance value for these properties is $4,486,000.[113] Based on the frequency, extent, and severity of historic flooding as well as the probability of future flooding in Groveland, Town emergency management officials consider the community to be at ***high risk*** from flooding.

Invasive Species

The Town of Groveland has noted impacts from a range of invasive species in recent years. As a heavily forested community, dotted with ponds and waterways, the town is susceptible to invasive species including Oriental bittersweet, purple loosestrife, common reed, European buckthorn, Japanese knotweed, Japanese barberry, multiflora rose, Norway maple, honeysuckle, burning bush, and autumn olive. Invasive insect species have also posed a risk for forest health in Groveland. In recent years, the Emerald Ash Borer and other invasive insect species have caused structural decline of trees, impacting forest health and also posing challenges for neighboring utilities and infrastructure due to downed trees. The Town has identified a need for a comprehensive tree management and removal plan to protect roadways and utility lines.

Invasives in Johnsons Creek



Groveland also experiences a range of invasive aquatic plant species as well, including Eurasian water milfoil, variable water milfoil and fanwort. Meadow Pond and Johnsons Pond are two locations within the Town with an abundance of invasive aquatic plants. In 2018, Community Preservation funds supported the removal of invasive plants growing the boat launch at Johnsons Pond. Due to the Town's susceptibility to invasive plant species, and the challenge of managing these invasives, Groveland has assigned a ***high risk*** to the hazard of invasive species.

Brush Fire/Wildfire Hazard

Although nearly half of the Town's land area is forest, incidents of brush fires annually have been low. The Town has experienced a total of 66 brush/wood fires since the last update in 2016, an average of 9 a year.

[113] Massachusetts Emergency Management Agency. 2023. *NFIP Summary Data Report* – 7/25/2023.

These have all been small incidents, with no major fire reported in the last eight years. Groveland officials note potential for major damage to property and have assessed hazard potential as ***moderate risk***.

Natural Hazard Management and Response

Groveland's Fire Department, led by Chief Robert Valentine, operates out of Central Station and South Station with three full-time and 25 on-call firefighters. The Groveland Police Department is led by Chief Jeffrey Gillen, with a team of five Superior Officers, eight full-time patrol officers and five reserve part-time officers. Within the department, Officer Stephen Sargent serves as the Town's Emergency Management Director.

Groveland is part of the Northeast Regional Emergency Planning Committee (REPC) along with the communities of Andover, Hamilton, Haverhill, Lawrence, Methuen, Middleton, North Andover and Wenham. The Town also uses CodeRed, an emergency alert system that sends out time-sensitive community-wide notifications. The Town's Municipal Electric Department and Highway Department provide emergency management support with equipment, communications, and personnel.

Natural Hazards Risk Assessment

The Town of Groveland's risk analysis reviews potential events that, according to Town officials, pose a high, medium, or low risk to the community. On the basis of this analysis, which incorporated the judgment of local emergency management and project planning team personnel, as well as community-based planning efforts such as previous HMPs and MVP plans, Groveland considers itself to be at ***high risk*** from Inland Flooding, drought, severe winter storms, and invasive species; ***medium risk*** hurricanes/tropical storms, high winds/thunderstorms, extreme temperatures, and wildfires; and ***low risk*** from earthquakes, tornadoes, and landslides. As an inland community, Groveland does not consider itself to be impacted by coastal flooding or tsunamis.

Table 5.16 Groveland's risk rating for the 15 natural hazards experienced in the Commonwealth.

Groveland Natural Hazard Risk Rating	
Natural Hazard	**Community Risk Rating**
Inland Flooding	High
Drought	High
Severe Winter Storms	High
Invasive Species	High
Hurricane/Tropical Storm	Moderate
High Winds/ Thunderstorms	Moderate
Extreme Temperatures	Moderate
Wildfires	Moderate
Coastal/Riverine Erosion	Moderate
Earthquake	Low
Tornadoes	Low
Landslide	Low
Coastal Flooding	NA
Tsunami	NA

Continue to page 195 of the Plan to review Groveland's next section: ***Town of Groveland Natural Hazard Challenge Statements.***

5.2.4 City of Haverhill Natural Hazard Risk Assessment

Community Profile


Haverhill City Hall

The City of Haverhill covers an area of 33.0 square miles, defined by its border with New Hampshire to the north, and greatly influenced by the Merrimack River which runs directly through the City. Haverhill contains a wide variety of land uses, ranging from rural agricultural areas to urban areas such as the City's historic downtown center.

According to the U.S. Census Bureau, Haverhill has a resident population of 67,774, with a population density of 2,052 people per square mile and an average household size of 2.53 people.[114] Residents under the age of 18 make up 22.2% of the population, with 14.3% over the age of 65. Haverhill saw an increase of 6,908 people (11.3%) from 2010. Population projections for the City from the UMass Donahue Institute forecast the 2030 population at 69,931 people, an increase of 3% from 2020.[115]

Haverhill is home to three different environmental justice (EJ) populations: minority population, income, and English isolation. According to the Massachusetts Executive Office of Energy and Environmental Affairs, EJ block groups range from 25.5-67.1% minority population; $17,601-47,254 median household income; and 25.1% language isolation.

Haverhill has 17 K-12 schools within the City: two pre-k schools, seven elementary schools, three middle schools, two high schools, and three middle and high schools. A total of 7,950 students were enrolled across all of Haverhill's public Schools during the 2023 school year (excludes Whittier Tech High School). In addition, Haverhill is also home to two colleges: Northern Essex Community College and Northpoint Bible College.

The large majority of residents within the City (>90%) are serviced via public drinking water supply. Surface water is drawn from Crystal Lake, Kenoza Lake, Millvalle Reservoir, Winnekenni Basin, and Round Pond. The City can access additional emergency water supplies from Johnsons Pond, Hovey's Pond, and Chadwick Pond. Haverhill's registered water withdrawal volume is 6.06 million gallons per day (mgd), and permitted withdrawal volume is 1.04 mgd, totaling 7.10 mgd (OSRP, 2018). According to the City's records, the average daily water demand in 2023 was 5.0 mgd. The maximum water demand for a single day that same year was 8.0 mgd on 7/28/2023. Haverhill provides public wastewater services through the Haverhill Wastewater Treatment Plant located on South Porter Street. Gas and electricity are provided to residents through National Grid.

The GIS analysis for the 2024 HMP reports both land cover and land use data derived from the state's most updated 2016 land cover layer.[116] Predominant *land cover* in Haverhill is forest (48%) followed by open land (15%), developed impervious land (15%), wetland (10%), open water (7%), and agricultural land (5%). According to assessor's data, *land use* in Haverhill is primarily residential (40%) and recreational (31%), followed by transportation (10%), open water (7%), commercial/industrial (7%), and agricultural (6%).

[114] United States Census Bureau. 2023. QuickFacts. U.S. Census Bureau QuickFacts: United States
[115] UMass Donahue Institute. 2022. Massachusetts Population Projections. UMass Donahue Institute | Population Projections
[116] MassGIS. 2019. 2016 Land Cover/Land Use. MassGIS Data: 2016 Land Cover/Land Use | Mass.gov

Recent Development and Land Use Changes

Since 2016, the City of Haverhill has initiated 14 major developments: five (5) mixed use, and nine (9) residential (*Table 5.17*). In Haverhill's Master Plan (2020) the City identifies targeting growth where development already exists to help preserve the balance of open and developed spaces within the community. Haverhill's Zoning Code was first adopted in 1971 and amended in 2020 following the City's adoption of Haverhill Vision 2035 master plan. Changes include the adoption of a cluster residential subdivision ordinance, which aims to focus development in downtown sections of the City and protect open space.

Table 5.17 Major development projects in Haverhill initiated since 2016

Haverhill Major Development Projects 2016-2023			
Facility Type	**Street Address**	**Total Housing Units**	**2023 Status**
Mixed use	2 Merrimack St	80	Completed
Residential	505 West Lowell	144	Completed
Mixed Use	24 Essex St	62	Completed
Residential	19 Railroad St	290	Construction
Residential	37 Stevens St	60	Pending/Planning
Mixed Use	2 Washington St	16	Completed
Residential	86 Essex St	46	Permitted
Residential	100 Water St	49	Construction
Residential	887 Boston Rd, 5 buildings	152	Construction
Residential	235 Essex St	27	Permitted
Mixed use	Merrimack St	400+	Planning
Mixed use	145 Oxford Ave	200+	Planning
Residential	85 Water St	113	Planning
Residential	38 Railroad	48	Planning

The City has made significant headway in renovating, adding, and improving recreational and open space locations for the community. This includes full-scale park renovations such as at Swasey Field, Cashman Field, Portland Street Park and Riverside Park. Other facilities such as G.A.R. Park, Bradford Rail Trail and various playgrounds have been upgraded or improved. A total of fifteen (15) new properties have been conserved since the 2016 update, totaling 293 acres of land (*Table 5.18*). Haverhill has diverse open spaces, especially its unique and notable farms and forestlands. Large sections of eastern, western, and southern Haverhill are home to these resource conservation areas.

Haverhill has experienced explosive growth in the last 30 years. With easy access to main corridors including I495, Route 125 and 113 and a developed industrial and retail centers, present day Haverhill provides regional resources for more rural communities such as Merrimac, West Newbury, Groveland, Georgetown, Methuen, North Andover, Boxford, and beyond. As the City experiences increased development pressure for housing, industry, and commercial space, there is also a significant interest to balance protection of recreation and open space.

Table 5.18 Newly conserved or preserved land in Haverhill since 2016

Haverhill Newly Conserved or Preserved Land 2016-2023				
Property Name	**Address/ Parcel**	**Area**	**Owner**	**Year Completed**
97 Corliss Hill Rd	462-204-71B-2	13.725	City of Haverhill, CR held by ECGA*	2022
97 Corliss Hill Rd	462-204-71B	9.035	ECGA, CR held by City of Haverhill	
Brandy Brow Rd	462-202-3	2.86	City of Haverhill by Order of Taking	2023
	462-202-6	1.83		
	462-202-7	4.58		
	462-202-8	2.31		
	462-202-9	2.86		
	462-203-5	2.86		
	462-203-12	1.859		
	462-203-12-2	1.855		
	462-203-12-3	1.78		
	462-8-1	2.65		
	462-8-2	1.83		
	462-8-3	1.83		
	462-8-4	1.83		
	462-8-5	1.83		
	462-204-5	6		
	462-203-11	11.2	City of Haverhill by Order of Taking	2022
Groveland Bridge Rd	464-3-1	25	City of Haverhill by Order of Taking	2021
650 Crystal St	576-436-18	47.76	Privately owned, CR held by ECGA and City of Haverhill	2023
	576-436-18C	2.21		
	576-436-18F	3.8		
450 Crystal St	573-2-6-2	10.000	City of Haverhill	2016
Middle Rd	466-195-12-3	10.710	ECGA	2019
	466-195-14	7.510		
369 Liberty St	573-2-2-1	5.850	ECGA	2019
454 Crystal St	576-436-27	18.460	Owned by ECGA, CR held by City	2023
Kingsbury Av	772-793-42	21.71	ECGA	2017
996 West Lowell Av	589-421-4-2	25.7	Anton Haverhill Realty Trust, CR held by ECGA	2019
Hilldale Av	585-430-5	19.2	ECGA	2019
Snow Rd	589-420-4C	9.7	ECGA	2020
	589-420-4D	2.97		
Montvale Street	778-797-17	6.14	City of Haverhill Con Com	2021
908 West Lowell Ave	589-421-5	4.3	Privately owned, CR held by ECGA	2023

**Essex County Greenbelt Association (ECGA)*

Since the last plan update, changes in development and land use in the City have not impacted Haverhill's risk to natural hazards. While the City has experienced expanded development, impacts have not increased or decreased the risk to resident safety or property. Additional risk has been mitigated through actions to encourage building in already developed areas, promoting smart growth strategies to concentrate development and promote the conservation of open space, as well as restricting development in hazard prone areas. Additionally, efforts to counteract impacts from development through the conservation of open space has allowed the City to increase flood storage, reduce drought and high heat impacts.

Community Lifelines

Table 5.19 Select list of Haverhill's community lifelines (emergency operation centers, hospitals, and shelters)

Haverhill Emergency Operation Centers, Hospitals, and Shelters							
Facility Type	**Common Name**	**Street Address**	**Health Facility Type**	**Average Daily Capacity**	**Maximum Capacity**	**Feeding Capability**	**Emergency Generator Available**
Emergency Operations	Emergency Operations Center (Haverhill PD)	40 Bailey Blvd	N/A	N/A	N/A	N/A	Yes
Hospitals and Healthcare Centers	Holy Family Hospital- Merrimack Valley	140 Lincoln Ave	Hospital	-	108	Yes	Yes
	Whittier Rehabilitation Hospital	76 Summer St	Hospital	45	60	Yes	Yes
	Hannah Duston Healthcare Center	126 Monument St	Rehabilitation	110	116	Yes	Yes
	Oxford Rehabilitation & Health Care Center	689 Main St	Rehabilitation	110	120	Yes	Yes
Emergency Shelters	Haverhill City Hall	4 Summer St	N/A	N/A	40	Yes	Yes
	Haverhill Citizens Center	10 Welcome St	N/A	N/A	100	Yes	No
	Bradford Elementary School	118 Montvale St	N/A	N/A	300	Yes	Yes
	Nettle Middle School	150 Boardman St	N/A	N/A	200	Yes	Yes
	Silver Hill Elementary School	675 Washington St	N/A	N/A	250	Yes	No
	Pentucket Lake Elementary School	252 Concord St	N/A	N/A	250	Yes	Yes
	Haverhill High School	137 Monument St	N/A	N/A	250	Yes	Yes
	Whittier Regional Vocational Tech. High School	115 Amesbury Line Rd	N/A	N/A	1000	Yes	Yes

A select list of community lifelines (emergency operations centers, hospitals/healthcare centers, public shelters) is shown in *Table 5.19*. This list was originally derived from the City's Comprehensive Emergency Management Plan (CEMP) and updated from other community plans and conversations with the LHMPT. The locations of these and other community lifelines in Haverhill were entered by MVPC into an Excel database and subsequently incorporated into MVPC's ArcGIS for use in digital mapping. As part of the plan update, the full list of community lifelines was reviewed and amended to reflect current conditions, as well as to incorporate new facilities and resources. The full list of community lifelines is depicted in the Haverhill map series that is presented in Appendix B of this Plan.

Bridges: The City of Haverhill has 51 bridges within its municipal borders.[117] Of these bridges, 10 are municipally owned, with the remaining 41 bridges owned and maintained by Massachusetts DOT (MassDOT). Haverhill currently has 16 bridges classified as structurally deficient (*Table 5.20)*. Two of these are owned by the City, with the remaining 14 owned by MassDOT. Nine (9) of the 16, just over half, are categorized as waterway bridges, with the other seven (7) intersecting roadways or other features. Two (2) prominent bridges in Haverhill are described below.

Table 5.20 List of Haverhill's structurally deficient bridges as identified by the Massachusetts Dept. of Transportation

Haverhill Structurally Deficient Bridges					
Bridge or Street Name	**Feature Intersected**	**Owner**	**Year Built**	**Structure Category**	**Last Inspection Date**
North Ave	Snows Brook	Municipality	1932	Short Span	5/26/2021
Rosemont Street	Little River	Municipality	1934	Short Span	5/23/2023
Antonio Franciosa Memorial	Merrimack River NB	DOT	1964	NBI	11/13/2023
495 SB	Railroad & Little River EB	DOT	1961	NBI	10/30/2023
495 N	Railroad & Little River WB	DOT	1961	NBI	10/27/2023
495 SB	Amesbury Rd E.	DOT	1964	NBI	5/18/2022
495 NB	Amesbury Rd W.	DOT	1964	NBI	5/18/2022
495 SB	Middle Rd	DOT	1964	NBI	3/23/2023
495 SB	Amesbury Line Rd	DOT	1964	NBI	3/22/2023
Antonio Franciosa Memorial	Merrimack River SB	DOT	1964	NBI	11/15/2023
Amesbury Road	E Meadow River	DOT	1907, improved 1922	Short Span	6/15/2023
PFC Ralph T. Basiliere	Merrimack River	DOT	1925	NBI	12/4/2022
Bridge Street	Railroad (abandoned)	DOT	1850, improved 1968	NBI	2/22/2023
495 SB	Newton Road	DOT	1964	NBI	1/17/2023
Industrial Ave	I 495 NB	DOT	1961	NBI	8/15/2023
Industrial Ave	I 495 SB	DOT	1961	NBI	8/15/2023

PFC Ralph T. Basiliere Bridge: The Route 125 ("Basiliere") Bridge was built in 1925 and has an AASHTO rating of 18.8 (out of 100). This state highway bridge spans the Merrimack River in downtown Haverhill, and is the

[117] MassDOT. 2024. Bridges. Bridges | Bridges | MassDOT Open Data Portal (arcgis.com)

major access route connecting the City's central business district to Bradford and points south. Because Route 125 carries an average traffic load of 30,000 vehicles per day, any closure of the bridge due to flood damage or other natural disaster would have enormous negative consequences on the City's public safety services, economy, and quality of life. The bridge is slated for replacement in 2025 as part of the Transportation Improvement Program (TIP) for the Merrimack Valley Metropolitan Planning Organization. The Antonio Franciosa Memorial Bridge is also planned to be funded as part of the TIP in 2024.

Rocks Village Bridge: The Rocks Village Bridge, which provides a connection between Route 110 in Haverhill and Merrimac and Route 113 in West Newbury and Groveland, *was* previously listed as structurally deficient on the last update. It is a major school bus route that connects the town of Merrimac to the other Pentucket Regional School system communities of Groveland and West Newbury. In addition to carrying the school-related traffic, the bridge is increasingly being used by commuters from southern New Hampshire/eastern Haverhill/western Merrimac to access I-95 in Newburyport.

Constructed in 1883 with major reconstruction in 1914, the Rocks Village Bridge spanning the Merrimack was closed to heavy vehicles such as tractor-trailers as major bridge rehabilitation work took place from Summer 2012 through Fall 2013. A new bridge deck was installed along with stronger guardrails and new lighting. The bridge's piers and ice fenders were repaired as were components of the superstructure. The rehabilitated bridge opened to traffic in fall 2013. In 2022, the bridge experienced significant structural damage following an over-height truck strike. After a series of emergency repairs by MassDOT crews, the bridge was re-opened seven months later.

Dams: The DCR Office of Dam Safety includes 12 Haverhill dams on its dam hazard classification list.[118] Ten (10) of the dams within the City are municipally owned, with two (Whittier and Little River) privately owned. Five dams are classified as significant hazard dams, with one dam classified as High hazard. These six (6) dams are identified and described in *Table 5.21* below. Little River Dam is the only high or significant hazard dam that is privately owned within Haverhill.

Table 5.21 List of Haverhill's Significant and High Hazard Dams as identified by the Massachusetts Office of Dam Safety

Haverhill High and Significant Hazard Dams				
Dam Name	**Impoundment Name** (maximum capacity in acre-feet)	**Year Completed**	**Hazard Class**	**Last Inspection Date**
Crystal Lake Dam	Crystal Lake (1,000 acre-feet)	1930 (rebuilt 2015)	Significant	7/2023
Frye Pond Dam	Frye Pond (90 acre-feet)	1932	Significant	12/14/2023
Kenoza Lake Outlet Dam	Kenoza lake (960 acre-feet)	1980	Significant	10/15/2019
Lake Pentucket Dam	Lake Pentucket (412 acre-feet)	1920	Significant	5/10/2023
Little River Dam	Little River (25 acre-feet)	1870	Significant	6/19/2019
Millvale Reservoir Dam	Millvale Reservoir (558 acre-feet)	1898	High	11/15/2023

[118] MassGIS. 2012. Dams. MassGIS Data: Dams | Mass.gov

To address hazardous dams in the City, Haverhill has been working with state and local partners to seek funding and support for dam removal efforts. In 2023, Haverhill received state approval and funding to begin design and permitting for the removal of Little River Dam. The project is anticipated to take two years and cost between $9-12 million. In addition, the City is also in the permitting process to remove Frye Pond Dam. Removal of both dams is expected to improve water quality and river health, bolster wildlife access, increase recreational activities, and reduce flooding for surrounding communities. All Significant and High Hazard Dams within Haverhill have Emergency Action Plans except for the Lake Pentucket Dam.

Millvale Reservoir Dam: The City has taken steps to manage risk associated with the Millvale Reservoir Dam. Because the Millvale Reservoir Dam is classified as a High Hazard Dam by the DCR Office of Dam Safety, it must be inspected every two years. As the dam owner, the City of Haverhill coordinates directly with the ODS office to ensure timely inspections are conducted and the dam is maintained. The City has an established Emergency Action Plan (EAP) in accordance with the Commonwealth of Massachusetts general Laws, M.G.L. 253, Section 44-49, Chapter 302 CMR. 10.00, "Dam Safety." This plan formalizes the response to an emergency condition at the Millvale Reservoir Dam site. The EAP also includes downstream inundation maps and a dam break analysis to further assess local and regional risk.

The dam breach and flood routing analyses using the HydroCAD model, were conducted through two phases. The first phase consisted of a hydrologic evaluation of the rainfall-runoff characteristics of the upgradient sub-basins, the stage-storage-discharge response of the reservoir and upgradient waterbodies, and the simulation of hypothetical failures of the dam under both dry weather and wet weather conditions. The second phase consisted of a hydraulic evaluation of the potential downstream impacts of the hypothetical dam failures. Under dry weather conditions it was estimated that a dam break would have a maximum discharge of 7,966 cubic feet per second (cfs) causing water surface elevation downstream to increase between 5-15 feet. Wet weather conditions were estimated to have a maximum discharge of 11,393 cfs, causing water surface elevation downstream to increase 0-5 feet above ½ Probably Maximum Flood (PMF) conditions.

The EAP identifies a number of natural hazards that may impact the dam. These include:

- Earthquakes which could cause shifting of structures, cracking, or settlements, which may lead to leakage/dam deformation/seepage/sliding/overtopping/ catastrophic failure.
- Severe storms including precipitation, freezing and thawing, and severe wind which could cause washout and undermining of soil from surrounding bank, washout of soil foundation material below dam, overtopping undermining, shifts in foundation/embankment or abutment slopes, deformation of the dam or outlet, and cracking or shifting of granite masonry blocks.

Millvale Reservoir Dam is located in a residential area, as such there are environmental and societal impacts associated with dam failure. The development downstream of the dam includes residential neighborhoods, roads, utilities, and public safety structures. Additionally, a dam breach is anticipated to impact the City's water supply. Inundation maps for dam failure expand out from the East Meadow River to cover portions of two roadways: Millvale Road and East Broadway, as well as nine dwellings.

The City is committed to ensuring general maintenance and inspection of the Millvale reservoir Dam is conducted, including completing vegetation control around the reservoir and repairs to the upstream surface of the dam. Further, the City intends to ensure the emergency plans and policies remain updated and in place to reduce vulnerability from High Hazard dams in Haverhill.

The City of Haverhill is also responsible for the operation and maintenance of one levee located along Washington Street and Merrimack Street adjacent to the Merrimack River. The levee is 0.4 miles in length and consists of 2,250 linear feet of concrete "T" floodwall and of the Little River pressure conduit, which is ~2,000 linear feet of underground concrete box/arch conduit. The US Army Corps of Engineers (USACOE)

conducted an evaluation of the levee system in 2014 to understand local risk. Results indicate the levee is likely to withstand water to the top of the levee without breaching.[119] However, to date no flood event has tested this limit, with storms only reaching 75% of the levee capacity. If a breach were to occur, inundation depths could be greater than 12 feet and could lead to over $46 million in damages and loss of life. A total of 100 buildings (no critical structures) and 511 people have been identified behind the levee.

Haverhill is also addressing barriers to flow through culvert restoration projects across the City. In 2023, state ecological restoration grant funding was received to address a 1932 culvert on Brandy Brow Road. Efforts will protect the flow of East Meadow River, a major source of drinking water for the City, while also expanding recreational and trail access. MassDOT has also identified three culverts for replacement on Amesbury Road (Route 110) over the tributary of the East Meadow River. This project is currently in the preliminary design phase (MassDOT, 2024).

Community Specific Hazards

Haverhill's LHMPT reviewed the full range of natural hazards that impact Massachusetts, as identified through the State Hazard Mitigation and Climate Adaptation Plan. The majority of the natural hazards considered impact the Merrimack Valley Region in a similar way. For those that have a different or locally-specific impact on the City of Haverhill, additional information has been supplemented in this section.

Flooding

Haverhill is fully located in the Merrimack River watershed. The City itself is bisected by the mainstem of the Merrimack River and is subject to flooding at select locations under particularly high river flow conditions.

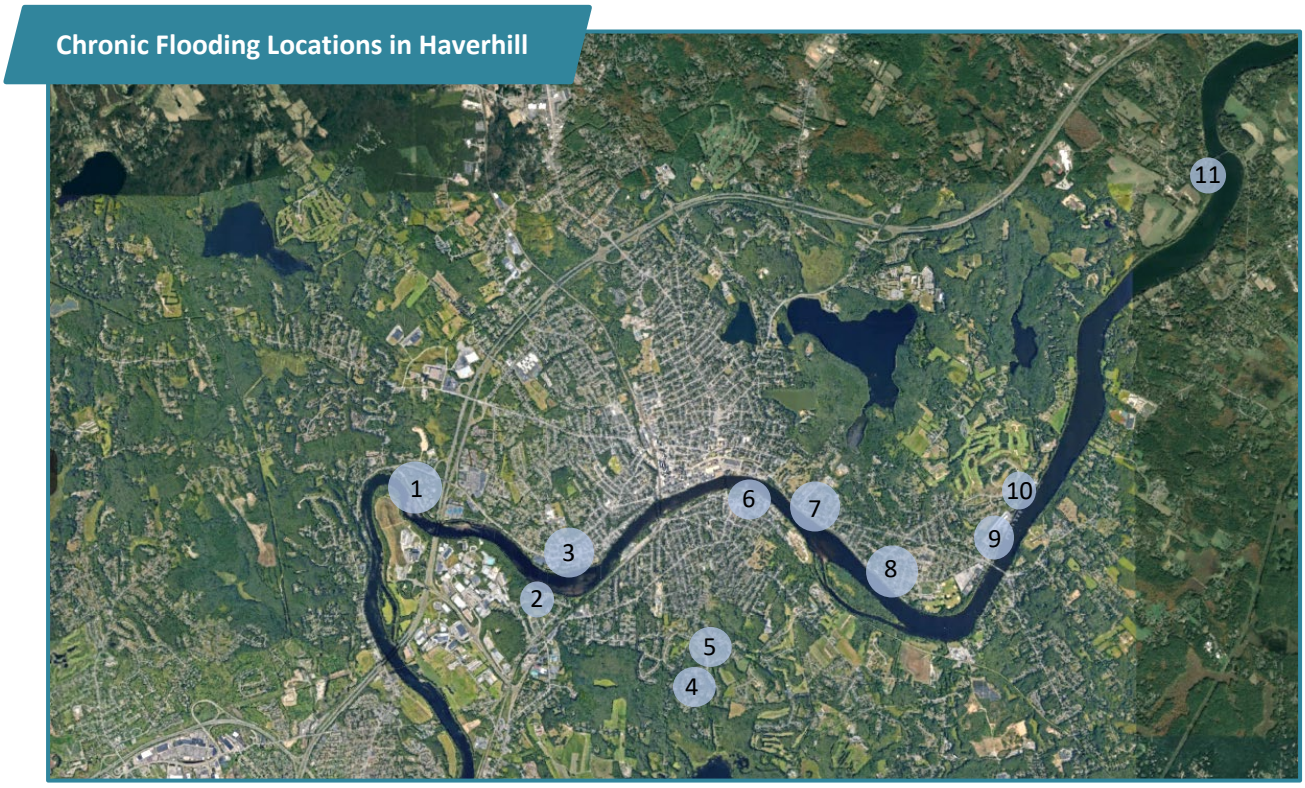


Figure 5.2 Chronic flooding locations identified across Haverhill by the Local Hazard Mitigation Planning Team.

[119] US Army Corps of Engineers. 2024. National Levee Database. National Levee Database (army.mil)

The floodplains of several of the Merrimack's tributary streams, including the Little River, East Meadow River, and Snow's Brook, are also subject to occasional flooding. In addition, there are numerous dispersed surface water and wetland areas, as well as poorly-draining low spots, where runoff water collects during high intensity/long duration rain events and periodically floods adjoining roads and properties.

Areas of Common Flooding: Haverhill emergency management officials have identified the following 11 flood-prone areas (*Figure 5.2*): 1.Lower River Street (Route 110) along Western Avenue; 2. Cove Road and Riverdale Avenue (Bradford); 3. Upper River Street along Margin Street; 4. South Elm Street; 5. Middlesex Street; 6. South River Street (Bradford); 7. Water Street; 8. Lincoln Avenue Neighborhood including lower Jefferson Street, lower Adams Street, lower Munroe Street and Polk Street; 9. Areas near Groveland Bridge including Riverside Ave, Coffins Ave, Old Ferry Road, Ordway Street, and Groveland Street; 10. East Broadway; 11. Wharf Lane.

All 11 of the areas identified in Haverhill are located along the Merrimack River. The river remains unrestricted upstream until the Great Stone Dam in Lawrence, and is therefore tidally influenced throughout Haverhill. Haverhill experiences common riverine flooding when high tide aligns with severe storm events, causing heightened river elevation and overtopping leading to flooding events.

Flooding in Haverhill during 2006 Mother's Day

The City was especially hard hit during the Mother's Day Flood of May 2006, when the Merrimack River overtopped its banks at the Water Street (Rt. 97)/Groveland Street intersection, forcing the closure of this heavily traveled east-west route through the community. During the same storm event, numerous other City roads were flooded and ordered closed when ponds and tributary streams overflowed their banks. These areas included: Crystal Lake (Lake St, Crystal St, Liberty St all closed); East Meadow River (6 roads closed); Little River (Rosemont St closed); and Snow's Brook (North Ave at the Haverhill Country Club closed).

More recently, on August 8th, 2023, Haverhill, along with a number of other Merrimack Valley Communities, experienced severe flooding when over 6 inches of rain fell within the region over the course of 6 hours. Widespread damage caused Mayor Fiorentini to declare a state of emergency in Haverhill. Buildings in the Riverside area experienced significant flooding and basement backups. A twenty-feet wide and twenty-feet deep sinkhole opened near Washington and Ford Street, forcing evacuations of local residents. Haverhill also experienced impacts to the City's infrastructure including the municipal combined sewer system. The City submitted claims for flood damage in three categories totaling $8.5 million to the Massachusetts Emergency Management Agency, but did not qualify for funding. To support Haverhill residents, the City established a Flood Damage Relief

Sinkhole in Haverhill, August 2023

program, allocating $300,000 in American Rescue Plan Act (ARPA) and State & Local Relief Funds (SLRF) to help residents recover from flood damages.

Flood Vulnerability Assessment: A GIS analysis of the City's FIRM flood hazard areas by MVPC has determined that 3,628 (5.67 sq. mi.) of land area in Haverhill is located within the 100-Year floodplain and thus is vulnerable to flooding. An additional 847 acres (1.32 sq. mi.) lies within the 500-Year floodplain. Together, these two flood zones constitute almost twenty percent (19.6%) of the total area of the community. Development of this open space would increase the impervious surface cover and stormwater runoff, thereby exacerbating the existing flooding problems.

As part of the mapping analysis, MVPC also identified the number of buildings located within the floodplain. A total of 1,219 buildings (5.5% of all buildings) are located within floodplains, collectively valued at $426.1 million. Of these buildings, 21 are considered critical facilities and thus are at risk of future flood damage or loss (*Table 5.22*). The collective value of critical facilities within floodplains is $22.4 million. The number of community lifelines identified within floodplains in this plan update is higher than 2016, which identified 11 critical facilities. This is a reflection of the 2023 update incorporating new FIRM maps, as well as the expanded definition of Community Lifelines used, which include a broader range of services compared to the 2016 plan. According to City officials, there are no current plans to site other critical facilities in the 100-year and 500-year flood zones with the exception of possible water supply facilities along the Merrimack River on East Broadway.

Table 5.22 List of Community Lifelines located across Haverhill within the 100- and 500-year

Haverhill Critical Facilities in Flood Hazard Areas

100-Year Floodplain

Facility Type	Name	Generator
Bus Station	Washington Square Transit Center	No
Elderly Housing	Phoenix Row Apartments	Yes
Elderly Housing	Washington Square Elderly Housing	Yes
Bus Facility	Merrimack Valley Regional Transit Authority	No
Sewage Pumping Station	Marginal Wastewater Pumping Station	No
Power Substation	Mass. Electric Company	No
Fire Station	Haverhill Fire Dept- Water Street Station	No
Community Organization	Community Action, Inc.	No
Subsidized Housing	Washington Square Housing	Yes
Subsidized Housing	The Phoenix	Yes
Subsidized Housing	Harbor Place	No
Subsidized Housing	25 Washington Square	Yes
3 Sewer Pump Stations	LS 18: Dutton Rd., LS 24: River St., LS 26: Flooded Suction	Yes

500-Year Floodplain

Facility Type	Name	Generator
Daycare Facility	N/A	No
Pre-school	Moody Early Childhood Center	No
Community Organization	Ruth's House	No
Subsidized Housing	Mission Towers	Yes
2 Sewer Pump Stations	LS 23: Rosemont St., LS2: Twin Brook Cir.	Yes

NFIP Information: Haverhill actively participates in the National Flood Insurance Program (NFIP). The City's initial Flood Hazard Boundary Map (NHBM) was identified in 1974, and the initial Flood Insurance Rate Map (FIRM) was identified in 1983. The latest effective FIRM was adopted in 2018. The Flood Hazard Management Program anticipates a new FIRM and Flood Insurance Study (FIS) will be available for adoption in 2024. Haverhill intends to update their local regulations to adopt the new maps and study ahead of the effective

date, anticipated in summer 2025. This will require updating Haverhill's Zoning Ordinance, where minimum floodplain management criteria appear. To ensure implementation and enforcement of local floodplain management regulations in Special Flood Hazard Areas (SFHAs), the City has added SFHAs to the City's GIS maps, and requires that building permits issued in SFHA obtain elevation certificates. In Haverhill, the City Building Commissioner serves as the enforcement officer, charged with compliance of the NFIP requirements. Following an event, substantial improvements/substantial damage provisions are assessed and managed by the City Building Commissioner.

Haverhill carries out a broad array of floodplain management activities in compliance with the requirements of the NFIP. They also began participating in the Community Rating System (CRS) program in 1992, and currently maintain a status as a Class 9 and receive a 5% discount on SFHAs and non-SFHAs.

The Massachusetts Emergency Management Association (MEMA) reports that as of July 2023, there are 287 properties in Haverhill with flood insurance policies in place.[120] The total insurance value of these properties is $59,595,000. Additionally, there are 233 policies in force within Special Flood Hazard Areas (SFHA) with a total insurance value of $39,609,000. According to data provided by the MA Department of Conservation and Recreation, there are fifteen (15) repetitive loss locations in Haverhill. All of the sites except for one are residential properties. Together, these 15 sites have resulted in the payout of 33 National Flood Insurance Program claims totaling $1,258,549. According to the City's former emergency management director, these repetitive losses stem both from periodic larger-scale *riverine* flooding of the Merrimack River and its tributaries and from recurring localized drainage problems.

Based on the frequency, areal extent, and severity of historical floods in Haverhill, City officials consider the community to be at ***high risk*** from flooding.

CSO Events

In addition to flooding, another major challenge posed by intensive precipitation is combined sewer overflow (CSO) events. Haverhill's infrastructure uses both separate and combined sewer pipes, with combined pipes accounting for about 20% of the sewer area (1,500 acres). There are a total of 13 active CSO outfalls that discharge to the Merrimack or Little River within Haverhill. The City has continuously monitored CSO outfalls since 2014. Overflow volumes fluctuate dramatically between years due to precipitation levels. In 2022, a historically dry year, reports indicated 10.8 million gallons of overflow from Haverhill. Whereas one year previously in 2021, 48.1 million gallons were discharged. In 2023, a historic year for CSO discharge due to the frequent storm events, Haverhill discharged a record 97.3 million gallons in 2023.

As climate change continues to cause more intense and frequent precipitation events, CSOs pose a greater risk for Haverhill and the other surrounding communities. Stormwater infrastructure is not designed to handle the intensity and severity of storms we are currently experiencing. In the 2006 Mother's Day flood heavy rains caused the failure of a 42" forced main failure near the Wastewater Plant. The forced main failure cost the City $1.5 million dollars and resulted in raw sewage entering the Merrimack River for a week while repairs were made. More recently, extreme precipitation in August 2023 caused numerous basement backups and flooding, leading to damage of residences and businesses across the City. The August storm also led to the failure of a sewer line between Washington Street and River Street, resulting in ~$1.3 million in damage and lengthy repairs.

To combat this risk, the City is actively working to address CSOs. As part of the CSO Abatement Program, the City completed Phase 1 ($22 million) in 2006 which reduced CSO volume by 57%. Haverhill completed Phase

[120] Massachusetts Emergency Management Agency. 2023. *NFIP Summary Data Report* – 7/25/2023.

II ($12 million) in 2017, reducing its new CSO volume by another 30%. The City is currently in Phase III (expected cost of $40 million) focused on the Locke Street area sewer separation, anticipated to take 9 years. With each completed phase, the City is making small and large-scale improvements to reduce its annual discharge. Following Phase III, the City acknowledges that numerous locations across Haverhill will still need to undergo separation to address the CSO challenge.

Due to the risk that heavy precipitation poses to public health and safety as well as environmental health, the City of Haverhill is committed to reducing CSO discharge events in the City. To meet this goal, Haverhill will continue to seek financial support and technical assistance to pair with local resources to improve technology, infrastructure, and management of this hazard.

Riverine Erosion

Another major challenge stemming from intensive precipitation and storm events is riverine erosion. In recent years, Haverhill has experienced significant bank erosion at locations along the Merrimack River. The City, in collaboration with public and private entities, has taken steps to address and minimize this hazard.

The Merrimack riverbank adjacent to Riverside and Coffin Avenues is owned and maintained by the City of Haverhill. During the May 2006 flood event, rapidly-moving, debris-laden floodwaters rose to the top of the riverbank, causing severe erosion to a 10-foot section of Riverside Avenue. A 54-inch sewer interceptor located in the center of Riverside Avenue became vulnerable to rupturing. The 2006 floodwaters also caused significant erosion adjacent to a sewer lift station at Coffin Avenue. The City acted to address this problem through a riverbank stabilization project, in which the eroded areas adjacent to the Riverside Avenue interceptor and the Coffin Avenue sewer lift station were outfitted with protective bio-vegetation mats and riprap. The first phase of the Riverbank Stabilization Project was completed in June 2011 at a cost of $489,000. The City received a Hazard Mitigation Grant from the Massachusetts Emergency Management Agency to cover 75% of the project cost.

Continued erosion along the Merrimack resulted in another site of major restoration in Haverhill along Railroad Avenue in 2018. The site is the headquarters for MeVa, the Merrimack Valley's public transit provider. Significant bank erosion threatening key infrastructure was first noticed in 2018. Following three years of permitting, bank stabilization and restoration was started in 2022. A total of 500 feet of riverbank was restored using steel pilings, a 9-foot-high terraced wall of interlocking blocks, backfill, and topped with biodegradable matting, rip rap, and native plants. The project itself cost $3.2 million which was funded by the Federal Transit Authority (80%) and MassDOT (20%). Currently, a number of areas along the river remain at risk. Notably, sections of River Street, which are privately owned.

Extreme Temperatures

While the Merrimack Valley, like the rest of the region, is experiencing greater extreme heat, Haverhill and other more developed communities within the region are feeling the effects to a greater degree. Impervious surfaces such as pavement and roofs absorb and re-emit heat more than natural landscapes such as grass and trees. This results in urban areas maintaining more heat which can lead to a cascade of effects including increased energy consumption, air pollution, greenhouse gas emissions, and health problems. In 2018, Haverhill schools released students early twice due to extreme heat. With climate change predicted to cause more extreme summer temperatures, communities like Haverhill will continue to be impacted.

To combat this challenge, Haverhill has participated in the State's Urban and Community Forestry Greening the Gateway Cities Program since 2012. This program is focused on increasing tree canopy cover in urban residential areas. Haverhill received Department of Conservation and Recreation (DCR) grants in 2023 and

2024 ($100,000 each year) to continue the effort. The City has shown additional commitments to this goal through the creation of a Forest Management Committee (FMG), and multiple partnerships with groups such as Urban Ecological Institute and Mass Audubon's Ecological Extension Services.

Natural Hazard Management and Response

The Haverhill Fire Department has a total of 97 full-time personnel led by Chief Robert O'Brien. The Police Department has a total of 105 full-time personnel led by Chief Robert Pistone. The Haverhill Department of Public Works, responsible for overseeing the operations and maintenance of critical community lifelines, is supported by 109 full-time employees. Emergency response staff in the City are committed to assisting in the event of any relevant emergency situation.

Natural Hazards Risk Assessment

Through using the City of Haverhill's previous Hazard Mitigation Plan, in association with other planning documents including Haverhill's Comprehensive Emergency Management Plan, and Municipal Vulnerability plan, natural hazards for the City were considered. On the basis of this analysis, Haverhill considers itself to be at ***high risk*** from floods, severe winter storms (blizzards/snow/ice storms), extreme temperatures, hurricanes/tropical storms, and high winds/thunderstorms; ***moderate risk*** from droughts, erosion, wildfire, and invasive species; and ***low risk*** from earthquakes, landslides, and tornadoes. Because Haverhill is not located on the coast, it does not consider itself to be at risk from coastal flooding or tsunamis.

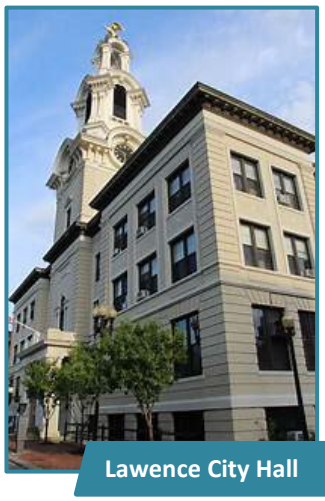
Table 5.23 Haverhill's risk rating for the 15 natural hazards experienced in the Commonwealth.

Haverhill Natural Hazard Risk Rating	
Natural Hazard	**Community Risk Rating**
Inland Flooding	High
Severe Winter Storms	High
Extreme Temperatures	High
Hurricane/Tropical Storm	High
High Winds/ Thunderstorms	High
Drought	Moderate
Coastal/Riverine Erosion	Moderate
Wildfires	Moderate
Invasive Species	Moderate
Earthquake	Low
Landslide	Low
Tornadoes	Low
Tsunami	NA
Coastal Flooding	NA

Continue to page 196 of the Plan to review Haverhill's next section: ***City of Haverhill Natural Hazard Challenge Statements.***

5.2.5 City of Lawrence Natural Hazard Risk Assessment

Community Profile


Lawence City Hall

The City of Lawrence was established in 1856 at the confluence of three rivers, the Merrimack, Shawsheen and Spicket Rivers. One of the nation's first planned communities, Lawrence covers a land area of 6.9 square miles and has a resident population of 89,143.[121,122] The City has the highest population density (12,861 persons per sq. mi.) in the Merrimack Valley region, and among the highest in the Commonwealth. There are a total of 30,291 housing units within the City, with an average household size of 2.86 people. Between 2010 and 2020, the population of Lawrence increased by 16.7% (12,766 people). Population projections for Lawrence from the UMass Donahue Institute forecast the 2030 City population of 96,484 people, an increase of 8.2% from 2020.[123]

The Lawrence Public School system has a pupil enrollment of 12,500. The district includes five early childhood centers, ten elementary schools, six middle schools and eight high schools (located in four buildings), opened in 2007, on a 42-acre campus on North Parish Road. The City also has a number of private parochial and charter schools.

Lawrence is home to four different environmental justice (EJ) populations: 1) minority population, 2) minority population and income, 3) minority population and English isolation, and 4) minority income, income, and English isolation.[124] All of Lawrence's census block groups meet with Executive Office of Energy and Environmental Affairs (EEA) criteria as Environmental Justice (EJ) areas, meaning 100% of residents fall within one of the four groups listed above. According to the EEA, EJ block groups within Lawrence range from 56-99% minority population; 26-59% language isolation and have a median household income of $13,363-53,125.

The GIS analysis for the 2024 HMP reports both land cover and land use data derived from the state's most updated 2016 land cover layer.[125] Predominant *land cover* in Lawrence is developed impervious land (53%), followed by forest (22%), open land (16%), open water (5%), wetlands (4%), and agricultural land (<1%). According to assessor's data, *land use* in Haverhill is primarily residential (40%) and recreational (31%), followed by transportation (10%), open water (6%), commercial/industrial (6%), and agricultural (6%).

The City is served by a municipal water supply system and centralized sewage treatment plant. Lawrence provides public drinking water exclusively from the Merrimack River via an 8 million gallons per day (mgd) water treatment plant. The current average water use is 6.5 mgd. The City also provides extensive sewer service and wastewater treatment via the 52-mgd Greater Lawrence Sanitary District (GLSD), which also serves the communities of Methuen, Andover, and North Andover in Massachusetts, and Salem in New Hampshire. GLSD processes an average of 135,000 gallons of wastewater sludge and 48,000 pounds of septage per day. Anaerobic digesters on site process the waste, resulting in biogas to run the plant and to dry biosolids into pathogen-free pelletized fertilizers. Gas is provided by Eversource Energy and electricity is provided by National Grid.

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[121] United States Census Bureau. 2023. QuickFacts. U.S. Census Bureau QuickFacts: United States

[122] NOTE: The City of Lawrence estimates the actual population closer to 100,000 individuals.

[123] UMass Donahue Institute. 2022. Massachusetts Population Projections. UMass Donahue Institute | Population Projections

[124] Massachusetts Executive Office of Energy and Environmental Affairs. 2022. Environmental Justice Populations in Massachusetts. Massachusetts 2020 Environmental Justice Populations (arcgis.com)

[125] MassGIS. 2019. 2016 Land Cover/Land Use. MassGIS Data: 2016 Land Cover/Land Use | Mass.gov

Recent Development and Land Use Changes

The City of Lawrence is a planned industrial community with a compact downtown, historic mill buildings, and common open space. Due to its industrial past, and dense population, Lawrence is a largely developed community. Since the 2016 update, Lawrence has initiated 46 large developments, of which 23 have been residential, 12 have been mixed-use, four have been commercial, four have been municipal, two have been industrial, and two have been healthcare related (*Table 5.24)*.

The City has also experienced 15 base changes and one overlay change since the last update. Of the 15 base changes, three were to establish Business Districts, one to establish a Highway district, four to establish Industrial districts, three to establish residential districts, and four to establish Open Space and Recreation districts. The overlay change was made to establish a Downtown Smart Growth Overlay District.

Table 5.24 Major development projects in Lawrence initiated since 2016.

Lawrence Major Development Projects 2016-2023					
Facility Type	**Common Name**	**Street Address**	**Sq Feet**	**Total Housing Units**	**Current Status**
Residential	Island Parkside	30 Island St.	26,030	40	In Process (5%)
Residential	Fabrica Lofts	608 Broadway	119,078	87	In Process (75%)
Residential	Van Brodie Bldg	590 Broadway #B	49,300	54	Complete
Residential	Trinity	582 Broadway #C	44,578	46	Complete
Residential	Loftfive 50 Apts	550-600 Broadway	175,743	75	Complete
Residential	MM Lawrence ii Lmtd	540-542 Broadway	97,086	62	Complete
Residential	Pacific Mills Lofts	300 Canal St. #1	437,842	176	Complete
Residential	Pacific Mills Lofts	300 Canal St. #6	104,344	81	Complete
Residential	Pacific Mills Lofts	300 Canal St. #8	144,000	88	Complete
Residential	LCW	50 Island St. #1	81,747	60	Complete
Residential	IP Phase ii LLC	30 Island St.	26,030	40	Under Contract
Residential	Island Parkside Housing	20 Island St.	49,900	40	35
Residential	Taom Pacific i	300 Methuen St. #1	397,155	180	Complete
Residential	Taom Pacific ii	300 Methuen St. #2	118,980	96	In Process (0%)
Residential	Chestnut Place LLC	121 Chestnut St.	39,548	28	Complete
Residential	Island Parkside LLC	20 Island St.	49,900	40	Complete
Residential	Mill 240 Apts	240-242 Canal St.	335,954	280	Complete
Residential	Riverwalk Lofts	250 Merrimack St.	357,000	338	Complete
Residential	Methuen Street Realty	578 Essex St.	35,490	28	Complete
Residential	Formerly a boxing gym	369 Haverhill St.	45,965	30	Complete
Residential	The Duck Mill Apts	4 Union St.	128,320	77	Complete
Residential	The Millex Apts	136-140 Essex St.	46,438	28	Complete
Residential	Riverwalk Lofts	1 So. Union St.	168,000	56	Complete
Healthcare	GLCAC Child Care Center	585 Andover St.	17,220	1	Complete
Healthcare	Unitex	155 Shepard St.	180,000	1	Complete
Commercial	Commonwealth Chevrolet	155 Marston St.	32,043	NA	Complete
Commercial	Enterprise	207b Marston St.	5,408	NA	Complete
Industrial	280 Riverwalk Development	280 Merrimack St.	369,898	37	Complete

Lawrence Major Development Projects 2016-2023					
Facility Type	**Common Name**	**Street Address**	**Sq Feet**	**Total Housing Units**	**Current Status**
Industrial	Safstor Essex LLC	600 Essex St.	2,614	2	Under Contract
Commercial	Pavilion Riverwalk Field	282 Merrimack St.	334,230	1	Complete
Commercial	Haffners Gas	423 Merrimack St.	6,168	NA	Complete
Mixed-Use	Yepez/Bell Tower	215 Canal St.	46,434	31 RES.+ 3 COMM.	In Process (90%)
Mixed-Use	TMJJ LLC	226-232 Common St.	62,496	41 RES. + 1 COMM.	Complete
Mixed-Use	Levis	215 Canal St.	46,434	31 RES. + 3 COMM	In Process (70%)
Mixed-Use	Common Realty LLC	170-180 Common St.	39,008	20 RES. + 5 COMM.	Complete
Mixed-Use	Lofts at 182 Common	182 Common St.	15,000	10 RES. + 1 COMM.	Complete
Mixed-Use	Markarian Properties	225 Essex St.	41,870	116 RES. + 14 COMM.	Complete
Mixed-Use	276 Essex Street LLC	276-280 Essex St.	27,332	16 RES. +2 COMM.	In Process (45%)
Mixed-Use	GLCAC	370 Essex St.	23,400	44	In Process (39%)
Mixed-Use	Selva LLC	440-442 Essex St.	19,434	42	In Process (50%)
Mixed-Use	EB Associates LLC	582-590 Essex St.	52,754	30 RES. + 7 COMM.	Complete
Mixed-Use	Sullivan Bldg	9-17 Appleton St.	26,250	18 RES. + 3 COMM.	Complete
Mixed-Use	The Jav Apts	115 Essex St.	29,400	24 RES. + 1 COMM.	In Process (25%)
Municipal	Museum Sq. Garage	1 Appleton St.	133,548	NA	Complete
Municipal	Oliver School	183 Haverhill St.	99,464	NA	Under Contract
Municipal	Leahy School	100 Erving Ave.	44,456	NA	Under Contract

Lawrence is also working to maintain and expand open space within the City. Lawrence has a large park system comprising of 48 city parks (340 acres), 3 park units operated by the Department of Conservation and Recreation (46 acres) and 3 municipally managed cemeteries (140 acres). In its OSRP, the City identifies a goal to prioritize the development of a connected network of parks and open spaces through the creation of greenways and rail trails. In 2019, the City acquired a lease from the MBTA for construction of the Lawrence-Manchester Rail Corridor (LMRC) to establish an Open Space Recreational Multi-modal trail. The City is actively working to develop the corridor with an anticipated completion date of 2026.

Through its partnership with Groundwork Lawrence, the City has also made significant improvements to parks and open spaces to bolster climate adaptation and resiliency. These projects include green stormwater infrastructure and the installation of rain gardens at Storrow Park and O'Neill Parks; comprehensive upgrades to Stockton Park; and habitat restoration and playground expansion at Donovan park. Through the Groundwork Lawrence Green Streets Urban Forestry Program, a total of 2,787 new trees have also been planted at 667 public spaces across the City since 2016 in parks, streetscapes, and at public schools. The City of Lawrence has also been working to increase access to green spaces across the City while reducing emissions through establishing Electric Bike Libraries in partnership with Metro Mobility. Currently the City has two libraries which offer a total of 20 bikes to residents and visitors.

Since the 2016 update, a total of three properties have been conserved, totaling 22.9 acres across the City (*Table 5.25)*.

Table 5.25 Newly conserved or preserved land in Lawrence since 2016.

Lawrence Newly Conserved or Preserved Land 2016-2023				
Property Name	**Address**	**Area (acres)**	**Year Completed**	**Landowner/CR Holder**
Jacques Pond	Devonshire St.	10	2017 (re-zoned from Residential to OSC)	City of Lawrence/ managed by ConCom
Spicket River Bank	Along Spicket River	6	2018 (re-zoned from Residential to OSC)	City of Lawrence/ managed by ConCom
O'Neill Park	65 Lawrence Street	6.9	2020 (re-zoned from Commercial/ Residential to OSR)	City of Lawrence/ managed by Recreation Dept.

**OSC, Open Space Conservation*

Since the last plan update, changes in development and land use in the City have impacted Lawrence's risk to natural hazards in both positive and negative ways. The City's growth in recent years has exceeded expectations, resulting in a greater demand for housing growth and development. Using its three Smart Growth Overlay Districts, the City has been able to promote new smart development in certain areas of Lawrence, resulting in condensed development and preservation of open space which provides vital benefits to Lawrence (e.g. flood storage, reduction in extreme heat, drought, and storm events). In older parts of the City that are already developed, increased growth has resulted in new housing being developed in basements, attics, and other vulnerable locations—leading to greater impacts from major storm events, flooding, and extreme temperatures. The mandate to increase accessory dwelling units in Lawrence has also increased risk to neighborhoods that may be located in already vulnerable locations near rivers, wetlands, or on steep slopes. Overall, due to both positive and negative impacts from land use change and development, the City feels they have experienced no net change in risk since the last plan update.

Community Lifelines

A select list of community lifelines (emergency operations centers, hospitals/healthcare centers, public shelters) is shown in *Table 5.26* and was originally derived from the City's Comprehensive Emergency Management Plan (CEMP) and updated from other community plans and conversations with the LHMPT. The locations of these and other community lifelines in Lawrence were entered by MVPC into an Excel database and subsequently incorporated into MVPC's ArcGIS for use in digital mapping. As part of the plan update, the full list of community lifelines was reviewed and amended to reflect current conditions, as well as to incorporate new facilities and resources. The full list of community lifelines is depicted in the Lawrence map series that is presented in Appendix B of this Plan.

Table 5.26 Select list of Lawrence's community lifelines (emergency operation centers, hospitals, and shelters).

Lawrence Emergency Operation Centers, Hospitals, and Shelters							
Facility Type	**Common Name**	**Street Address**	**Health Facility Type**	**Average Daily Capacity**	**Max Capacity**	**Feeding Capability**	**Emergency Generator Available**
Emergency Operations	Emergency Operations Center	90 Lowell St.	N/A	N/A	N/A	N/A	Yes
	Lawrence Fire Alarm Headquarters	66 Bodwell St.	N/A	N/A	N/A	N/A	Yes
Hospitals and Healthcare Centers	Lawrence General Hospital	1 General St.	Hospital	350-500	1,000	Yes	Yes
	Greater Lawrence Family Health	34 Haverhill St.	Healthcare Center	200-400	400	No	Yes
	Greater Lawrence Family Health	150 Park St.	Healthcare Center	200-400	400	No	Yes
	Greater Lawrence Family Health	73 Winthrop Ave	Healthcare Center	200-400	400	No	No
	Greater Lawrence Family Health	700 Essex St.	Healthcare Center	200-400	400	No	No
	Kronos Health	360 Merrimack St.	Healthcare Center	-	-	-	-
Hospitals and Healthcare Centers	MGH Brigham Express Care	370 Merrimack St.	Urgent Care	63	100	No	-
	Pentucket Medical Riverwalk Clinic MGH Brigham	500 Merrimack St.	Healthcare Center	322	403	No	-
	Merrimack Medical & Walk-In Healthcare Center	25 Marston St.	Rehabilitation Center	70-105	150	No	-
Emergency Shelters	Daybreak Shelter	91 Winter St.	Shelter	45	50	Yes	No
	Heading Home	555 South Union St.	Shelter	90	103	No	No
	Lazarus House	Holley St.	Shelter	22	41	Yes	Yes
	Casa Nueva Vida	57 Jackson St.	Shelter	20	20	Yes	No
	Windsor House	248 Broadway	Shelter	51	65	No	Yes
	South Lawrence East Elementary	165 Crawford St.	Emergency Shelter	1,300	200	Yes	Yes
	Arlington Elementary	150 Arlington St.	Emergency Shelter	1,300	200	Yes	Yes

Critical Infrastructure

Bridges: Lawrence has a total of 44 bridges within its municipal borders.[126] The City owns 16 of these bridges, with the Massachusetts Department of Transportation (MassDOT) owning the remaining 28. The majority of bridges in Lawrence (25) provide passage over water features including the Merrimack, Spicket, and Shawsheen Rivers. The other nineteen (19) intersect roads including I-495 and ST-114. Currently, ten (10) bridges in Lawrence are listed as structurally deficient. Three of these bridges are owned and operated by the

[126] MassDOT. 2024. Bridges. Bridges | Bridges | MassDOT Open Data Portal (arcgis.com)

City of Lawrence (Mann Bridge, Majowicz Bridge, and Mario Lucchesi Memorial Bridge), with the remaining seven owned and operated by MassDOT. A list of structurally deficient bridges has been included in *Table 5.27*.

Table 5.27 List of Lawrence's structurally deficient bridges as identified by the Massachusetts Dept of Transportation.

Lawrence Structurally Deficient Bridges					
Bridge Name	**Feature Intersected**	**Owner**	**Year Built/ Improved**	**Bridge Type**	**Last Inspection Date**
Mann Bridge (Parker St.)	South Canal	Municipality	1918	NBI	10/30/2022
Majowicz Bridge	Spicket River	Municipality	1850/1938	NBI	9/19/2022
Mario Lucchesi Memorial Bridge	North Canal	Municipality	1860/1939	NBI	10/12/2021
Charles F. Nyhan Sr Bridge	MBTA/BMRR	MassDOT	1928/1997	NBI	9/22/2023
Lowell Street Bridge	BMRR (abandoned)	MassDOT	1927/1987	NBI	11/27/2023
101 off Ramp from I495	Merrimack St. & MBTA	MassDOT	1963	NBI	12/6/2021
Rev. James T. O'Reilly Mem Bridge	I495 lower level	MassDOT	1962/2006	NBI	9/25/2023
I495 Lower Level	Merrimack River	MassDOT	1962	NBI	10/10/2022
I495 NB	Highway Ramps A&B	MassDOT	1962/2002	NBI	12/12/2022
I495 SB	Highway Ramps A&B	MassDOT	1962/2002	NBI	12/13/2022
Route 28 (near Stevens Pond)	Spicket River	MassDOT	1900/1949	NBI	7/4/2022

Two of the three municipally owned bridges, Mario Lucchesi and Majowicz, are in need of critical repair. Both bridges currently have sidewalk closures, forcing pedestrians into the street to cross the bridge. This is a concern on the Lucchesi bridge, which is a highly trafficked corridor and on the Majowicz bridge, which is located between two schools. In 2022, $3 million in funding was folded in to the State's clean energy bill to conduct improvements to three (3) Lawrence bridges. These bridges included the Mario Lucchesi Memorial Bridge, the Majowicz Bridge, and the O'Reilly Memorial bridge. The Majowicz Bridge has also been scheduled on the Transportation Improvement Plan (TIP) for the Merrimack Valley Metropolitan Planning Organization for 2026. The Mario Lucchesi Memorial Bridge and O'Reilly Memorial Bridge are both listed in the preliminary design phase on the TIP. Additional funding to complete these infrastructure updates is still being sought at the local and state level.

Dams: The DCR Office of Dam Safety includes three operating and regulated Lawrence dams on its dam classification list: the Great Stone Dam (also called "Essex Dam"), Lower Locks Dam ("North Canal Outlet Dam") and the Stevens Pond Outlet Dam.[127] Two other formerly active dams—the Lawrence Reservoir Dam and the Spicket River Dam—are no longer operational. The Lawrence Reservoir was converted to a municipal drinking water storage tank and the Spicket River Dam, built of granite block, has been dismantled providing free flow of the Spicket in Lawrence. Of the Lawrence dams in operation, one, the Stevens Pond Outlet Dam, is listed as a High Hazard dam (*Table 5.28)*. The City has an Emergency Action Plan (EAP) for the dam which was issued in January 2019.

The massive Great Stone Dam, spanning the Merrimack River mainstem, is a hydropower generation facility, and as such is not regulated by the state DCR but rather by the Federal Energy Regulatory Commission (FERC). According to FERC officials, the dam is inspected every three years and is classified as a low hazard dam. The dam is also currently undergoing relicensing through FERC, allowing for an opportunity for local stakeholders to provide commentary on the dam's functionality and any management or monitoring recommendations.

[127] MassGIS. 2012. Dams. MassGIS Data: Dams | Mass.gov

Table 5.28 List of Lawrence's Significant and High Hazard Dams as identified by the Massachusetts Office of Dam Safety

Lawence High and Significant Hazard Dams				
Dam Name	**Impoundment Name** (maximum capacity in acre-feet)	**Year Completed**	**Hazard Class**	**Last Inspection Date**
Stevens Pond Outlet Dam	Stevens Pond (112 acre-feet)	1877	High	6/4/2020

Stevens Pond Outlet Dam: The City has taken steps to manage risk associated with the Stevens Pond Outlet Dam. Because the Dam is classified as a High Hazard Dam by the DCR Office of Dam Safety, it must be inspected every two years. As the dam owner, the City of Lawrence coordinates directly with the ODS office to ensure timely inspections are conducted and the dam is maintained. The City has an established Emergency Action Plan (EAP) in accordance with the Commonwealth of Massachusetts general Laws, M.G.L. 253, Section 44-49, Chapter 302 CMR. 10.00, "Dam Safety." This plan formalizes the response to an emergency condition at the Stevens Pond Outlet Dam site. The EAP also includes downstream inundation maps and a dam break analysis to further assess local and regional risk.

The dam breach analysis was conducted through two phases. The first phase consisted of developing a rainfall-runoff model for the watershed and Pond utilizing the U.S. Army Corps of Engineers' (ACOE) HEC-HMS computer program to estimate the ½ Probable Maximum Flood. The second phase consisted of a hydraulic evaluation of the potential downstream impacts of the hypothetical dam failures under "fair weather" and "wet weather" conditions using the National Weather Service DAMBRK analysis. Under fair weather conditions it was estimated that a dam break would have a maximum discharge of 3,000 cubic feet per second (cfs), with the leading-edge reaching Lawrence Street fifteen minutes following the breach/break. Wet weather conditions (1/2 Probable Maximum Flood) were estimated to have a maximum discharge of 33,300 cfs, causing significant flooding in low-laying areas within the City.

The EAP identifies a number of natural hazards that may impact the dam. These include:

- Extreme seismic events which could cause shifting of structures, cracking, or settlements, which may lead to leakage/dam deformation/seepage/sliding/overtopping/ catastrophic failure.
- Severe hydrologic events which could cause washout and undermining of soil from surrounding bank, washout of soil foundation material below dam, overtopping and undermining, and shifts in foundation/embankment or abutment slopes.

Stevens Pond Dam is located in a heavily developed area, as such there are economic, environmental and societal impacts associated with dam failure. The development downstream of the dam includes residential neighborhoods, roads, utilities, and public safety structures. Inundation maps for dam failure expand out from Stevens Pond and travel south east along the Spicket River, encompassing main corridors including Route 128, Route 110, Lawrence Street, Haverhill Street, Lawrence Street, and Canal Street.

The City is committed to ensuring general maintenance and inspection of the Stevens Pond Dam is conducted, including completing monthly visual observations of the dam to check for seepage, boils and/or other signs of increased leakage or another unusual occurrence at the dam. Additional inspection is outlined in the EAP to be completed following every major storm event (exceeding approximately 3 inches of rainfall) and after earthquake events. Further, the City intends to ensure the emergency plans and policies remain updated and in place to reduce vulnerability from High Hazard dams in Lawrence.

Hazardous Sites

In addition to community lifelines and critical facilities, Lawrence has hazardous sites that are important to consider for hazard mitigation planning:

Brownfields: As a planned industrial community, the City of Lawrence has historic contaminated brownfields and modern contaminated brownfields that may release hazardous materials into the environment due to a significant weather event such as flooding. Over its history, the City has had 273 Brownfield sites. Brownfield sites within Lawrence are located along the river and canals, where retired mill factories previously resided, with additional sites sprinkled throughout the City including the 15-acre Tombarello site off of Marston Street, and a small triangle of pavement intersecting Bennington, Lawrence, and Alder Street. Both sites have received assistance from MVPC to conduct assessment and remedial planning work for redevelopment as an industrial park and pocket greenspace respectively. At large, the City has aspirations to revitalize economic growth and development along the Merrimack River and canals through the clean up and redevelopment of many long-standing Brownfields parcels. The City intends to prioritize green space, walking trails, and smart design principles in these spaces to ensure an accessible and resilient riverbank.

Community Specific Hazards

Lawrence's LHMPT reviewed the full range of natural hazards that impact Massachusetts, as identified through the State Hazard Mitigation and Climate Adaptation Plan. The majority of the natural hazards considered impact the Merrimack Valley Region in a similar way. For those that have a different or locally-specific impact on the City of Lawrence, additional information has been supplemented in this section.

Flooding

Parts of the City of Lawrence lie within the floodplains of the Merrimack River and two of its major tributaries, the Shawsheen River to the south and the Spicket River to the north. All three rivers are subject to recurring (and sometimes *highly damaging*) flooding from heavy watershed snowmelt and prolonged rainfall from intense tropical storms. The lower Spicket River also floods due to backwater effects from several major constriction points on the river, including those at the Daisy Street Bridge in Lawrence and at the railroad bridge upstream in Methuen.

When the Merrimack River mainstem floods, it inundates and impacts a predominantly commercial and industrial district in the City. The Shawsheen River floods a predominately undeveloped recreational area, as well as some residences and parts of the Highway Access District (most notably busy Route 114 that connects the City to Route I-495 and neighboring North Andover.) The Spicket River floods a predominantly residential district, with some commercial flooding as well. All told, 16% of the City area lies within the combined 100-year floodplains of these three rivers, and 25% lies within the 100 and 500-year floodplain.

Lawrence has experienced disastrous flooding events, such as the notorious "Mother's Day Flood" of May 2006, depicted geographically on the following page. Impacts were widespread and included the week-long inundation and closure of numerous key commuter streets and parking facilities, widespread water damage to residences, businesses, and institutions, and the forced evacuation of nursing home residents and other sensitive populations. City emergency services were taxed to the extreme, and property damage estimates – residential, commercial, municipal – exceeded $34 million.

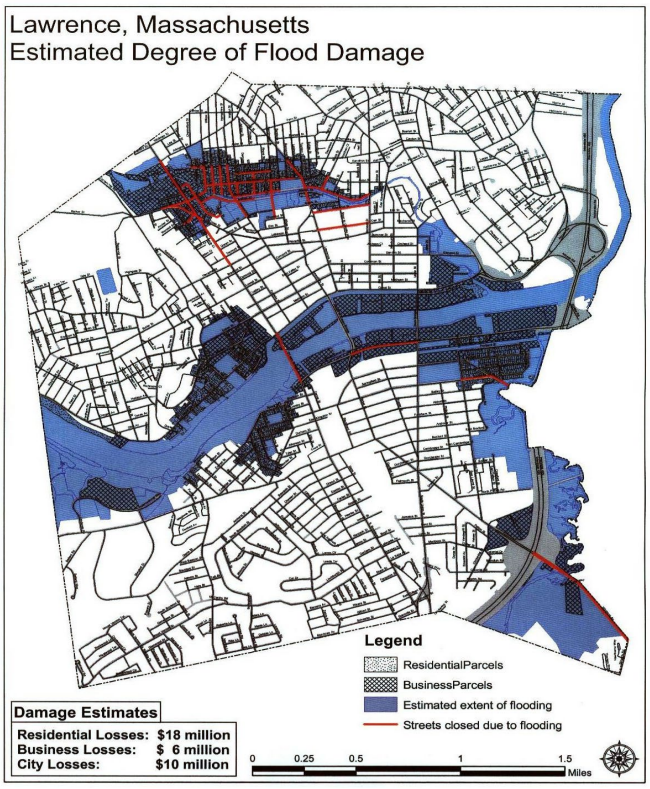


Figure 5.2 Map of estimated degree of flooding in Lawrence during the 2006 Mother's Day Storm.

More recently, on August 8th, 2023, Lawrence along with a number of other Merrimack Valley Communities experienced severe flooding when over 6 inches of rain fall within the region over the course of 6 hours. Widespread damage caused Mayor Brian A. DePena to declare a state of emergency in Lawrence. Damage to vehicles, residential homes and business was widespread. The City submitted claims for flood damage in three categories from the storm to the Massachusetts Emergency Management Agency, however total claims did not meet the minimum damage threshold.

Areas of Common Flooding: The City experiences chronic and problem flooding locations across the municipality. City public safety officials cite six specific locations in which recurring flooding problems are of particular concern and warrant ongoing attention in order to protect public safety, private property, and municipal infrastructure. These six locations are shown in *Figure 5.4* and outlined in more detail below.

1. Spicket River @ Daisy Street Bridge: The Spicket River routinely backs up at this bridge and causes flooding at Holly, Daisy, Spruce and Myrtle streets. The City, with FEMA assistance between 2006-2016, purchased nine homes adjacent to the Daisy Street bridge and, combined with land provided by Central Catholic High School, built a recreational park/trail network designed with expanded flood storage.
2. Spicket River @ Hampshire Street Bridge: The Spicket routinely backs up at this bridge, flooding Hampshire Street and Marion Avenue. The bridge, located near Central Catholic High School, in 2012-13 replaced with a new structure. Funding from the Massachusetts Department of Environmental Protection's (DEP) 604(B) Grant Program in 2021 supported the development of the Spicket River Watershed-Based Plan, a collaborative project completed by the Cities of Lawrence and Methuen, Merrimack River Watershed council, Groundwork Lawrence, and the Merrimack Valley Planning Commission. This plan identifies hydrologic and water quality challenges along the river and proposes green infrastructure improvements. The City is currently pursuing a subsequent DEP 319 implementation for these improvements.

Figure 5.4 Chronic flooding locations identified across Lawrence by the LHMPT

3. Bloody Brook at Intersection of Swan/Knox Streets and Jackson Street: The Bloody Brook routinely backs up at this location at the Methuen City Line due to inadequately sized culverts and increased development upstream in Methuen. Several buildings in the flood area have been demolished and properties are now owned by the City of Lawrence. Prior to the 2016 plan update, the City completed drainage improvements in the Jackson Street area to increase storm drain capacity. With funding from the Municipal Vulnerability preparedness (MVP) program, the City of Lawrence and Methuen partnered with the Merrimack River Watershed Council, Groundwork Lawrence, and Pare Corp to develop the Bloody Brook and the Searles Pond Resilience Plan in 2022. Outcomes from this community-driven project, explored and proposed flood mitigation options for the region.

4. Sow Brook at Young, Rollins, and LeRoy Street: This is a new location which routinely floods in Lawrence. Following work done in Methuen to manage flooding and waterflow, a greater volume of stormwater has been routed to the Sow Brook, leading to increased flow and flooding downstream near Young, Rollins, and LeRoy Streets.

5. Shawsheen River at Merrimack Street Culvert: The Shawsheen River flows below ground for approximately 1/8 mile passing beneath Merrimack Street, a public way, as well as a rail line and commercial parking lot, before exiting to the Merrimack River. During the 100-year flood, the Shawsheen backs up into the local neighborhood impacting several homes and streets. Funding through the MassBays program is currently supporting the development of a Shawsheen River Watershed-Based Plan, which, much like the Spicket, will support future green infrastructure implementation projects.

6. Shawsheen River at Route 114 Bridge: The Shawsheen River, during the 100-year flood, is backed up by the existing bridge structure causing the river to overtop its and banks and flood Route 114, effectively closing the busy public thoroughfare.

Table 5.29 List of Community Lifelines located across Lawrence within the 100 and 500-year floodplain.

Lawrence Community Lifelines within Floodplain		
100-Year Floodplain		
Feature	**Category**	**Generator**
Municipal Office	Retirement Board & Office of Planning and Development	No
Municipal Resource	City Public Works Garage	No
2 Medical Facilities/ Clinics	Greater Lawrence Family Healthcare Center @ Essex Street Merrimack Medical & Walk in Center	No Unknown
Fire Station	Engine 7	No
3 Pumping Stations	Water St. pumping Stn., Pembrook Drive Sewage Pumping Stn., Rt114 Sewage Pumping Stn.	Yes
Office Park Job Center	Business	No
8 Daycare Facilities	Multiple Locations	No
11 Subsidized Housing Locations	Multiple Locations	No
3 Elderly Housing Locations	Mary Immaculate Residential Community & Lawrence Housing Authority	Yes & No
Nursing Home	Mary Immaculate Nursing & Restorative Center	Yes
School	Central Catholic High	No
2 Churches	Iglesia Bautista Hispana & Phoenix Rising	No
Community Organization	Boys & Girls Club	No
Community Garden	Spruce & Myrtle Street Garden	No
Hayden Schofield Playstead	Recreational Feature	No
6 Food Service Locations	Neighbors in Need at Boys and Girls Club, House of Mercy, Groundwork Lawrence CSA, Mary Immaculate, Good Sheperds, Lazarus House	No
6 Food Retail Locations	Market Basket, Nizao Supermarket, El Mercadito Grocery, Rojas Food Market, Simon Grocery, Fama Market	No
500-Year Floodplain		
Citizen Center	Lawrence Citizens Center	No
Municipal Office	Department of Transitional Assistance	No
2 Schools	Francis M. Leahy Elementary & UP Academy Leonard Middle	No
Youth Correctional Facility	Essex County Correctional Alternative Center (Lawrence)	Yes
5 parks	Manchester Street Playground, Pemberton Park, Misserville Park, Ferrous Park, Spicket River Greenway	No
2 College	Northern Essex Community College & Cambridge College	Yes & No
Costello Garden and Urban Farm	Community Garden	No
2 Community Organizations	Asperger, Inc. & Greater Lawrence Community Action Council	No
2 Medical Facility	Greater Lawrence Family Health Center & Merrimack Valley Hospice	Yes
Church	Congregation Ansha Sholum	No
2 Power Substations	Mass. Electric Company	No
10 Daycare Facilities	Multiple Locations	No
19 Low Housing Locations	Multiple Locations	Yes (select)
3 Elderly Housing Locations	Valebrook Apartments & Lawrence Housing Authority	Yes & No
2 Food Service Locations	Soup Kitchen, Food Pantry, etc.	No
4 Food Retail Locations	Union Supermarket (2 locations), Hernandez Market, La Fruteria Supermarket	No

Flooding Vulnerability Assessment: A GIS analysis of the City's FIRM flood hazard area maps by MVPC has determined that 762 acres (1.2 sq. mi.) of land area in Lawrence is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 431 acres (.67 sq. mi.) lies within the 500-year floodplain. Together, these two flood zones constitute twenty-five percent (25%) of the City's total area. As part of the mapping analysis, MVPC also identified the critical facilities that are located within the City's 100-year and 500-year floodplains and thus are at risk of future flood damage or loss. A total of 109 critical facilities are located within floodplains in Lawrence. These facilities are listed in *Table 5.29*.

Also situated within the floodplains is the Lawrence drinking water plant, located on the north bank of the Merrimack River on Water Street, as well as much of the Greater Lawrence Sanitary District's (GLSD) sewer interceptors and collector pipes. The GLSD is the region's largest (52-mgd) wastewater treatment facility, serving the four Merrimack Valley municipalities of Lawrence, Methuen, Andover, and North Andover, as well as nearby Salem, NH.

According to City officials, there are no current plans to site other critical facilities in the 100-year or 500-year flood zones. MVPC has also reviewed non-critical structures within Lawrence floodplain areas and through GIS analysis has identified 1,756 structures within the floodplain. The combined value of these structures/properties is $1.46 billion (19% assessed value in Lawrence), according to Assessor records (2023).

NFIP Information: Lawrence actively participates in the National Flood Insurance Program (NFIP). The City's initial Flood Hazard Boundary Map (NHBM) was identified in 1974, and the initial Flood Insurance Rate Map (FIRM) was identified in 1982. The latest effective FIRM was adopted in 2012. The Flood Hazard Management Program anticipates a new FIRM and Flood Insurance Study (FIS) will be available for adoption in 2024. Lawrence intends to update their local regulations to adopt the new maps and study ahead of the effective date, anticipated in summer 2025. This will require updating Lawrence's Code of Ordinances (15.32.010), where minimum floodplain management criteria appear. Lawrence implements and enforces local floodplain management regulations in Special Flood Hazard Areas (SFHAs) through complying and enforcing their City Ordinance, the State Building Code (780 CMR), the State Wetland Protection Regulations and Inland Wetland Regulations (310 CMR 10.00), and the NFIP Standards. The City's Planning Board is responsible for ensuring regulations are met regarding development and redevelopment in SFHAs. Lawrence's Building Inspector ensures local compliance and leads oversight of substantial improvement/substantial damage following an event.

The Massachusetts Emergency Management Association (MEMA) reports that as of 7/2023, there are 229 properties with flood insurance policies in place with a total insurance value of $68,183,000.[128] There are also an additional 202 policies in force within Special Flood Hazard Areas, with a total insurance value of $56,390,00 0. According to data provided by the MA Department of Conservation and Recreation, there are 27 NFIP repetitive loss sites in Lawrence. Eighteen of these sites are residential, with nine classified as "other nonresidential". Together, these 27 sites have resulted in the payout of 79 National Flood Insurance Program claims totaling $7,698,765. Lawrence has six (6) NFIP severe repetitive loss sites (2 residential, 4 non-residential). Together these 6 severe repetitive loss sites have resulted in the payout of 25 National Flood Insurance Program claims totaling $4,761,156.

Based on location, previous occurrence, severity, and future probability of floods in Lawrence, City officials consider the community to be at ***high risk*** from flooding.

CSO Events

In addition to flooding, another major challenge posed by intensive precipitation is combined sewer overflow

[128] Massachusetts Emergency Management Agency. 2023. *NFIP Summary Data Report* – 7/25/2023.

(CSO) events. Lawrence's infrastructure uses both separate and combined sewer pipes, with combined pipes accounting for about 70% of the sewer lines in Lawrence (96 of 137 miles). There are a total of 5 active CSO outfalls which discharge to the Merrimack within Lawrence. The Greater Lawrence Sanitary District (GLSD), the regional wastewater treatment facility, monitors CSO volumes and makes reports available to the public. Overflow volumes fluctuate dramatically between years due to precipitation levels. In 2022, a historically dry year, reports indicated 41.5 million gallons of overflow were discharged by GLSD into the river in Lawrence. Whereas in 2023, a record high precipitation year, a total of 164 million gallons were discharged.

As climate change continues to cause more intense and frequent precipitation events, CSOs pose a greater risk for Lawrence and the other surrounding communities. Especially for communities like Lawrence who rely entirely on water from the Merrimack River as their potable water source. Stormwater infrastructure is not designed to handle the intensity and severity of storms we are currently experiencing.

To combat this risk, the Greater Lawrence Sanitary district is actively working to address CSOs. As part of the CSO Abatement Program, GLSD has invested over $60 million in CSO towards reducing CSO events by completing projects that bolster the treatment process, increasing maximum flow to the plant, and operating a high flow treatment system. To ensure continued operation, GLSD also added full backup power to the main treatment plant in 2019 and the Riverside pumping station in 2020.

Extreme Temperatures

While the Merrimack Valley, similar to the rest of the region, is experiencing greater extreme heat, Lawrence and other more developed communities within the region are feeling the effects to a greater degree. Impervious surfaces such as pavement and roofs absorb and re-emit heat more than natural landscapes such as grass and trees. This results in urban areas maintaining more heat, and can lead to a cascade of effects including increased energy consumption, air pollution, greenhouse gas emissions, and health problems. In 2018 and again in 2023, Lawrence schools released students early due to extreme heat. With climate change predicted to cause more extreme summer temperatures, more developed communities like Lawrence will continue to be impacted. Given the location, occurrence and future probability of extreme heat in Lawrence, the City considers it to be a ***high risk***.

To combat this challenge, Groundwork Lawrence, a non-profit based in the City, has run the Green Streets program since 2008, working to increase tree canopy in Lawrence. Over 4,300 trees have been planted in Lawrence through the program, which is supported by partnerships and funding from the City of Lawrence, Massachusetts Greening the Gateway Cities program, Massachusetts Department of Energy Resources, Executive Office of Energy and Environmental Affairs, and the Massachusetts Department of Conservation and Recreation's Urban and Community Forestry Program.

Invasive species

The City of Lawrence has identified invasive species as a concern. Common invasive species in the region including Asian Bittersweet and Japanese Knotweed have been identified and managed by community groups in Lawrence. Through the Green Streets Program, an inventory of the City's trees was also completed, revealing that Lawrence is overplanted with the Norway Maple, an invasive species that re-seeds aggressively and outcompetes native species. The lack of tree diversity provides a potential pathway for insects and disease which could jeopardize tree health in the City. The City is working with partners to create a more resilient and diverse native urban tree canopy.

Wildfires

The Lawrence Fire Department responds to approximately 60 brush fires on average each year. Some of the more serious brush fires have occurred in wooded sections of Lawrence specifically Den Rock Park; behind

the Frost School, the area between Shawsheen Road and Route 495, and Riverfront Park along the south bank of the Merrimack River. Given the frequency but limited extent of this hazard in the community, brush-fire hazard is considered a ***moderate risk***.

Natural Hazard Management and Response

The Lawrence Fire Department has a total of 126 personnel led by Chief Robert O'Brien. The Police Department has a total of 162 personnel led by the Acting Chief of Police William Castro. The Lawrence Department of Public Works, responsible for overseeing the operations and maintenance of critical community lifelines, is supported by 60 employees.

Starting in 2018, the Lawrence Police Department began operating Code Red, a city-wide notification system. Through Code Red, along with the Police Department and IT Department, public announcements concerning natural hazards and safety are distributed to community members via phone, social media, and City websites.

Natural Hazards Risk Assessment

Through using the City of Lawrence's previous Hazard Mitigation Plan, in association with other planning documents including Haverhill's Comprehensive Emergency Management Plan, and Municipal Vulnerability plan, natural hazards for the City were considered. On the basis of this analysis, Lawrence considers itself to be at ***high risk*** from inland flooding, drought, severe winter storms (blizzards/snow/ice storms), extreme temperatures, and invasive species; ***moderate risk*** from high wind/thunderstorms, hurricanes/tropical storms, wildfires, and riverine erosion; and ***low risk*** from landslides, earthquakes, and tornadoes. Because Lawrence is not located on the coast, it does not consider itself to be at risk from coastal flooding or tsunamis.

Table 5.30 Lawrence's risk rating for the 15 natural hazards experienced in the Commonwealth.

Lawrence Natural Hazard Risk Rating	
Natural Hazard	**Community Risk Rating**
Inland Flooding	High
Drought	High
Severe Winter Storms	High
Extreme Temperatures	High
Invasive Species	High
High Winds/ Thunderstorms	Moderate
Hurricane/Tropical Storm	Moderate
Wildfires	Moderate
Coastal/Riverine Erosion	Moderate
Landslide	Low
Earthquake	Low
Tornadoes	Low
Tsunami	NA
Coastal Flooding	NA

Continue to page 197 of the Plan to review Lawrence's next section: ***City of Lawrence Natural Hazard Challenge Statements.***

5.2.6 City of Methuen Natural Hazard Risk Assessment

Community Profile


Methuen City Hall

The City of Methuen covers an area of 22.2 square miles, defined by its border with New Hampshire to the North, and the Merrimack River and Lawrence to the South. The City of Methuen contains a wide variety of land uses, ranging from rural agricultural areas to densely developed neighborhoods in the City's center.

According to the 2020 US Census, Methuen has a resident population of 53,059.[129] The City is predominantly a single-family residential community with a density of 2,389 people per square mile and an average of 2.77 people per household. Residents under the age of 18 make up 21.3% of the population, with 16.4% over the age of 65 (U.S. Census, 2020). Methuen experienced an increase of 5,804 people (12.3%) from 2010. Population projections for the City from the UMass Donahue Institute forecast the 2030 population at 58,869 people, an increase of 11% from 2020.[130] The public school system includes four large K-8 schools and one high school (grades 9 – 12). Total student enrollment across all public schools K-12 is 6,334.

Methuen is home to three different environmental justice (EJ) populations: minority population, income, and English isolation.[131] A total of 82% of Methuen's residents live within the 29 census block groups in the City that meet with Executive Office of Energy and Environmental Affairs (EEA) criteria as Environmental Justice (EJ) areas. This is a significant increase from 2010 census levels in which only 37% of residents lived within a designated EJ area. According to the Massachusetts Executive Office of Energy and Environmental Affairs, EJ block groups within Methuen range from 24.9-90.8% minority population; 25-26.2% language isolation, and have a median household income of $27,692-53,452.

The GIS analysis for the 2024 HMP reports both land cover and land use data derived from the state's most updated 2016 land cover layer.[132] Predominant *land cover* in Methuen is forest (44%), followed by developed impervious land (19%), open land (19%), wetlands (14%), water (3%), and agricultural land (1%). According to assessor's data, *land use* in Methuen is primarily residential (49%) and recreational/other (30%), followed by transportation (12%), commercial/industrial (7%), and agriculture (1%) and water (1%).

The City provides public drinking water from the Merrimack River. Sewer is operated by the City through the Greater Lawrence Sanitary District (GLSD). In a typical year, the plant treats approximately 30 million gallons of wastewater per day and an additional 75,000 gallons of septage per day from the six district communities of Lawrence, Methuen, Andover, North Andover, Dracut, MA and Salem, NH. Electricity is provided to residents through National Grid, while gas is provided by Eversource, which in 2020 acquired the prior utility service Columbia Gas.

[129] United States Census Bureau. 2023. QuickFacts. U.S. Census Bureau QuickFacts: United States
[130] UMass Donahue Institute. 2022. Massachusetts Population Projections. UMass Donahue Institute | Population Projections
[131] Massachusetts Executive Office of Energy and Environmental Affairs. 2022. Environmental Justice Populations in Massachusetts. Massachusetts 2020 Environmental Justice Populations (arcgis.com)
[132] MassGIS. 2019. 2016 Land Cover/Land Use. MassGIS Data: 2016 Land Cover/Land Use | Mass.gov

Recent Development and Land Use Change

Methuen is a mature suburban city that has experienced moderate, steady commercial and housing growth. Since 2016, 15 major developments: six (6) commercial and nine (9) residential have been initiated or completed in Methuen (*Table 5.31*).

Methuen has had several zoning changes since the 2016 update, including a rezoning from Residential A (RA) to Rural Residential (RR) to allow for the construction of an Assisted Living Facility at 195 Howe Street, and a zoning change from Rural Residential (RR) to Multi-Family A (MA) to allow for the development of The Preserve, a residential sub-division. The City also adopted a 40R Smart Growth Overlay District in central Methuen.

Table 5.31 Major development projects in Methuen initiated since 2016.

Methuen Major Development Projects 2016-2023				
Facility Type	**Common Name**	**Address**	**Square Feet/ Housing Units**	**Project Status**
Commercial	Malden Mills retrofit (IndusPAD)	100 Chase St.	600,000 sq ft	Complete
Residential	Liam's Lane	Liam's Lane	10 units (single family)	Complete
Residential	Maple Park	Maple St. Extension	12 units	Complete
Residential	Merrimack Green Phase IV	Country Club Cir.	11 units	Complete
Residential	Masonic Lodge	5 Pleasant Street	19 units	Complete
Commercial	Warehouse	33 Danton Drive	58,000 sq ft	In Construction
Commercial	Self-Storage	14 Calumet Road	124,000 sq ft	Complete
Commercial	Warehouse	45 Old Ferry Road	147,000 sq ft	In Construction
Commercial	Warehouse	501-600 Griffin Brook Drive	101,000 sq ft	In Construction
Residential	Great Oaks	off North Street	30 units	Complete
Residential	The Preserve	off Howe Street	192 units	In Construction
Residential	The Woods at Merrimack	95 Howe Street	140 units (senior housing)	Complete
Residential	Marbella Lofts	5 Hampshire Street	14 units	Complete
Residential	Cooper Lane	Cooper Lane	12 units (single family)	Complete
Industrial	New Balance	596 Lowell Street	80,000 sq ft	Complete

Increased development has reduced the City's open space in the east and west ends. Notably, 127 open green acres in Methuen that were Chapter 61A Agricultural lands have been withdrawn from the tax incentive program. In the City's Open Space and Recreation Plan (2020), the Methuen identifies the goal of guiding development away from historically undeveloped space and instead to areas that already have the infrastructure to support it, such as the 291 brownfields sites within the City. Methuen is actively working to preserve and conserve open space within the City. While historically, Methuen has had a low supply of protected and conserved acreage (3%) since the 2016 update, seven (7) new parcels have been protected totaling 217 acres of land (*Table 5.32*).

Since the last plan update, changes in development and land use in the City have not impacted Methuen's risk to natural hazards. While the City has experienced new development, impacts have not increased or

decreased the risk to resident safety or property. Additional risk has been mitigated through actions including regulatory updates such as enactment of the City's stormwater management ordinance, update of Conservation Commission stormwater regulations, update of Methuen subdivision control rules and regulations and adoption of floodplain zoning ordinance amendment. Additionally, efforts to counteract development impacts through Open Space restrictions enabled by OSRD provision in the City's zoning ordinance has allowed the City to preserve habitat areas and provide stormwater storage capacity within new neighborhoods including The Preserve, Maple Park, Emerald Pines, and Great Oaks.

Table 5.32 Newly conserved or preserved land in Methuen since 2016.

Methuen Newly Conserved or Preserved Land 2016-2023				
Property Name	**Parcel**	**Area**	**Owner/ CR Holder**	**Year Completed**
Macoul Parcel	812-80-10C	4.194	City of Methuen	2020
The Preserve at Emerald Pines	1006-78E	100	Privately owned, CR held by State and City as grantee responsible party	Pending Approval
Liam's Lane	906-74-71	15.9	Pending City of Methuen	In Process
Great Oaks OSRD	906-74-71	63.8	City of Methuen	2017
Maple Park	906-76-11M	13.72	City of Methuen	2019
Ivy Island	418-162-18	0.55	City of Methuen	2019
Ayers Village Road (Didio Property)	704-72-30E	18.9	City of Methuen	2017

Community Lifelines

A select list of community lifelines (emergency operations centers, hospitals/healthcare centers, public shelters) is shown in *Table 5.33* and was originally derived from the City's Comprehensive Emergency Management Plan (CEMP) and updated from other community plans and conversations with the LHMPT.

Table 5.33 Select list of Methuen's community lifelines (emergency operation centers, hospitals, and shelters).

Methuen Emergency Operation Centers, Hospitals, and Shelters						
Facility Type	**Common Name**	**Street Address**	**Health Facility Type**	**Maximum Capacity**	**Feeding Capability**	**Emergency Generator Available**
Emergency Operations	Methuen Fire Department	24 Lowell Street	N/A	N/A	N/A	Yes
	Methuen PD Quinn Building	90 Hampshire Street	N/A	N/A	N/A	Yes
Hospitals and Healthcare Centers	Holy Family Hospital	70 East Street	Hospital	243	Yes	Yes
	Pediatric Health Center / Women's Health Center	60 East Street	Clinic	N/A	No	Yes
	Family Health Center satellite clinic	147 Pelham Street	Clinic	N/A	No	Yes
Emergency Shelters	Donald P Timothy Grammar (primary)	45 Pleasant View Street	N/A	350	Yes	Yes
	Methuen High School (secondary)	1 Ranger Road	N/A	2,000	Yes	Yes

The locations of these and other community lifelines in Methuen were entered by MVPC into an Excel database and subsequently incorporated into MVPC's ArcGIS for use in digital mapping. As part of the plan update, the full list of community lifelines was reviewed and amended to reflect current conditions, as well as to incorporate new facilities and resources. The full list of community lifelines is depicted in the Methuen map series that is presented in Appendix B of this Plan.

Critical Infrastructure

Bridges: The City of Methuen has 36 bridges within its municipal borders.[133] Of these bridges, five (5) are municipally owned, with the remaining 31 bridges owned and maintained by MassDOT. Fifteen (15) of the 36 are categorized as waterway bridges, with the remaining intersecting roadways or other features. There are currently three (3) bridges classified as structurally deficient in Methuen, all of which are owned by MassDOT (*Table 5.34*).

During the 2016 plan, Route 213 Westbound Bridge over the Spicket River was also classified as structurally deficient. However, upgrades made to the bridge in 2018 totaling $13 million, restored the bridge's condition, removing it from the structurally deficient list.

Replacement of the Antonio Franciosa Memorial Bridge both North and South Bound is planned to be funded through the 2024 Transportation Improvement Program (TIP) for the Merrimack Valley Metropolitan Planning Organization. The 2013 Loop Connector over the Methuen Rail Trail is also planned to be funded through the 2025 TIP. The notice to proceed to begin work on the contract has been issued as of 12/2022.

Table 5.34 List of Methuen's structurally deficient bridges as identified by the Massachusetts Dept of Transportation.

Methuen Structurally Deficient Bridges					
Bridge Name	**Feature Intersected**	**Owner**	**Year Built**	**Structurally Deficient**	**Last Inspection Date**
Antonio Franciosa Memorial	I495 over 110 North Bound	MassDOT	1963	Yes	10/11/2021
Antonio Franciosa Memorial	I495 over 110 South Bound	MassDOT	1963	Yes	10/11/2021
213 Loop Connector	Methuen Rail Trail	MassDOT	1959	Yes	10/25/2022

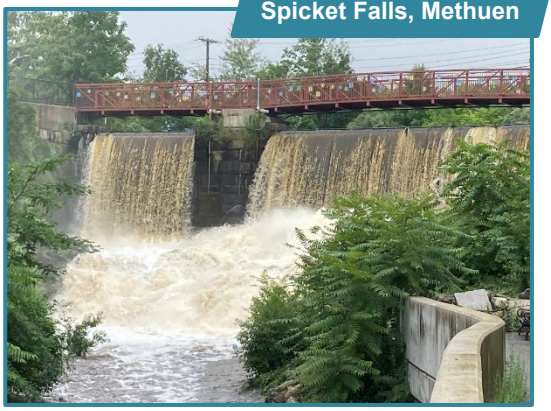
Dams: The DCR Office of Dam Safety includes 12 Methuen dams on its dam hazard classification list.[134] Three (3) of these dams are municipally owned (Searles Pond Dam, Forest Lake Dam, and Hill Pond Upper Dam), with the other nine (9) privately owned. One dam within Methuen is classified as a High or Significant hazard Dam: the Searles Pond Dam, owned and operated by the City of Methuen. This dam is identified and described in *Table 5.35* below.

Table 5.35 List of Methuen's Significant and High Hazard Dams as identified by the Massachusetts Office of Dam Safety.

Methuen High and Significant Hazard Dams				
Dam Name	**Impoundment Name** (maximum capacity in acre-feet)	**Year Completed**	**Hazard Class**	**Last Inspection Date**
Searles Pond Dam	Searles Pond (63 acre-feet)	1979 improved 2019	Significant	10/16/2019

[133] MassDOT. 2024. Bridges. Bridges | Bridges | MassDOT Open Data Portal (arcgis.com)
[134] MassGIS. 2012. Dams. MassGIS Data: Dams | Mass.gov

In 2020, Methuen worked with Pare Cooperation to develop an Emergency Action Plan for the Searles Pond Dam. This plan defines responsibilities and lays out a notification procedure for identifying conditions which may endanger the dam or infrastructure downstream of the dam in time to take mitigative action. It also includes an inundation mapping and impacted area summary for the region surrounding the dam.


Spicket Falls, Methuen

While classified as a Low Hazard Dam, during the May 2006 Mother's Day Flood surging floodwaters began to overtop the Spicket River Dam and threatened the abutment, requiring City public safety crews to deploy sandbags in an effort to contain the water and prevent further scouring and erosion. According to the U.S. Geological Survey (USGS), the Spicket River peaked at 2,080 cubic feet per second (cfs), the highest flow recorded since streamflow monitoring began in the river in 2000. Maintenance restoration work at the dam with Riverwalk pedestrian bridge resulted in upgrade of the dam to enable operational functioning of the dam gates. City management officials will work with the dam owner, Methuen Hydro, to ensure safe dam operation and plan for upgrades that can reduce natural hazard risk for the Spicket River Dam and others within the City.

Hazardous Sites

In addition to community lifelines and critical facilities, Methuen has hazardous sites that are important to consider for hazard mitigation planning:

Brownfields: The City of Methuen has historic contaminated brownfields and modern contaminated brownfields that may release hazardous materials into the environment due to a significant weather event such as flooding. Brownfield sites within the City are located in downtown as well as the Eastern Industrial Area which include contamination from former metal plants, and illegal construction debris dumping. In July 2023, Methuen received $500,000 from the U.S. Environmental Protection Agency as part of their Brownfields Assessment Grant program. Funds will be used to conduct environmental site assessments, develop property reuse and remediation plans, and support community outreach activities. High on the City's list is addressing the Battye property, an abandoned brownfields site, currently in tax title foreclosure, that the City is exploring as a possible location for their DPW yard, as well as smaller industrial legacy properties in proximity to the Spicket River. Currently, the City is pursuing assessment work through a combination of MVPC's assessment grant and the City's ARPA funds to understand the Battye property's contamination levels and prospects for redevelopment.

Community Specific Hazards

Methuen's LHMPT reviewed the full range of natural hazards that impact Massachusetts, as identified through the State Hazard Mitigation and Climate Adaptation Plan. The majority of the natural hazards considered impact the Merrimack Valley Region in a similar way. For those that have a different or locally-specific impact on the City of Methuen, additional information has been supplemented in this section.

Flooding

Parts of the City of Methuen lie within the floodplains of the Merrimack River and the Spicket River (a tributary of the Merrimack) and are subject to recurring (and sometimes *highly damaging*) flooding during prolonged rainfall events. In addition, the City has numerous other surface water bodies – lakes, ponds, streams, and wetlands – that give rise to occasional localized flooding problems. These latter water bodies include Forest Lake, Mystic Pond, Mill Pond, Searles Pond, and Hills Pond, as well as Bloody Brook, Hawkes Brook, Bare Meadow Brook, Harris Brook, Bartlett Brook, Sawyer Brook, Griffin Brook, and Bradley Brook.

While flooding is a common experience in Methuen, a few key events stand out over recent years. The May 2006 flood event inundated key areas of the City, shutting down commercial establishments and forcing the evacuation of numerous residences, including six multi-family homes. Roadways across Methuen were also closed for this period, seriously impacting commuter traffic. A minimum of five police officers were required to post detours around the impacted areas. Other City personnel and private utility company crews were also required to respond. More recently in August 2023, Methuen along with a number of other Merrimack Valley Communities experienced severe flooding when over 6 inches of rain fall within the region over the course of 6 hours causing flash flooding.

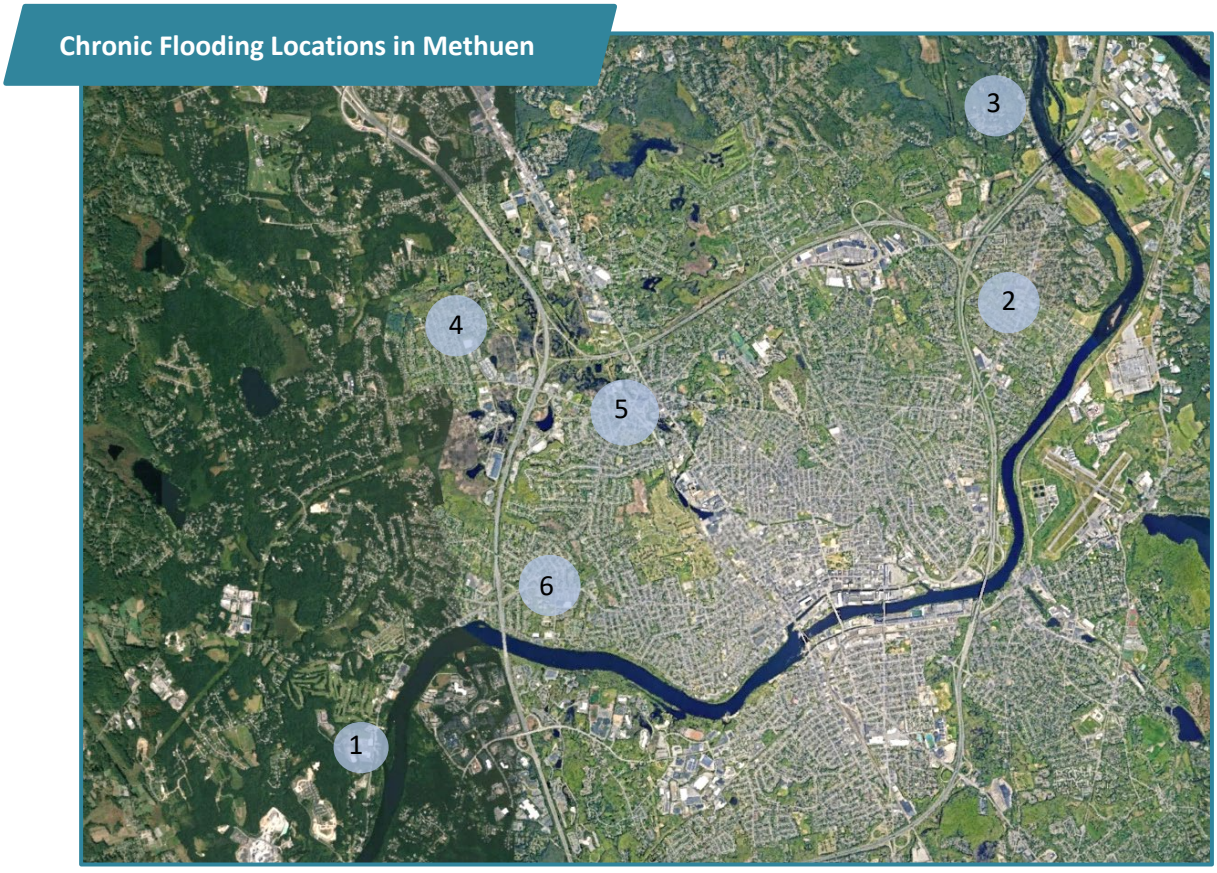


Figure 5.5 Chronic flooding locations identified across Methuen by the Local Hazard Mitigation Planning Team.

Areas of Common Flooding: According to the City's CEMP and LHMPT, vulnerable flood locations are common along the Merrimack River at 1: Armory and Lowell Streets, 2: Frye Road along Baremeadow Brook Tributary, and 3: Grandview Ave near Tobey Ave. The Spicket River flooding in Methuen can be particularly severe causing flooding at 4: Hampshire Road and Cross Street, and 5: City Center along Pine Street, Horne Street, Bentley Circle, Broadway, Park Street, Morrison Court. Additionally, chronic flooding has been noted along 6: Joy Terrace/Newbury Street. The locations are detailed in *Figure 5.5*.

Specifically, City public safety officials cite two recurring flooding problems that are of particular concern and warrant immediate attention in order to protect public safety, private property, and municipal infrastructure:

Spicket River @ MRT Bridge/Pine Street: The Methuen Rail Trail Bridge (formerly the Guilford RR Bridge), spanning the Spicket River at the end of Pine Street, has long been a troublesome "choke" point on the river. During high water events, of which there have been many over the last 10-15 years alone, the bridge causes a major backup (ponding) of the Spicket River upstream from the bridge. Large areas of Hampshire Road, Cross Street, and Pelham Street, as well as many of their side streets, are severely impacted and frequently closed to the public. Additionally, at this same location, the floodwaters jump the bridge, follow the path under the City's "5-corner" intersection, and spill out between the VFW building and the John Tenney House on River Street. Back in the 1980's, an occurrence of this nature inundated and washed-out part of the regional sewer system of the Greater Lawrence Sanitary District (GLSD). At this same location today, a 48-inch sewer interceptor operated by the GLSD remains at risk. During each major high water event Methuen DPW crews have been required to construct and maintain a sizeable containment berm next to the Spicket River at the MRT Bridge. Without this berm, the GLSD sewer line would be in danger of being compromised by the erosive power of the surging Spicket River. This recurring task places an added strain on the City's emergency response workforce at a time when their services are needed at other vulnerable locations in the community.

Bloody Brook @ Intersection of Swan and Jackson Streets: The City experiences significant recurring flooding along Bloody Brook in the vicinity of Swan Street (Route 110) and Jackson Street. The Swan Street/Jackson Street area is a commercial neighborhood and major commuter route for residents of both Methuen and neighboring Lawrence. The area is drained by the Bloody Brook culvert that begins between Curtis and Swan Streets (parallel to Jackson Street) as a 48-inch reinforced concrete pipe for approximately 100 feet, and changes to a 48-inch corrugated metal pipe. At the intersection of Swan Street, the culvert becomes a 4-ft X 4-ft mortared stone box culvert with a concrete roof. From here, the book continues to drain from Methuen into Lawrence where it eventually empties into the Spicket River. Undersized culverts in Lawrence cause severe water back-up in Methuen, leading to common and sustained flooding.

Jackson Street Flooding, May

To address these and other flooding concerns across the City, Methuen has partnered with neighboring communities, and community groups such as the Merrimack River Watershed Coalition, Groundwork Lawrence, and Merrimack Valley Planning Commission to develop the Bloody Brook and Searles Pond MVP Resilience Plan, as well as the Spicket River Watershed-Based Plan. Both plans aim to assess impacts and identify management strategies and proposed solutions to minimize flooding, improve water quality, and manage hydrological flow throughout the region. The plans outline concepts for green infrastructure and nature-based solutions to better manage stormwater control capacity. In addition, within the Bloody Brook corridor, action plan options include hard infrastructure upgrades including replacing undersized culvert segments from Swan/Jackson St. in Methuen to the Bloody Brook Lawrence outlet, a project that will require approvals and coordination between both Methuen and Lawrence in design/permitting, financing and implementation. Currently, the City of Methuen is pursuing implementation funding for green

Biofiltration Area at Riverside

infrastructure improvements along the Spicket River through DEP's 319 grant program.

Flood Vulnerability Assessment: A GIS analysis of the City's FIRM flood hazard area maps by MVPC has determined that 1,938 acres (3sq. mi.) of land area in Methuen is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 726 acres (1.1 sq. mi.) lies within the 500-year floodplain. Together, these two flood zones constitute eighteen percent (18%) of the total area of the community.

As part of the mapping analysis, MVPC also identified the buildings and critical facilities located within the City's 100-year and 500-year floodplains and thus are at risk of future flood damage or loss. A total of 697 buildings (3.5% of all buildings in the City) are located within a floodplain, collectively valued at $526.9 million. A total of 18 of these have been identified as community lifelines, valued at $50.7 million (*Table 5.36)*. According to City officials, there are no current plans to site other critical facilities in the 100-year or 500-year flood zones.

Table 5.36 List of Community Lifelines located across Methuen within the 100 and 500-year floodplain.

Methuen Critical Facilities within Floodplain 100-Year Floodplain		
Facility Type	**Name**	**Generator**
Assisted Living Facility	Housing location- Methuen Village 4 Gleason Street	Yes
Historic/Cultural Asset	Sands Arch Bridge	NA
Public Works Garage	Methuen DPW Garage	Yes (portable)
Water Supply	Methuen Water Supply Intake Structure	Yes (reliability issue with cable connection to WTP generator)
Sewer System	Sewage Pumping Station- Howe St. at Hawks Brook	Yes
500-Year Floodplain		
Public Housing	MHA 19 Mystic St.	No
Public Housing	MHA 601 Lowell St.	No
Emergency Housing/ Operation Center	Days Inn-159 Pelham St.	No
Emergency Operation Center	National Guard Armory	Yes
Nursing Home	Cedar View Rehab and Health Care Center- 480 Jackson St.	Yes
Day Care Facility	Merrimack Valley Children's Academy- 468 Merrimack St.	No
Day Care Facility	My Little Dream Learning Center- 103 Jackson St.	No
Eversource Gas Substation	Natural Gas Facility East/Jackson St.	N/A
Power Substation	N.E. Power Company- 141 Pelham St.	N/A
Sewer System	Sewage Pumping Station- Bolduc St.	Yes

NFIP Information: Methuen actively participates in the National Flood Insurance Program (NFIP). The City's initial Flood Hazard Boundary Map (NHBM) was identified in 1974, and the initial Flood Insurance Rate Map (FIRM) was identified in 1980. The latest effective FIRM was adopted in 2012. The Flood Hazard Management Program anticipates a new FIRM and Flood Insurance Study (FIS) will be available for adoption in 2024. Methuen intends to update their local regulations to adopt the new maps and study ahead of the effective date, anticipated in summer 2025. This will require updating Methuen's Wetland Regulations, where minimum floodplain management criteria appear. Methuen implements and enforces local floodplain management regulations in Special Flood Hazard Areas (SFHAs) through complying and enforcing their City

Ordinance, the State Building Code (780 CMR), the State Wetland Protection Regulations and Inland Wetland Regulations (310 CMR 10.00), and the NFIP Standards. The City's Conservation Commission is responsible for ensuring NFIP regulations are met. Depending on the level of damage incurred, Methuen's Conservation Commissioner, Emergency Management Director, and Department of Public Works may all be involved in oversight of substantial improvement/substantial damage following an event.

The Massachusetts Emergency Management Association (MEMA) reports a total of 162 properties with flood insurance policies in place. Of these, 106 are within flood hazard areas and are collectively valued at $35,684,000, while the remaining 56 are located within *severe* flood hazard areas and are collectively valued at $16,954,000 (July 2023).

According to data provided by MEMA in July 2023, there are 16 properties in Methuen that since 1978 have sustained repetitive flood losses.[135] Twelve of the sites are classified as single-family residential. Three repetitive loss properties are commercial/non-residential and one site is listed as 2-4 family residential. In total, these 16 properties have resulted in the payout of 50 National Flood Insurance Program claims totaling $903,548.5 since 1979. Methuen also has one non-residential property classified as a severe repetitive loss site with 4 recorded losses with claims totaling $75,492.

Based on the frequency, areal extent, and severity of historical floods in Methuen, City officials consider the community to be at ***high risk*** from flooding.

Extreme Temperatures

While the Merrimack Valley, like the rest of the region, is experiencing greater extreme heat, Methuen and other more developed communities within the region are feeling the effects to a greater degree. Impervious surfaces such as pavement and roofs absorb and re-emit heat more than natural landscapes such as grass and trees. This results in urban areas maintaining more heat and can lead to a cascade of effects including increased energy consumption, air pollution, greenhouse gas emissions, and health problems. During periods of extreme heat, Methuen issues public heat advisories, and makes cooling stations available to residents at multiple locations across the City. With climate change predicted to cause more extreme summer temperatures, more urban communities like Methuen will continue to be impacted.

To combat this challenge, Methuen has partnered with Groundwork Lawrence to plant trees across the City as part of the Greening the Gateway Cities Program. This program is focused on increasing tree canopy cover in urban residential areas. In the spring of 2023, 120 trees were planted in Methuen through the program.

Response Management Capacity

Methuen has a full-time professional Police Department and Fire Department. The Police Department is staffed by a total of 98 professional employees, 16 dedicated civilian employees, and an additional 5 administrative staff members. The Police Department is the primary answering point for the Enhanced 911 System and handles approximately 33,000 calls each year. The department is led by the Chief of Police Scott McNamara and divided into three Bureaus: Field Operations, Support Services and the Criminal Investigations Bureau. Each Bureau is headed by a Captain who responds directly to the Executive Captain to the Chief of Police.

The Fire Department has 106 full-time employees with an additional three administrative staff. The Department runs four (4) Engines, one (1) Ladder, one (1) Rescue and two (2) Ambulances, and one (1) incident Command Vehicle out of four Stations. All personnel are trained at the Massachusetts Fire Academy's

[135] Massachusetts Emergency Management Agency. 2023. *NFIP Summary Data Report* – 7/25/2023.

nine-week recruit training program. In addition to firefighting duties, fire personnel provide emergency medical care to the citizens and visitors to the City of Methuen. The Methuen Fire Department provides emergency ambulance service. The Department provides Basic Life Support (BLS), while Advance Life Support (ALS) is provided by Paramedics from the Lawrence General Hospital. All Fire Department personnel are trained and certified as Emergency Medical Technicians (EMTs), at both the Massachusetts and National level. The MFD is led by the Fire Chief Tim Sheehy.

The City has a range of departments that further bolster its emergency response capacity. This includes the Community Development Department, Health Department and Board of Health, as well as the City's Department of Public Works. Maintenance of City infrastructure falls within the Department of Public Works organized in nine department divisions: Management, Engineering, Building Maintenance, Environmental Management, Equipment Maintenance, Highway, Water Distribution, Water Treatment and Sewer Maintenance.

Natural Hazards Risk Assessment

Through using the City of Methuen's previous Hazard Mitigation Plan, in association with other planning documents including Methuen's Comprehensive Emergency Management Plan, and Municipal Vulnerability plan, natural hazards for the City were considered. On the basis of this analysis, Methuen considers itself to be at ***high risk*** from floods, extreme temperatures, high winds/thunderstorms, and severe winter storms; ***moderate risk*** from droughts, invasive species, hurricane/tropical storms; and ***low risk*** from wildfires, riverine erosion, landslides, earthquakes, and tornadoes. Because Methuen is an inland community, it does not consider itself to be at risk from coastal flooding or tsunamis.

Table 5.37 Methuen's risk rating for the 15 natural hazards experienced in the Commonwealth.

Methuen Natural Hazard Risk Rating	
Natural Hazard	**Community Risk Rating**
Inland Flooding	High
Extreme Temperatures	High
High Winds/ Thunderstorms	High
Severe Winter Storms	High
Drought	Moderate
Invasive Species	Moderate
Hurricane/Tropical Storm	Moderate
Wildfires	Low
Coastal/Riverine Erosion	Low
Landslide	Low
Earthquake	Low
Tornadoes	Low
Tsunami	NA
Coastal Flooding	NA

Continue to page 198 of the Plan to review Methuen's next section: ***City of Methuen Natural Hazard Challenge Statements.***

5.2.7 Town of Newbury Natural Hazard Risk Assessment

Community Profile


Newbury Upper Green

The Town of Newbury is a small rural-residential community located 28 miles north of Boston in the historic North Shore region. The Town covers approximately 23.4 square miles and features an intricate tapestry of scenic vistas, woods, wetlands, working farms, salt marsh, and ecological communities that define the Town's present landscape and serve as a vital link to its proud agrarian and coastal historic and current identity. Included within Newbury are large tracts of undeveloped land and salt marsh containing some of the most significant and fragile natural resources found anywhere on the North Shore or in the Commonwealth. These include the Parker River National Wildlife Refuge, the Great Marsh, state Wildlife Management Areas, and the "Common Pasture," to name a few.

The Town contains three distinct sections, each with its own identity:

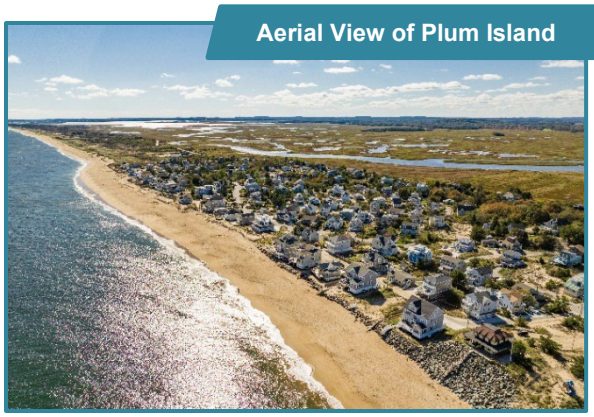
Old Town: Located along Route 1A/High Road, Old Town is anchored by two Greens – the Lower Green near the southern end, close to the Parker River and the landing place of the first settlers who founded Newbury in 1635, and the Upper Green at the northern end, close to the municipal boundary with Newburyport. The Upper Green, which is in a National Register Historic District, is a classic village green, surrounded by historic homes, former farmhouses, municipal buildings, and a few businesses. Historic houses and a few working farms are located along the length of High Road (Route 1A), indicating the original development pattern of Old Town. Since the 1950s, new residential development has slowly radiated out from the Greens along High Road, Parker, Hanover, and Hay Streets, and Newman Road, and a number of residential subdivisions have been built.

Byfield: Created as a parish of Newbury in 1706, Byfield is located in the western part of the Town, west of Route 1. Byfield Village, located around the intersection of Central and Main Streets, is the "commercial" center of Byfield and, like the area around the Upper Green, is comprised of a relatively dense cluster of houses, small service-oriented businesses, and municipal facilities, including Newbury's library and the currently rented Municipal Offices. Byfield contains the Middle School and High School for the Triton Regional School District, as well as The Governor's Academy, an independent day and boarding high school founded in 1763. The remainder of Byfield is primarily residential, with some remaining farms and agricultural land. As in Old Town, residential development since World War II has moved out from the Village center along main roads and within new suburban subdivisions.

Plum Island: Plum Island is a barrier island fronting the Atlantic Ocean at the eastern end of Newbury. The island includes land owned by Newburyport, Newbury, Rowley, and Ipswich (from north to south) as well as conserved areas owned by federal and state agencies (the Parker River National Wildlife Refuge and the Department of Conservation & Recreation's Sandy Point State Reservation). The developed portion of the island includes land in both Newbury and Newburyport and reflects the character of a one-time vacation retreat with small ("postage stamp") lots created by the Plum Island Beach Company in the 1920s and many modest "summer camp" style homes. In recent years, following the installation of municipal water and sewer in 2007, scores of the original homes have been converted or demolished and rebuilt as year-round residences. Plum Island Center, located along Plum Island Boulevard between Northern Boulevard and Old Point Road, is a mixed-use area containing both residences and small businesses, and is the primary access to

the beach. Plum Island Turnpike provides the sole means of access on and off the island. The southern end of the Island is undeveloped and owned by the Parker River National Wildlife Refuge and the Department of Conservation & Recreation (Sandy Point Reservation).

Aerial View of Plum Island



Newbury has low-lying and gently rolling terrain ranging from sea level to 168 feet above mean sea level at its highest point, on top of Old Town Hill in Old Town. A current GIS analysis for Newbury uses both land cover and land use data derived from the state's most updated 2016 land cover layer.[136] Predominant *land cover* in Newbury is wetland (38%) and forest (36%), followed by open land (12%), agricultural land (6%), and open water (5%) and developed impervious land (5%). According to assessor's data, *land use* in Newbury is primarily recreational (61%), followed by residential (26%), agricultural (7%), transportation (3%), open water (1%), and commercial/industrial (1%).

The 2020 population in Newbury was 6,716, a minor increase of 50 residents (0.75%) from the 2010 population.[137] In the most recent census (2020), Newbury had 2,533 households, and the average household size was 2.6 people. The UMass Donahue Institute projects that by 2030 the population of Newbury will drop to 6,311, a decrease of 6%. [138]

Newbury Saltmarsh

The Town of Newbury has one public elementary school, Newbury Elementary, and hosts two public regional schools, Triton Middle and Triton High School. The Governor's Academy, a private day and boarding high school, is also located within Newbury. In addition, some students in Newbury attend Essex Technical High School, located in Danvers, and Whittier Regional Vocational Technical School, located in Haverhill. Across the public school system, a total of 1,381 students are enrolled, with Newbury residents accounting for 672 or 48% of these students. The Governor's Academy has another 406 students enrolled, with 19 of them identified as Newbury residents.

Public drinking water is provided to some areas of Newbury by either the Byfield Water District in the western part of Town or the City of Newburyport Water Department in the eastern part of Town and Plum Island. Approximately 569 households in Newbury rely on private drinking wells. The majority of households and businesses have individual on-site septic systems for wastewater disposal. However, Plum Island and some northern portions of Old Town are serviced with public sewer through the Newburyport Wastewater Treatment facility. Governor's Academy operates its own wastewater treatment plant, which discharges into the Mill River. National Grid provides gas and electric services to Newbury.

Recent Development and Land Use Changes

Transportation access to and from Newbury is convenient owing to the presence of Interstate 95, which runs north-south near the western end of the Town. The Town also benefits from proximity to I-495, which is not only a major circumferential highway around the Boston metropolitan area, but also serves as a primary

[136] MassGIS. 2019. 2016 Land Cover/Land Use. MassGIS Data: 2016 Land Cover/Land Use | Mass.gov
[137] United States Census Bureau. 2023. QuickFacts. U.S. Census Bureau QuickFacts: United States
[138] UMass Donahue Institute. 2022. Massachusetts Population Projections. UMass Donahue Institute | Population Projections

connector to the seacoast region of southern New Hampshire and Maine. State roads passing through Newbury are Routes 1 (Newburyport Turnpike) and 1A (High Road). The section of Route 1A in Newbury is part of the Essex National Heritage Area's Essex Coastal Scenic Byway.

According to Newbury's Local Hazard Mitigation Planning Team (LHMPT), there have been 17 noteworthy development projects in the community since the last 2016 Hazard Mitigation Plan update. Seven of these are commercial, seven residential, one mixed-use, one municipal, and one educational. These projects are summarized below (*Table 5.38)*.

Table 5.38 Major development projects in Newbury initiated since 2016.

Newbury Major Development Projects 2016-2023				
Facility Type	**Common Name**	**Address**	**Square Feet/ Housing Units**	**2023 Status**
Commercial	Yoga Studio- Roots to Wings	76 Newburyport Tpke.	5,295 + 14,300 s.f. paving	Complete
Commercial	Newbury Self Storage	131 Newburyport Tpke.	~365,904 s.f. (building and surrounding asphalt)	Complete
Commercial	Newbury Golf Center and Ice Cream	131 Scotland Rd	2,550	Complete
Municipal	Newbury Police Station	7 Morgan Ave	4,795 + asphalt lot for 41 vehicles	Complete
Commercial	K & R Construction	84 Boston Rd	6,500 + asphalt lot for 10 vehicles	Construction
Mixed-used	Condo and Retail Space	3 Newburyport Tpke.	15,000 + 5,000 s.f. paving/ 14 units	Construction
Commercial	The Sunset Club	4 Old Point Rd	400	Complete
Commercial	Ground Mounted Solar PV Facility	140R Main St (Byfield)	NA	Complete
Educational	Science Center Governor's Academy	313 Newburyport Tpke.	6,200	Complete
Commercial	Ground Mounted Solar PV Facility	75 Boston Rd	NA	Permitted
Residential	40B	55/55R Pearson Dr	24, including 6 affordable units	Permitted
Residential	Colantoni Crossing (subdivision)	108 Main St	5 single-family	Permitted
Residential	Gadsden Lane (subdivision)	217/221 High Rd	4 single-family	Construction
Residential	Farm View Lane (subdivision)	68 Green St	3 single-family	Construction
Residential	Fieldstone Lane (OSRD)	15 Coleman Rd	6 single-family	Construction
Residential	Fields Way (subdivision)	170 Orchard St	4 single-family	Permitted
Residential	Seagate (OSRD)	105 High Rd	9 single-family	Construction

Two commercial developments listed above are Ground Mounted Solar PV Facilities. One of these facilities has been constructed on property consisting of approximately 93.6 acres located off of Main Street in Byfield; the other will be constructed on the Town's capped landfill off of Boston Road in Old Town. A special permit was granted by the Planning Board for each of these projects. Development for the project in Byfield included clearing of approximately 12 acres of existing forested area in order to construct a 2.795 mW Ground-Mounted Solar PV Installation and associated stormwater infiltration trenches, redevelopment of an existing cart path and installation of a bridge to serve as primary access to the solar facility and redevelopment of a second existing cart path into a secondary utility access roadway, along with installation of a 150-foot-long

truss bridge. Approximately 82 acres of the property are subject to a Conservation Restriction. The second project at the Town Landfill has been permitted and construction is anticipated to commence in 2024. Development will include construction of a proposed ground-mounted 573.3 kW (DC) +/- photovoltaic installation on the Town's capped landfill and improvement of an existing access road on the property.

Newbury is also actively working to preserve and conserve land within the Town, including parcels that have resiliency benefits. Since the 2016 update, a total of nine new parcels have been conserved within Newbury, totaling 92.9 acres of land (*Table 5.39)*. This work has been achieved through collaboration at the local, municipal and state level with partners that include Essex County Greenbelt and the Massachusetts Department of Fish and Wildlife. Subdivisions permitted by the Planning Board, including Open Space Residential Development projects (OSRDs), have also resulted in open space protection, public recreational opportunities, and preservation of active agricultural areas and historic resources.

In reviewing development and local conditions since adoption of the 2016 Multi-Hazard Mitigation Plan, the local planning team identifies that the Town has become marginally more vulnerable to natural hazards. While Newbury has experienced increased development since 2016, risk has largely been mitigated through application and enforcement of local bylaws and regulations, the building code, and efforts to control stormwater runoff and to elevate new and substantially improved structures in areas subject to flooding. Changes in vulnerability have resulted from impacts of climate change, rather than significant alterations in land use and development within the Town. Newbury's vulnerability has been most pronounced on Plum Island, a densely developed beach community of approximately 1,200 homes in Newbury and Newburyport. Severe storms are consistently impacting access to and development on the island, with flooding and wind that affects homeowners and businesses, as well as causing impacts on the beach, such as erosion, and on other natural resources, such as salt marsh degradation. In the face of these ongoing impacts, the Town has taken multiple steps to manage the community's vulnerability. These steps include encouraging homeowners to pursue more resilient redevelopment (e.g. elevating structures in flood-prone areas) and partnering with our neighbor, Newburyport, to reduce the vulnerability of shared roads, utilities, and other infrastructure (e.g. sewer and water supply). In addition, small-scale development in the town is required to include robust review of stormwater impacts and encouragement of nature-based solutions. The Town has also increased its efforts at more effective communications, education, and strategies for public safety.

Table 5.39 Newly conserved or preserved land in Newbury since 2016.

Newbury Newly Conserved or Preserved Land 2016-2023				
Property Name	**Address**	**Area (acres)**	**Owner**	**Year completed/projected**
Stichter	18 Marsh Avenue	7	CR held by ECGA	2016
Purinton	Main St	0.08	Owned by ECGA	2019
Creed	Orchard St	14	Owned by ECGA	2019
Cavanagh	254 Middle Road	2.987	CR held by ECGA	2020
Aham Saltmarsh	High Road	8	Owned by ECGA	2022
Fieldstone Way	15 Coleman Road	27.181	Owned by ECGA	2022
Witchstone Lot	15 Coleman Road	0.017	Owned by Newbury/Historical Commission	2023
Cavanagh	254 Middle Road	14	Owned by MA DFW	2020
Morrison	247 (Rear) Middle Road	19.6	Owned by MA DFW	2020

Community Lifelines

A list of selected community lifelines (emergency operations centers, hospitals/healthcare centers, public shelters) is shown in *Table 5.40* and was derived and updated from the Town's Comprehensive Emergency Management Plan (CEMP) and from conversations with local personnel. The locations of these and other community lifelines in Newbury were entered by MVPC into an Excel database and subsequently incorporated into MVPC's ArcGIS for use in digital mapping. As part of the plan update, the full list of community lifelines was reviewed and amended to reflect current conditions, as well as to incorporate new facilities and resources. The full list of community lifelines is depicted in the Newbury map series that is presented in Appendix B of this Plan.

Table 5.40 Select list of Newbury's community lifelines (emergency operation centers, hospitals, and shelters).

Newbury Emergency Operation Centers, Hospitals, and Shelters						
Facility Type	**Common Name**	**Street Address**	**Health Facility Type**	**Maximum Capacity**	**Feeding Capability**	**Emergency Generator Available**
Emergency Operations	Newbury Police Department	7 Morgan Ave	N/A	N/A	N/A	Yes
Hospitals and Healthcare Centers	None					
Emergency Shelters	Plum Island Taxpayers Association (PITA Hall)	8 Plum Island Blvd.	N/A	85-125	Yes	Yes
	Newbury Elementary	63 Hanover St.	N/A	500	Yes	Yes
	Triton Regional Middle & High School	112 Elm Street	N/A	1,500	Yes	Yes
	Governor's Academy	1 Elm Street	N/A	1,000	Yes	Yes
	Former Newbury Town Hall	25 High Road	N/A	74	No	Yes

Critical Infrastructure

Bridges: The Town of Newbury has 20 bridges within its municipal borders.[139] Of these bridges, nine (9) are municipally owned, with the remaining eleven (11) bridges owned and maintained by MassDOT. More than two-thirds (16) of the bridges are categorized as waterway bridges, with the remaining intersecting roadways or other features. There are currently three (3) bridges classified as structurally deficient in Newbury, the U.S. Route 1 NB bridge along the Newburyport Turnpike located over the Little River, the Central Street Bridge over the Parker River, and the Sgt. Donald Wilkinson Bridge along Plum Island Turnpike (*Table 5.41)*.

[139] MassDOT. 2024. Bridges. Bridges | Bridges | MassDOT Open Data Portal (arcgis.com)

Table 5.41 List of Newbury's structurally deficient bridges as identified by the Massachusetts Dept. of Transportation.

Newbury Structurally Deficient Bridges					
Bridge Name	**Feature Intersected**	**Owner**	**Year Built**	**Structurally Deficient**	**Last Inspection Date**
Route 1 NB	Little River	MassDOT	1922 improved 1935	Yes	7/27/2023
Central Street	Parker River	Municipality	1968	Yes	7/25/2022
Sgt. Donald Wilkinson Bridge	Plum Island River	MassDOT	1978	Yes	9/14/2022

During development of the first Merrimack Valley Region Multi-Hazard Mitigation Plan in 2008, the (then) Massachusetts Highway Department listed two additional bridges in Newbury as being "Structurally Deficient": the Route 1A bridge over the Parker River and the Bill Plante Memorial Bridge over the Little River. However, in 2008, both of these outmoded bridges were replaced with modern structures that now meet the latest AASHTO structural standards. In the summer of 2016, repairs, including new deck beams and a new railing system, were made to the Main Street Bridge which spans approximately 20 feet over the Parker River; repairs were funded by the State's Municipal Small Bridge Program. The Wheeler Brook culvert, also on Larkin Road, failed in September 2014 and was closed to vehicular traffic. In 2022 the culvert was replaced with a new culvert designed in accordance with current standards and Larkin Road was re-opened to through traffic in January 2023. The Town is now working on two additional bridge projects - replacement of the Central Street Bridge over the Parker River, for which design is complete, and replacement of the River Street Bridge over the Parker River, for which Newbury has received a design grant. Two culvert replacements on Orchard Street are also being planned. Design and permitting for replacement of the Orchard Street culvert over Cart Creek is complete and planning is underway for replacement of the Orchard Street culvert over Courser Brook.

The Sgt. Donald Wilkinson Bridge along Plum Island Turnpike has more recently been designated as "structurally deficient" and is undergoing structural repairs by MassDOT. Starting in March 2024, MassDOT installed a temporary traffic control plan to reduce speed and shift traffic over the drawbridge, as well as restricted opening for marine vessels to allow for repairs as part of an ongoing $7.7 million district-wide drawbridge operations and repair contract. Work is expected to conclude in August 2024. The operation of this bridge is critical as it serves as the only access point on and off the barrier beach.

Dams: The DCR Office of Dam Safety lists eight (8) Newbury dams on its statewide dam classification inventory.[140] These are: Blackwell Dam, impounding Blackwell Pond; Highfield Road Dam, impounding Highfield Road Pond; Central Street Dam, impounding the Parker River; Snuff Mill Dam, impounding the Parker River; Main Street Dam, impounding the Parker River; Parker River Dam North at River Street, impounding the Parker River; Parker River Dam South at River Street, impounding the Parker River; and Triton Dam, impounding a tributary of the Parker River. None of Newbury's dams are classified by DCR as either a "high hazard" or a "significant hazard."


Central Street Dam

A ninth dam, the Larkin Road Dam, was downgraded by DCR to "non-jurisdictional" status as it no longer

[140] MassGIS. 2012. Dams. MassGIS Data: Dams | Mass.gov

impounds enough water to pose a risk. As part of the Parker River Restoration Project, Newbury is actively working with the Ipswich River Watershed Association, the Massachusetts Department of Ecological Restoration (DER), the Massachusetts Department of Fisheries and Wildlife (DWF), and the National Oceanic and Atmospheric Administration (NOAA) to remove the Larkin Dam to restore natural flow of the river and to improve fish passage and other wildlife habitat. With the support of state and federal funding, Newbury is now in the final design and permitting for this project which has been worked on for more than a decade.

Community Specific Hazards

Newbury's LHMPT reviewed the full range of natural hazards that impact Massachusetts, as identified through the State Hazard Mitigation and Climate Adaptation Plan. The majority of the natural hazards considered impact the Merrimack Valley Region in a similar way. For those that have a different or locally-specific impact on the Town of Newbury, additional information has been supplemented in this section.

Flooding

Newbury is located within the watersheds of both the Merrimack River and Parker River. The Town has an abundance of surface waters, ranging from the Parker River that bisects the lower third of the community, to the Atlantic Ocean that forms the Town's eastern border, to the innumerable small tidal creeks that interlace the vast Great Marsh lying behind Plum Island. Fresh water wetlands abound as well.

The *Parker River* mainstem flows eastward from its headwaters in the Town of Boxford through Groveland and Georgetown and finally into Newbury. The river is fresh water upgradient from the Central Street dam, then becomes brackish on its course to Plum Island Sound. The tidal portion of the Parker River runs roughly nine miles. The dominant land uses in this area are forest and salt marsh.

The *Little River*, a major tributary to the Parker River, is roughly seven (7) miles long and flows south through neighboring Newburyport into Newbury. About four (4) miles of the Little River are tidal. The Little River subwatershed contains the Newburyport Industrial Park; commercial retail properties; an inactive, unlined landfill in Newburyport; a lined and capped landfill as well as an active transfer station in Newbury; agricultural land; and protected open space.

The *Mill River*, another major Parker River tributary, begins in the Georgetown-Rowley State Forest and runs north-northeasterly through Rowley until it joins the Parker River at Oyster Point about a mile east of The Governor's Academy. The lower section of the Mill River forms the boundary between Newbury and Rowley. The Mill River drainage area is the largest Parker River subwatershed (at least 8,200 acres in size). Mill River tributaries in neighboring Rowley include Muddy Brook, Great Swamp Brook, Bachelder Brook, and Ox Pasture Brook. The Mill River, also once known as Mill Creek, derives its name from the several mills it once powered.

Areas of Common Flooding: Because Newbury is both a water-rich and a low-lying coastal community, significant portions are located in Special Flood Hazard Areas (SFHA) and thus are susceptible to flooding. This is especially the case when high river flows from heavy rains coincide with high ocean tides. Town Conservation and Highway Department personnel along with LHMPT members have documented and confirmed fifteen (15) locations in Newbury that either flood on a regular basis or represent a significant potential flood hazard (*Figure 5.6).* These include 1: Plum Island (multiple locations), 2: Plum Island Turnpike, 3: Pine Island Road, 4: Cottage Road, 5: Newman Road, 6: Hay Street at the intersection with Newman Road, 7: Middle Road at Tolman's Auto, 8: Highfield Road, 9: Middle Road at Thurlow's Bridge over the Parker River,

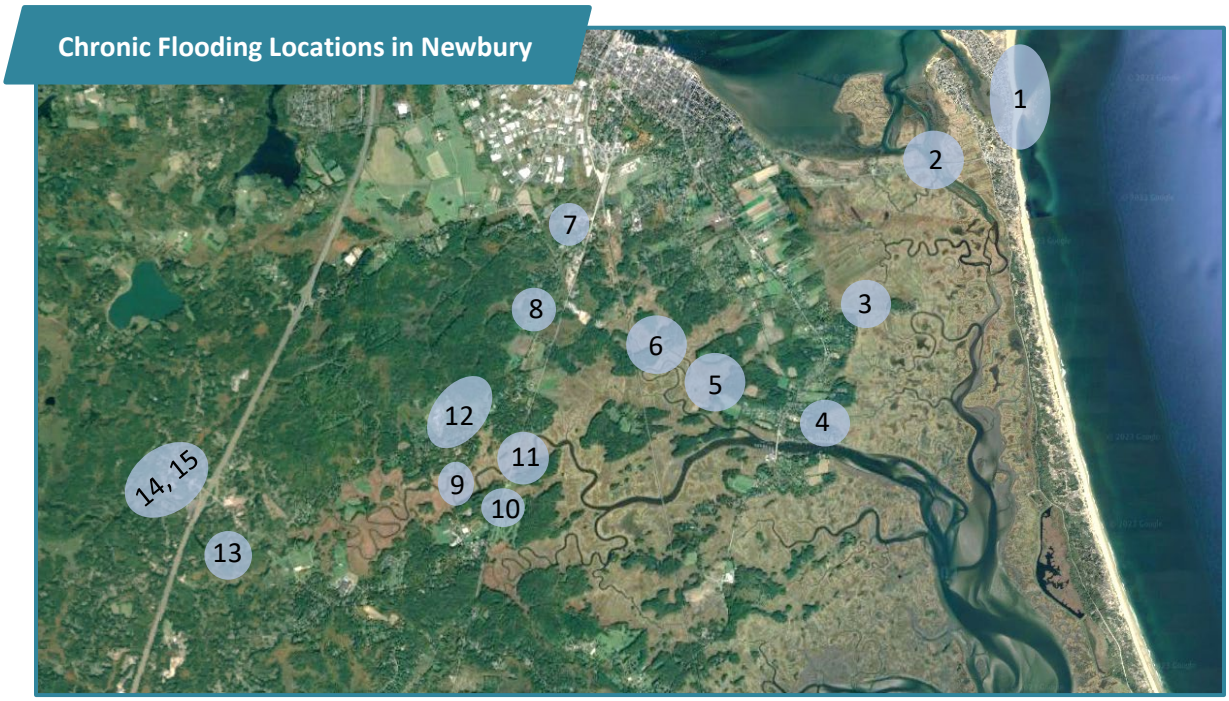


Figure 5.6 Chronic flooding locations identified across Newbury by the Local Hazard Mitigation Planning Team.

10: Newburyport Turnpike near Ould Newbury Golf Course, 11: Newburyport Turnpike at the Parker River Bridge, 12: Orchard Street at Cart Creek and Courser Brook; 13: Larkin Road, 14: River Street, 15: Moody Street near Ash Street intersection.

Of these locations, Plum Island has garnered attention in recent years due to the limited accessibility that flooding causes island residents and visitors. In January 2024, two back-to-back storm systems caused major flooding on Plum Island, resulting in closure of the Plum Island Turnpike, which acts as the only vehicular access road on and off the island. In preparation for closures, Newbury stationed emergency personnel (Police and Ambulance) on the Island to ensure services were available during the closure. These closures occurred during periods of moderate high tides, paired with periods of precipitation, and southeasterly winds.

In addition, the January 2024, storm events caused flooding on Plum Island and elsewhere in Town that was more significant than the 2006 Mother's Day storms. The Town's emergency management team conducted two water rescues from vehicles, one on Middle Road and another on Newman Road, using MEMA's high water rescue vehicle. Acquiring a rescue vehicle for the Town is under consideration by the Police and Fire Departments. As climate change causes increased sea level rise, more intense precipitation and storm events, closures like these are expected to become more common.

Flooding Vulnerability Assessment: A GIS analysis of the Town's most recent (2023) FIRM flood hazard areas by MVPC has determined that a total of 7,825 acres (12.3 sq. mi.) of land area and salt marsh in Newbury is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 182.6 acres (0.3 sq. mi.) lies within the 500-year floodplain. Together, these two flood zones constitute forty-eight percent (48%) of the total area of the community. Among the communities in the Merrimack Valley region, Newbury has the highest percentage of land area within the floodplain. Future development of open space within Newbury could increase the impervious surface

cover and stormwater runoff volumes in the two flood zones, thereby exacerbating the existing flooding problems.

Table 5.42 List of Community Lifelines located across Newbury within the 100 and 500-year floodplain.

Newbury Community Lifelines within Floodplain 100-Year Floodplain		
Feature	**Category**	**Generator**
Airport	Plum Island Community Airport	No
Pump Station	Plum Island Sewage Pump Station	No
Community Building	Plum Island Taxpayers Association (PITA Hall)	Yes
500-Year Floodplain		
Well (at Boston Rd & Middle Road)	Well water source for Fire Dept	No

As part of the mapping analysis, MVPC also investigated the presence of any community lifelines at potential risk of future flood damage or loss. Four (4) such facilities have been identified in floodplains, collectively valued at $2.5 million (*Table 5.42)*. These sites are feeling the impact of flooding today, with PITA Hall, the Plum Island Taxpayers' Association community center, recounting common occurrences of water backup in and through the drains during periods of flooding. While located in neighboring Newburyport, the Water Street Sewer Pump Station services Newbury and Newburyport residents on Plum Island. Due to its position within the 100-year floodplain, the City of Newburyport has identified the Pump Station as a critical facility and listed it on their five-year HMP Action Plan. As a vital resource for both Newburyport and Newbury residents, the Town of Newbury has also identified the Pump Station and its long-term functioning as key to daily operations within the Town.

MVPC also examined *non*-critical facilities in the floodplain areas. This analysis revealed the presence of 1,082 residential, commercial, industrial, and institutional structures in the floodplains. This accounts for 24.7% of all buildings in Newbury. Based on current (2023) Assessor records, these structures are collectively valued

at $594.7 million. The current figure of 1,082 structures on Newbury properties within the floodplain represents a greater than eight-fold increase in structures within Newbury's flood zone since preparation of the first Hazard Mitigation Plan. In 2008, 124 buildings in Newbury were located within the 100-year floodplain. In 2016, that number jumped to 799 buildings.

The number of critical facilities identified within floodplains in this plan update is higher than the 2016 update which identified two. However, it is important to point out that the increase of structures and critical facilities within floodplains is not the result of new building construction in the floodplain since 2008, but rather is due to the Town's adoption in 2012 and 2014 of the updated FIRM maps prepared by FEMA. The new maps expanded the previous (1979) flood hazard area in Newbury by 223 acres in 2012 and by another 1,023.9 acres in 2014. Many structures that formerly were located outside of the floodplain now fall within the floodplain. Additionally, the 2024 plan includes structures within both the 100 and 500 floodplain for more targeted planning in the face of sea level rise and intensive climate change events, and uses an expanded definition of critical facilities based on FEMA's definition of Community lifelines.

Flooding on Middle Road
January 2024

NFIP Information: Newbury actively participates in the National Flood Insurance Program (NFIP). The Town's initial Flood Hazard Boundary Map (NHBM) was identified in 1974, and the initial Flood Insurance Rate Map (FIRM) was identified in 1977. The latest effective FIRM was adopted in 2014. The Flood Hazard Management Program anticipates a new FIRM and Flood Insurance Study (FIS) will be available for adoption in 2024. Newbury intends to update their local regulations to adopt the new maps and study ahead of the effective date, anticipated in summer 2025. This will require updating Newbury's Zoning Bylaw (Article IV, Regulation of Overlay Districts, Section 97-4.E. Flood Hazard), where minimum floodplain management criteria appear. Newbury implements and enforces local floodplain management regulations in Special Flood Hazard Areas (SFHAs) through requirements associated with the Planning Board (location within flood zone, base flood elevation, and ground elevation) and the Conservation Commission (to ensure compliance with conservation bylaws). Newbury's Building Commissioner is the enforcement officer for the NFIP requirements. Following an event, substantial improvement/substantial damage provisions are addressed by the Building Commissioner, who determines the value of the structure and the allowed dollar value of work that can be done before the structure must come into compliance with the floodplain regulations.

According to data provided by MEMA, as of 2023, there are 17 repetitive flood loss sites in Newbury.[141] The majority of these sites are single-family residences (13), followed by multi-family/ condominium residences (2) and non-residential and other properties (2). Flooding incidents at these sites have resulted in the payout of 45 National Flood Insurance Program claims totaling $1.85 million since 1978.

Town-wide, there are 400 flood insurance policies in place for properties located in FIRM flood hazard areas. The combined insurance value in-force for these properties is $122,126,000. There are an additional 109 policies for properties in severe flood hazard areas (SFHA) in Newbury, totaling $27,293,000 (*NFIP Policy Statistics for Massachusetts, 2023*). Newbury carries out a broad array of floodplain management activities in compliance with the requirements of the NFIP. These are detailed later in the plan in Newbury's Existing Capabilities Section.

Based on the frequency, areal extent, and severity of historical floods and storm surges in Newbury, especially on and around Plum Island, Town emergency management officials consider the community to be at ***high risk*** from flooding.

Coastal erosion

Heavy precipitation events and coastal storms impact Newbury beyond coastal and inland flooding. Along Plum Island, a barrier beach system that includes developed portions of Newbury and Newburyport, coastal erosion has removed large swaths of beach frontage and seriously damaged or destroyed a number of ocean-side structures. In 2013, a March Nor'easter wreaked havoc on Plum Island, demolishing six homes, and seriously damaging seven more, while putting an additional 24 in imminent danger.

Since 2016, Plum Island has experienced an average of 2-3 major storms each year, including major storms in March of 2018, February 2021, January 2022, and March 2023. As an exposed barrier beach system, Plum Island acts as the first line of defense against large waves, wind, and heavy precipitation – a service that will be impacted by events that cause greater erosion.

[141] Massachusetts Emergency Management Agency. 2023. *NFIP Summary Data Report* – 7/25/2023.

Wildfire/Brush Fires

In addition to large wooded areas in Newbury (Crane Pond Wildlife Mgmt. Area, Martin H Burns Wildlife Mgmt. Area, and Old Town Hill), the Newbury Fire Chief shared that because salt marsh areas in Town are expansive and hard to access, they can be highly vulnerable to fire. Newbury has identified that it is most vulnerable to fires during periods of drought when groundwater tables are exceedingly low, there is no moisture in the air (low humidity), and during periods of somewhat regular coastal wind. Since the last hazard mitigation plan update (2016-2023), Newbury firefighters have responded to 119 brush fires throughout the community. These fires have been small in scale and occurred primarily during the dry season. Based on the number, frequency, and areal extent of brush fires in the community, Town emergency management personnel have assigned a ***moderate risk*** to the hazard of brush fires in Newbury.

Invasive Species

With an abundance of forest, salt marsh, and freshwater rivers and wetlands, Newbury has a diversity of habitats that are at risk from invasive species. Efforts to control invasive saltmarsh species such as perennial pepperweed (*Lepidium latifolium*) and the common reed (*Phragmites australis*) have been underway for nearly two decades. Removal and treatment for both invasives have been conducted across the region through partnerships with federal, state, and local entities. Efforts have been substantial to reduce and manage mono-cropping of these invasive vegetative plants across Newbury, allowing for native plant species to thrive, which in turn support critical wildlife species. In addition to these two prolific invasive salt marsh species, Newbury has also identified a range of other invasives species including: Japanese Knotweed, Oriental Bittersweet, and Autumn Olive.

Natural Hazard Management and Response

Newbury is a small rural-residential community with limited Town government that is almost entirely dependent on residential property taxes for financing local government operations. Planning for and responding to recurring incidents of flooding, coastal storm surges and erosion, and other natural hazards is an ongoing challenge for community officials. The response team for natural disasters in Newbury includes the Police Chief, Fire Chief, Town Administrator, Building Commissioner, Conservation Agent, Health Director, and Chief Harbormaster, as well as personnel within their departments.

The *Newbury Police Department* (PD) currently maintains a roster of 12 full-time officers and 2 part-time officers; beginning July 1, 2024, the number of part-time officers will be reduced to one (1). In 2022, the Police Department responded to 21,255 incidents, up from 20,596 incidents in 2021. The Police Department maintains an active outreach and education program, including the School Resource Officer program in conjunction with the Triton Regional School District and the House Check Program. The Police Department is the Emergency Management response agency for the Town. The Newbury PD is also part of NEMLEC (Northeast Massachusetts Law Enforcement Council), which provides comprehensive emergency response. This affiliation affords the Town of Newbury access to dozens of personnel and equipment for searches and rescues as well as scene security during hazard events.

The *Newbury Fire Department* (FD) has seven (7) full-time employees and 40 on call/per diem fire fighters. There are two (2) Fire Stations in Town. The Byfield Station, which is located at 44 Central Street, was built in 2005, and is typically staffed Monday through Friday during the day. The Newbury Station, located at 3 Morgan Avenue in the Old Town section of Newbury, is staffed 7 days/week, 24 hours/day. All shifts are complemented by call Firefighters and EMT's as available. In 2022, the Fire Department responded to a total of 1,510 calls.

The *Newbury Department of Public Works* (DPW) maintains all the Town's buildings and facilities, as well as

public roads and parks. Utilizing a staff of eight (8) full-time employees, DPW maintains approximately 54 miles of road and 17 parks and open space properties, services all Town vehicles, maintains 457 public catch basins, and cleans the streets as needed with a Town-owned street sweeper. The DPW is the department primarily responsible for implementing the Town's NPDES Phase II Stormwater Management Regulations. For snow plowing operations, the DPW has eight (8) plow trucks (one of which currently serves as a spare), one excavator, and two front-end loaders. They depend on 15-20 hired contractors to assist with plowing.

Newbury's *Building Commissioner* serves as the Town's Zoning Enforcement Officer, Americans with Disabilities Act (ADA) Administrator, and National Flood Insurance Program (NFIP) Coordinator. The Building Commissioner's responsibilities are wide-ranging and include: 1) interpreting and enforcing the Massachusetts State Building Code and all applicable codes as they relate to it; 2) interpreting and enforcing the Town's zoning by-laws; 3) issuing building permits and assisting contractors and property owners in the permit application process; and 4) performing site inspections to ensure compliance with the State Building Code and permitted plans.

Newbury's *Chief Harbormaster* is responsible for managing the Town's harbor and navigable waters, enforcing waterways by-laws and Massachusetts General Laws, and responding to emergencies on the waterways. In addition to carrying out administrative duties, the Harbormaster participates in marine rescues, manages recovery and securing of boats lost or adrift, patrols the Town's shorelines and waterways enforcing local, state, and federal laws and regulations, and issues citations and warnings for violations of the law. The Harbormaster also oversees maintenance of all Town piers, launching ramps, and docks, as well as the installation and maintenance of channel markers and all other aids to navigation. The Harbormaster also manages responses to oil spills and calls for marine mammals in distress.

Newbury also utilizes a number of resources to support their emergency management and response:

- *Command Post Trailer (CP2):* The Town has a Command Post Trailer (CP2) that is fully equipped with heat and air conditioning, radios for Police, Fire, and MEMA personnel, as well as internet access and complete dispatch capabilities, scene lighting, a 10,000-watt generator, a command table for seven, and a radio operator station. This command post is used for deployment at events requiring a unified command.
- *ARGO Purchased for Off-road Emergency Response/Rescue:* This track vehicle is capable of transporting emergency personnel into hazardous areas and hard-to-reach locations for rescues and fire response. It is capable of navigating water, deep snow, and steep dunes, and is equipped with a stretcher attachment that allows Emergency Medical personnel to treat injured parties during extractions.
- *M1 Utility Terrain Vehicle (UTV):* This UTV is registered and capable of traveling on public ways and off-road in various terrains including sand and hiking trails.
- *Code Red Emergency Notification System:* This Emergency Notification System utilizes telephone and e-mail to rapidly notify residents of hazard emergencies and other important events.
- *Social Media messaging and news announcements:* The Police Department utilizes social media and other messaging to keep residents informed about ongoing emergencies, incidents, weather-related events and other critical situations.

Natural Hazards Risk Assessment

Through using the Town of Newbury's previous Hazard Mitigation Plan, in association with other planning documents including Newbury's Comprehensive Emergency Management Plan, and Municipal Vulnerability Plan, natural hazards for the Town were considered. On the basis of this analysis, Newbury considers itself to be at ***high risk*** from coastal flooding, coastal erosion, drought, extreme temperatures, severe winter storms, and hurricane/tropical storms; ***moderate risk*** from inland flooding, high winds/thunderstorms, invasive species, and wildfires; and ***low risk*** from tsunamis, tornadoes, earthquakes, and landslides.

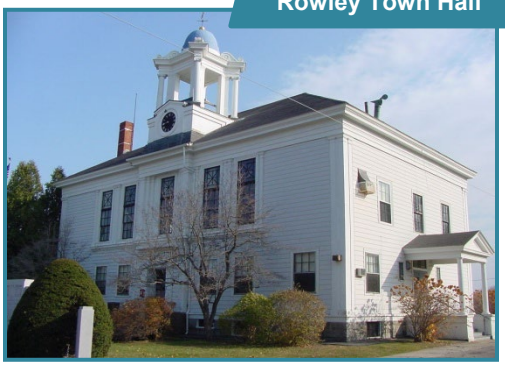
Table 5.43 Newbury's risk rating for the 15 natural hazards experienced in the Commonwealth.

Newbury Natural Hazard Risk Rating	
Natural Hazard	**Community Risk Rating**
Coastal Flooding	High
Coastal/Riverine Erosion	High
Drought	High
Extreme Temperatures	High
Severe Winter Storms	High
Hurricane/Tropical Storm	High
Inland Flooding	Moderate
High Winds/ Thunderstorms	Moderate
Invasive Species	Moderate
Wildfires	Moderate
Tsunami	Low
Tornadoes	Low
Earthquake	Low
Landslide	Low

Continue to page 199 of the Plan to review Newbury's next section: ***Town of Newbury Natural Hazard Challenge Statements.***

5.2.8 Town of Rowley Natural Hazard Risk Assessment

Community Profile


Rowley Town Hall

The Town of Rowley is located approximately 32 miles north of Boston on Massachusetts' historic North Shore. The Town encompasses 18 square miles, and is characterized by gently rolling uplands and expansive salt marsh. It is bordered to the north by the Town of Newbury, to the west by the Town of Georgetown, to the southwest by the Town of Boxford, to the south by the Town of Ipswich, and to the east by Plum Island Sound and the Atlantic Ocean. According to the 2020 U.S. Census, the year-round resident population is 6,161, an increase of 5.2% from 2010.[142] The pace of growth moderated since the 2000s after a 25% population increase in the 1990s. There are 2,326 households and the town-wide population density is 338.5 people per square mile. Population predictions from the UMass Donahue Institute anticipate Rowley will grow to 6,208 residents by 2030, an increase of less than 1%.[143]

The Town of Rowley has one public elementary school, Pine Grove Elementary, and sends students to two public regional schools, Triton Middle and Triton High School, located in neighboring Newbury. Rowley has 432 students currently enrolled a Pine Grove, and sends an additional 96 students to Triton Middle School and 181 to Triton High School. Students from Rowley account for 29% of the total enrolled in the Triton Regional School System.

Public drinking water is provided to a majority of residents through three Town wells (Well 2, Well 3, and Well 5) serviced by the Rowley Water Department. An additional ~400 residents rely on private wells. Due to high levels of manganese in 2010, the Town constructed a water treatment plant, the Pinegree Farm Filtration Plant off of Haverhill Street. Since 2014, water from Wells 3 and 5 have been treated by the plant which uses a process known as conventional filtration. The water from Well 2 is not filtered through the treatment plant and is treated chemically on site. Rowley has no municipal sewer system, therefore all residents rely on individual on-site septic systems for wastewater disposal. National Grid provides gas to Rowley Residents, with electric provided by the Rowley Municipal Light Plant.


Rowley Salt Marsh

The GIS analysis for the 2024 HMP reports both land cover and land use data derived from the State's most updated 2016 land cover layer.[144] Predominant *land cover* in Rowley is forest (44%) and wetlands (31%), followed by open land (12%), open water (5%), developed impervious land (5%), and agricultural land (3%). According to assessor's data, *land use* in Rowley is primarily recreational/other (55%) and residential (31%), followed by commercial/industrial (6%), agricultural (5%), transportation (3%), and open water (1%). Rowley's most conspicuous and visually stunning landscape feature is its vast salt marshes. Part of the 25,000-acre, multi-community Great Marsh ACEC (Area of Critical

[142] United States Census Bureau. 2023. QuickFacts. U.S. Census Bureau QuickFacts: United States
[143] UMass Donahue Institute. 2022. Massachusetts Population Projections. UMass Donahue Institute | Population Projections
[144] MassGIS. 2019. 2016 Land Cover/Land Use. MassGIS Data: 2016 Land Cover/Land Use | Mass.gov

Environmental Concern), the Rowley salt marshes protect broad upland areas in Town from the full brunt of high-energy coastal winds and waves. Interlaced with myriad tidal creeks, these ecologically-rich salt wetlands are home to diverse plant and animal species, including commercially-valuable soft-shell clams. They also provide outstanding recreational opportunities for bird watchers, kayakers, and other outdoor enthusiasts.

Recent Development and Land Use Changes

Rowley's Village Center is designated a Historic Preservation Priority Development Area in the Merrimack Valley Region Priority Growth Strategy (2015 update). The Town's Master Plan outlines goals for the Village Center focus on maintenance of existing municipal and civic uses; protection of historic character and specific historic properties, and accommodation of new commercial growth along Route 1 and Route 133, away from the historic Village Center. According to the Rowley Planning Board and the Town Planner, there have been eight (8) noteworthy development projects in the community since the last 2016 Hazard Mitigation Plan update. Six (6) residential and two (2) municipal. These projects are summarized in *Table 5.44* below.

Table 5.44 Major development projects in Rowley initiated since 2016.

Rowley Major Development Projects 2016-2023				
Facility Type	**Common Name**	**Address**	**Square Feet/ Housing Units**	**2023 Status**
Municipal	Pinegree Farm Filtration plant	Haverhill Street	6,665 sf	Complete
Municipal	Rowley Fire Station and Police Dept.	473 Haverhill Street	30,000 sf	Complete
Residential (OSRD)	Wild Pasture Estates	Wild Pasture Lane	29 units	Complete
Residential	Cindy Lane/Bell Circle	Cindy Lane	18 units	Complete
Residential	Falcon Ridge	Taylor Lane	49 units	Complete
Residential	Harts Way	2 Harts Way	16 units	Complete
Residential	Jeans Way	1 Jeans Way	9 Units	Complete
Residential	Rowley Windward Crossing	236 NBPT	28 Units	In process

According to the Town's Open Space and Recreation Plan (2021) land use and development in Rowley is governed by the Protective Zoning Bylaw, first adopted in March of 1960, and last revised in June of 2020. The bylaw identifies ten land use districts: Central, Residential, Outlying, Coastal Conservation, Retail, Business/Light Industry, Floodplain, Municipal Water Protection, Flea Market/Antique Store, Retail Village Overy. Additionally, the Wetland Bylaw, Floodplain District and the Municipal Water Supply Protection District provide a basic framework, including required setbacks, that help to protect the Town's water resources and drinking water supply from the negative effects of development. The Historic District Bylaw, which was adopted in 1988, applies to land in the historic Town Center and in the immediate vicinity of Glen Mills. The Historic District Bylaw provides renovation and improvement guidelines for Historic District properties, and was designed to ensure that the historic character of these properties is maintained. The Bylaw helps to ensure that development is respectful of the rural and natural environment, but does not necessarily provide permanent protection of the Town's natural resources.

While Rowley identifies the need and interest in further development, the Town is working to mitigate the impact of new development through the issuance of special permits for Open Space Residential (OSRD) projects, or "cluster developments" that, "promote integrated, creatively-designed residential development that results in the preservation of open space and natural resources, the reduction of infrastructure and site

development costs, and the promotion of attractive standards of appearance consistent with Town character (OSRD, 2021)." OSRDs are required by law to dedicate a minimum of 50% of the OSRD land as permanent open space to be, "devoid of structures and impervious surfaces, and shall be left in its undisturbed natural condition or developed to assure its use as an area for passive recreation or a visual amenity (OSRD, 2021)."

In a further effort to balance land preservation and protection with increased development, Rowley has conserved or preserved nine (9) parcels totaling 119.7 acres of land since the last HMP update in 2016. Details on each of these properties in included in *Table 5.45* below. Rowley has also made four zoning changes, all to overlay zones, since the 2016 update. These include two Retail Village Overlay districts: 35 acres along Route 133 in 2019 and 44 areas along Newburyport Turnpike in 2021, and two Historic Districts: Glen Mills Historic District (14 acres) in 2021, and Central Historic District (668 acres) in 2021.

Since the last plan update, the LHMPT has identified that changes in development and land use in the Town have not impacted Rowley's risk to natural hazards. While the Town has experienced new development, impacts have not increased or decreased risk to resident safety or property. Additional risk has been mitigated through actions to promote smart growth strategies by concentrating development and promote the conservation of open space through OSRDs; restrict development in hazard prone areas (e.g. wetlands and coastal areas); and update critical regulations such as Rowley's Floodplain District Protective Zoning Bylaw, Stormwater Management and Erosion Control Bylaw & Regulation, Local Wetland Protection Bylaw, and Open Space & Recreation Plan. Additionally, efforts to counteract impacts from development through the conservation of open space has allowed the Town to limit increased impervious cover, maintaining flood storage capacity, and managing drought and high heat impacts.

Table 5.45 Newly conserved or preserved land in Rowley since 2016.

Rowley Newly Conserved or Preserved Land 2016-2023				
Property Name	**Address**	**Area (acres)**	**Owner**	**Year completed/ projected**
Mehaffey Farm	179 Newbury Road	28.8	CR held by Greenbelt	2018
Twin Hill Farm	42 Newbury Road	5.69	CR held by Town	2018
Bachelder Brook	Newburyport Tnpk and 340- 344 Wethersfield St.	23	Donated to Town	2016
Bachelder Meadow	Newburyport Tnpk	3	Donated to Town	2017
Bachelder Brook	351 & 355 Wethersfield St.	5	Town accepted through tax title taking	2017
Hunsley Hills Addition	Kathleen Circle	23.9	Donated to Town	2019
Saunders Ln Cons Area	Saunders Lane	17.5	Donated to Town	2019
Hart's Way Cons Area	Hart's Way	10	Donated to Town	2020
Glen St Cons Area	28 Glen Street	2.8	Donated	2021

Community Lifelines

A list of selected community lifelines (emergency operations centers, hospitals/healthcare centers, public shelters) is shown in *Table 5.46* and was derived and updated from the Town's Comprehensive Emergency Management Plan (CEMP) and from conversations with local personnel. The locations of these and other community lifelines in Rowley were entered by MVPC into an Excel database and subsequently incorporated into MVPC's Arcview GIS for use in digital mapping. As part of the plan update, the full list of community lifelines was reviewed and amended to reflect current conditions, as well as to incorporate new facilities and resources. The full list of community lifelines is depicted in the Rowley's map series that is presented in Appendix B of this Plan.

Table 5.46 Select list of Rowley's community lifelines (emergency operation centers, hospitals, and shelters).

Rowley Emergency Operation Centers, Hospitals, and Shelters						
Facility Type	**Common Name**	**Street Address**	**Health Facility Type**	**Maximum Capacity**	**Feeding Capability**	**Emergency Generator Available**
Emergency Operations Center	Rowley Fire Department	473 Haverhill Street	N/A	N/A	N/A	Yes
	Rowley Police Department	477 Haverhill Street	N/A	N/A	N/A	Yes
Hospitals and Healthcare Centers	None					
Emergency Shelters	Pine Grove Elementary School	191 Main Street	N/A	300-400	Yes	Yes

Critical Infrastructure

Bridges: The Town of Rowley has seven (7) bridges within its municipal borders.[145] Of these bridges, six (6) are municipally owned, with one bridge owned and maintained by MassDOT. All but one are categorized as waterway bridges, with the remaining intersecting a railroad track (MBTA). There are currently two (2) bridges classified as structurally deficient in Rowley, one which is owned by MassDOT and one which is owned by the Town of Rowley (*Table 5.47)*. The Glen Street Bridge is currently being engineered to be widened and replaced. Funding from Municipal small bridge program, design complete. More funding for structural components.

Table 5.47 List of Rowley's structurally deficient bridges as identified by the Massachusetts Dept of Transportation.

Rowley Structurally Deficient Bridges					
Bridge Name	**Feature Intersected**	**Owner**	**Year Built**	**Structurally Deficient**	**Last Inspection Date**
Main St./1A	Railroad MBTA	MassDOT	1907 improved in 1931	Yes	9/19/2023
Glen Street	Mill River	Municipality	1900	Yes	6/22/2022

[145] MassDOT. 2024. Bridges. Bridges | Bridges | MassDOT Open Data Portal (arcgis.com)

Dams: The DCR Office of Dam Safety lists seven (7) Rowley dams on its statewide dam classification inventory.[146] These are: Central Street Dam, Country Club Pond Dam, Jewel Mill Dam, Lower Millpond Dam, Ox Pasture Brook Dam, Ox Pasture Brook No.2 Dam, Upper Millpond Dam. Two of these dams are owned by the Department of Conservation and Recreation (Ox Pasture Dam and Ox Pasture Brook No.2), with the remaining five privately owned. Currently, none of the dams in Rowley are listed as "Significant" or 'High" hazards. Previously, both the Jewel Mill Dam, an impoundment of Mill River, and the Lower Mill Pond Dam, a mortared stone dam, were previously listed as significant hazard dams. Following recent inspection and downstream analysis by the ODS, both dams were reclassified to "Low Hazard." The Lower Mill Pond Dam is privately owned, and still identified by the Town as a concern due to its poor condition. As both the Jewel Mill Dam and Lower Mill Pond Dam are privately owned, the Town has limited control in direct remediation, but has tried to work with owners to reduce risks.

Community Specific Hazards

Rowley's LHMPT reviewed the full range of natural hazards that impact Massachusetts, as identified through the State Hazard Mitigation and Climate Adaptation Plan. The majority of the natural hazards considered impact the Merrimack Valley Region in a similar way. For those that have a different or locally-specific impact on the Town of Rowley, additional information has been supplemented in this section.

Flooding

The Town of Rowley spans two watersheds, the Parker and the Ipswich. Rowley is blessed with a diverse array of interconnected rivers, streams, ponds, estuarine waters, and wetlands including:

- *Mill River*, which rises from a series of wetlands in the northwest corner of the Town and flows northeastward to the Parker River above the Town's northern border;
- *Upper and Lower Mill Ponds*, two elongated impoundments created by a broadening of the Mill River channel;
- *Great Swamp Brook*, a southeastward-flowing tributary of the Mill River;
- *Mud Creek*, which flows through the salt marsh into Plum Island Sound;
- *Bachelder and Ox Pasture Brooks*, which emerge from wetlands in the central part of Town and flow northward to the Mill River;
- *Rowley River*, a tidal waterway that forms the Town's southeast boundary and provides important shellfish habitat; and
- *Plum Island Sound*, a broad estuary on the Town's eastern edge fed by the Parker and Rowley Rivers.

Together, these surface waters offer many environmental and public benefits, including important ecological functions and a variety of opportunities for recreational enjoyment. However, they also give rise to occasional floodwaters that place selected homes, businesses, and municipal infrastructure at periodic risk.

Areas of Common Flooding: According to Rowley Highway Department personnel, several areas in Town are subject to *chronic* flooding. These include: 1. Wethersfield Street at Bachelder Brook, 2. Hillside Street at Great Swamp Brook, 3. Route 133 at Cedarwood Lane, and several areas on the west side of Town south of Route 133, including: 4. Boxford Road, 5. Leslie Road, and 6. Newbury Road (*Figure 5.7)*. A number of these older roads were built across the floodplains of perennial streams. Since they were constructed at existing grade, the roads can become inundated and impede travel during high rainfall-runoff events.

[146] MassGIS. 2012. Dams. MassGIS Data: Dams | Mass.gov

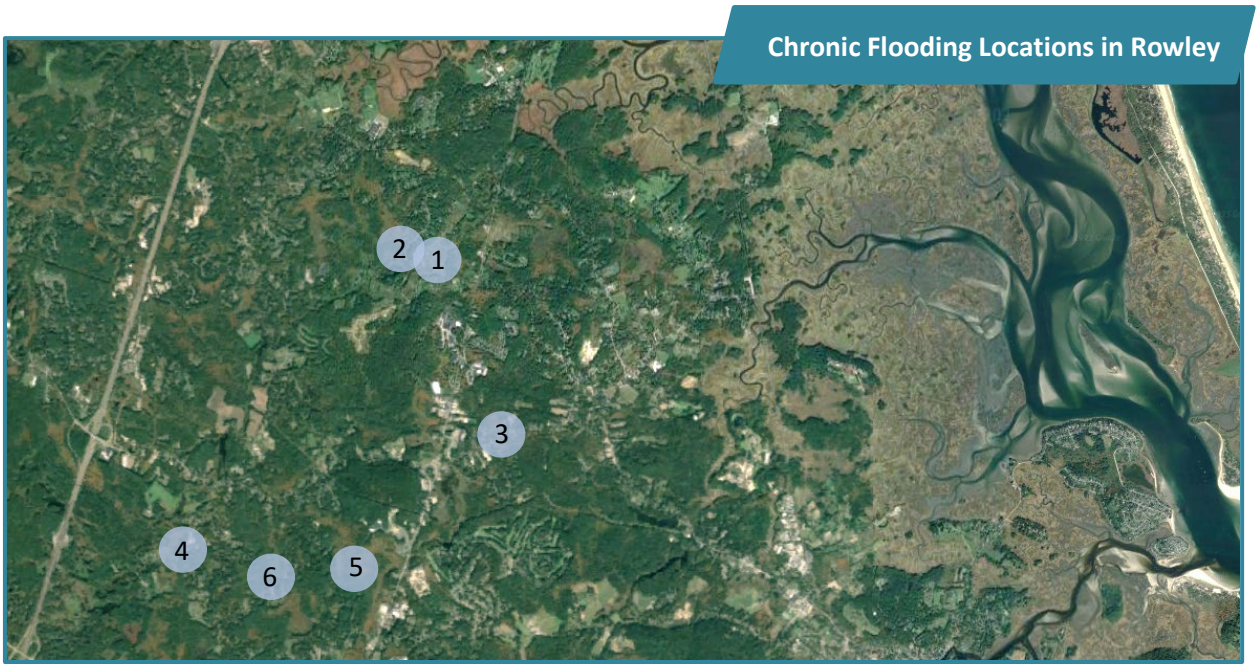


Figure 5.7 Chronic flooding locations identified across Rowley by the Local Hazard Mitigation Planning Team.

The May 2006 "Mothers Day" Flood in particular caused widespread damage to key town roads and drainage infrastructure, and resulted in several long-term road closures and detours. The following excerpt from the Town's *2006 Annual Highway Department Report* aptly sums up the flood's devastating impacts:

Dodge Road Bridge Damage, 2006

"… The May floods caused many problems throughout the town. Three main culverts/bridges were heavily damaged, two beyond repair, and are closed until they can be replaced (Dodge Road Bridge and Taylor Bridge on Wethersfield Street). The Bachelder Bridge, also on Wethersfield Street, has been temporarily secured with two 10' x 8' x 1" steel road plates for the deck until replaced; the crossing has one lane and weight limit of 2-1/2 tons. Many roadway shoulders and curbing were washed out, … causing catch basins and culvert pipes to collapse. Localized street flooding throughout the town caused many detours, making it difficult to travel within the town and from town to town until the water subsided and that section of roadway could be inspected and/or repaired for safe travel…"

Flooding Vulnerability Assessment: A GIS analysis of the Town's most recent (2023) FIRM flood hazard areas by MVPC has determined that a total of 4,802 acres (7.5 sq. mi.) of land area and salt marsh in Rowley is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 402 acres (0.63 sq. mi.) lies within the 500-year floodplain. Together, these two flood zones constitute over forty (40.7%) of the total area of the community.

As part of the mapping analysis, MVPC also investigated the presence of facilities in flood hazard areas. This analysis revealed the presence of 149 residential and commercial structures (3.4%) in the floodplains, collectively valued at $52.4 million. Of these, a total of three (3) are listed as critical community lifelines, valued at $7.2 million (*Table 5.48)*. The number of critical facilities within floodplains is the same as what was listed in the 2016 update.

Table 5.48 List of Community Lifelines located across Rowley within the 100 and 500-year floodplain.

Rowley Critical Facilities within Floodplain 100-Year Floodplain			
Feature	**Category**	**Floodplain**	**Generator**
Subsidized Housing	Woodside Condominiums	100	No
Communication Tower	Cell Tower	100	No
Water Supply	Rowley Town Well #3	100	No

NFIP Information: Rowley actively participates in the National Flood Insurance Program (NFIP). The Town's initial Flood Hazard Boundary Map (NHBM) was identified in 1974, and the initial Flood Insurance Rate Map (FIRM) was identified in 1986. The latest effective FIRM was adopted in 2014. The Flood Hazard Management Program anticipates a new FIRM and Flood Insurance Study (FIS) will be available for adoption in 2024. Rowley intends to update their local regulations to adopt the new maps and study ahead of the effective date, anticipated in summer 2025. This will require updating Rowley's Zoning Bylaw (Section 4.10), where minimum floodplain management criteria appear. Rowley implements and enforces local floodplain management regulations in Special Flood Hazard Areas (SFHAs) through requirements associated with the Planning Board and the Conservation Commission. Rowley's Conservation Agent serves as the Floodplain Administrator for the Town. Following an event, substantial improvement/substantial damage provisions are addressed by the Floodplain Administrator (Conservation Agent), who coordinates damage assessments.

The Town of Rowley began their participation in the National Flood Insurance Program (NFIP) in 2009. As a result, town residents and businesses were not eligible to carry an NFIP insurance policy prior to this date, and thus no NFIP claims were filed for property damage sustained from previous flooding. In the fall of 2009, the Rowley Board of Selectmen requested detailed information on the National Flood Insurance Program from the state flood hazard mitigation program (DCR/MEMA) and the Merrimack Valley Planning Commission. Equipped with this information, and in consultation with other town boards and personnel, the Rowley Selectmen carefully evaluated the potential benefits of the National Flood Insurance Program and subsequently voted to join the Program. The Town's enrollment in the NFIP became effective on December 3, 2009.

As of 2023, there are flood insurance policies in place for ten (10) Rowley properties.[147] Total insurance value of these properties is $3,207,000. Two additional policies are in place for properties located in special flood hazard areas (SFHA) with a total insurance value of $407,000 (NFIP Summary Data-MEMA, 2023). To date, there have not been any flood loss structures or repetitive flood loss structures in Rowley.

Based on the frequency, areal extent, and severity of historical floods and storm surges in Rowley, Town emergency management officials consider the community to be at ***high risk*** from coastal flooding and moderate risk from inland flooding.

[147] Massachusetts Emergency Management Agency. 2023. *NFIP Summary Data Report* – 7/25/2023.

Drought

In 2022, a Level 3: Critical Drought was declared by the State. The impacts were felt across the region, with downstream communities seeing and experiencing some of the largest impacts first-hand. Rowley, as a downstream community bordered by the Parker River to the North and the Rowley River to the South, was particularly impacted by the historic drought. The Town responded with firm restrictions, putting in place a series of progressively more stringent water restrictions over the summer, culminating in a mandatory outdoor water use restriction in early August 2022.

Natural Hazards Management and Response

The Rowley Board of Selectmen is the executive body of the town. The Board of Selectmen is responsible for setting administrative policies and it appoints the Town Administrator. The Town Administrator provides professional assistance to the Board of Selectmen and implements town policies in day-to-day administration.

Rowley Fire Department is a combination 9 full-time and 25 on-call firefighters. The department is led by a full-time Chief who also heads the Town's Emergency Management Agency. Operations are out of the Fire Station at 473 Haverhill street.

Rowley Police Department is led by the Chief and staff that includes 13 full-time officers and another six reserve officers. The Police Station is located at 477 Haverhill Street.

Rowley DPW oversees key functioning of many community lifelines in the Town. In addition to providing roadwork, culvert and public facility maintenance, the DPW provides vehicles and equipment used in emergencies including barriers, generators and pumps. Additional departments also help to provide and manage community lifelines. These departments include the Municipal Light Plant (RMPL), Highway Department, Tree Department, and Water Department. The Rowley Municipal Lighting Plan is led by a general manager. The Highway Department is led by an elected Highway Surveyor. The Tree Department is led by an appointed Tree Warden. The Water Department is led by the Superintendent. The Fire Department also provides pumps.

Natural Hazards Risk Assessment

Through using the Town of Rowley's previous Hazard Mitigation Plan, in association with other planning documents including Rowley's Comprehensive Emergency Management Plan, and Municipal Vulnerability plan, natural hazards for the Town were considered. On the basis of this analysis, Rowley considers itself to be at ***high risk*** from drought, coastal flooding, and severe winter storms; ***moderate risk*** from inland flooding, extreme temperatures, high winds/thunderstorms, wildfires, invasive species, hurricanes/tropical storms, and coastal erosion; and ***low risk*** from tsunamis, earthquakes, landslides, and tornadoes.

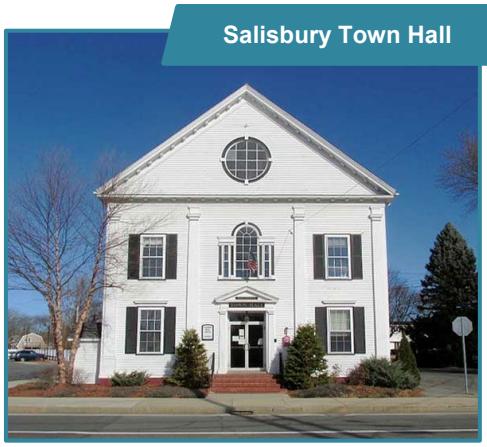
Table 5.49 Rowley's risk rating for the 15 natural hazards experienced in the Commonwealth.

Rowley Natural Hazard Risk Rating	
Natural Hazard	**Community Risk Rating**
Drought	High
Coastal Flooding	High
Severe Winter Storms	High
Inland Flooding	Moderate
Extreme Temperatures	Moderate
High Winds/ Thunderstorms	Moderate
Wildfires	Moderate
Invasive Species	Moderate
Hurricane/Tropical Storm	Moderate
Coastal/Riverine Erosion	Moderate
Tsunami	Low
Earthquake	Low
Landslide	Low
Tornadoes	Low

Continue to page 200 of the Plan to review Rowley's next section: ***Town of Rowley Natural Hazard Challenge Statements.***

5.2.9 Town of Salisbury Natural Hazard Risk Assessment

Community Profile


Salisbury Town Hall

The Town of Salisbury is located about 40 miles north of Boston on Massachusetts' scenic and historic North Shore. Defined by its border with the Merrimack River to the South and the Atlantic Ocean to the east, Salisbury is a water-rich community, with a diversity of ecological landscapes which shape its economic, recreational, and community character. Salisbury covers a land area of 15.4 square miles.

According to the 2020 US Census, Salisbury has an estimated year-round resident population of 9,236.[148] There are 3,885 households in the Town with an average of 2.34 people per household. The population density is approximately 601 people per square mile. Salisbury experienced a population increase of 11.5% from the 2010 census. The UMass Donahue Institute projects additional growth of 3% by 2030, with the Town's population reaching 9,504 people.[149]

The Town of Salisbury has one elementary school within its municipal borders, Salisbury Elementary, which educates students from Pre-K through 6th grade. A total of 442 students are enrolled at Salisbury Elementary. The Town sends students 7th-12th grade to Triton Regional Middle and High School in Newbury. Salisbury currently has 128 students enrolled at the regional middle school, and 250 enrolled in the regional high school. Students from Salisbury account for 36% of total enrolled in the Triton Regional School System.

A municipal water supply system serves most of the community, although about 165 private wells are still in use. The public water system consists of four gravel-packed wells which together are permitted by the State to pump up to 1.4 million gallons per day (mgd) of drinking water. The system currently serves 3,967 residential, commercial, and industrial accounts, including 150 users in the Ring's Island Water District. Salisbury pumps, on average, about 850,000 gallons per day (gpd), the total future (10 years) projected increase is approximately 300,000 gpd, which would require a new (5th) well.

A municipal sewer system serves approximately 65% of the homes in Town. Sewage is treated at the Town's wastewater treatment plant, which currently processes about 700,000 gallons of wastewater per day. The design capacity of the plant is 1.3 million gallons per day, so sufficient excess capacity exists to tie in more households, businesses, and industries over time. Salisbury is actively working to replace sewer lines in the Town, especially to areas that experience frequent tidal or riverine flooding such as Bayberry Lane, Jak-Len Drive, Lafayette Road, State Highway Route 1, and portions of Main Street, Rabbit Road, and Toll Road. Between 2020-2022 18,000 linear feet of sewer mains in roadways were replaced. National Grid provides gas and electricity to Salisbury Residents.

The GIS analysis for the 2024 HMP reports both land cover and land use data derived from the State's most updated 2016 land cover layer.[150] Predominant *land cover* in Salisbury is forest (34%) and wetlands (33%), followed by open land (12%), developed impervious (10%), water (9%), and agricultural land (3%). According to the assessor's data, *land use* in Salisbury is primarily recreational/other (59%), followed by residential (27%), agricultural (5%), transportation (4%), commercial/industrial (4%), and water (2%).

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[148] United States Census Bureau. 2023. QuickFacts. U.S. Census Bureau QuickFacts: United States

[149] UMass Donahue Institute. 2022. Massachusetts Population Projections. UMass Donahue Institute | Population Projections

[150] MassGIS. 2019. 2016 Land Cover/Land Use. MassGIS Data: 2016 Land Cover/Land Use | Mass.gov

Vast wetlands (3,613 acres) cover the landscape and buffer broad upland areas from the full brunt of high-energy coastal winds and waves. Interlaced with myriad tidal creeks, the ecologically-rich salt wetlands are home to diverse plant and animal species, including commercially-valuable soft-shell clams. Due to its wealth of diverse and biologically important habitats, Salisbury has a number of large conservation lands located within Town. These include, Salisbury Beach State Reservation owned and operated by the Department of Conservation and Recreation, Salisbury Salt Marsh Wildlife Management Area, and Carr Island State Reservation both operated by the Department of Fish and Game.

Recent Development Activity in Salisbury

Salisbury benefits from its location at the junction of Interstates 95 and 495 as well as Route 1 & 1A; making access to New Hampshire, Maine and other parts of Massachusetts, including Boston, readily accessible.

Salisbury's Open Spaced and Recreation Plan (OSRP, 2016-2023) identifies the greatest opportunity for new housing units to be established in Low Density residential districts (including sections of the Plains, the Lafayette Road area, and Baker Road). These locations represent some of the highest quality remaining landscapes, and development would come at an environmental cost, while also expanding the area in which critical services are needed across Town. Within Salisbury, development is generally concentrated in four distinct areas:

- *Salisbury Beach*, a 3.8-mile long barrier beach and salt marsh complex surrounding dense residential and commercial development;
- *Salisbury Plains*, featuring farms and suburban homes set in fields and rolling woodlands;
- *Salisbury Square*, a colonial village center with a town common fringed by municipal buildings and institutions, small stores, and village residences; and
- *Ring's Island*, a former colonial fishing village fronting on the Merrimack River and now supporting a neighborhood of restored antique homes and riverfront marine businesses.

According to Salisbury Planning Board and Town Planner, there have been 13 noteworthy development projects in the community since the adoption of the 2016 Hazard Mitigation Plan. These include 12 residential and one municipal. These projects are summarized in the *Table 5.50* below:

Table 5.50 Major development projects in Salisbury initiated since 2016.

Salisbury Major Development Projects 2016-2023				
Facility Type	**Common Name**	**Address**	**Square Feet/ Housing Units**	**2023 Status**
Residential	Atlantic Villas	504 North End	9 units	Construction
Residential	Beachpoint Crossing Condominiums	207 Beach Road	14 Units	Construction
Residential	The Townhomes on Beach Road	3 Bridge Road	13 Units	Complete
Residential	N/A	56 Railroad	6 Units	Complete
Residential	N/A	54 Beach Road	14 Units	Complete
Residential	Residences at Salisbury Square (YWCA)	3 Park/ 29 Elm	42 Units	Complete
Residential	N/A	32 Elm	16 Units	Complete
Residential	N/A	44 Railroad Ave	6 Units	Complete
Residential	N/A	71-75 North End Blvd	9 Units	Complete
Residential	N/A	159 Beach Road	19 Unites	Planning
Residential	N/A	14,16,18 North End Blvd	11 Units	Planning
Residential	Meadowbrook	6 Forest Road	76 units	Planning
Municipal	Salisbury Police Department	181 Beach Road	18,000 s.f.	Complete

In an effort to balance land protection and access to open space with increased development, Salisbury has made strides in developing a network of rail trails since the 2016 plan, a Town-wide Action Plan Priority identified in the Town's Community Development Plan (2014). In addition, a total of 1,318 acres have been conserved within Salisbury since the 2016 plan (*Table 5.51)*.

Table 5.51 Newly conserved or preserved land in Salisbury since 2016.

Salisbury Newly Conserved or Preserved Land 2016-2023				
Property Name	**Address**	**Area (acres)**	**Owner**	**Year completed**
Choice Housing	63 Beach Rd	0.59	DMH	2017
Salisbury Beach St Res	Beach Front	167.2	DCR	2017
Salisbury Beach St Res	Beach Rd	257.53	DCR	2017
Salisbury Beach St Res	Beach Front	2.25	DCR	2017
Salisbury Beach St Res	Beach Front	5.34	DCR	2017
Salisbury Beach St Res	Murray St	0.02	DCR	2017
Salisbury Beach St Res	Beach Front	0.08	DCR	2017
Salisbury Beach St Res	1 Ocean Front South	0.92	DCR	2017
Salisbury Beach St Res	Murray St	0.2	DCR	2017
Salisbury Beach St Res	Ocean Front South	0.93	DCR	2017
Various Salt Marsh Lots	Beach Rd	34.45	DFG	2017
Various Salt Marsh Lots	Beach Rd	6	DFG	2017
Various Salt Marsh Lots	Beach Rd	7.7	DFG	2017
Various Salt Marsh Lots	Beach Rd	4	DFG	2017
Various Salt Marsh Lots	Beach Rd	12	DFG	2017
Salt Marsh WMA	Sweet Apple Tree Ln	178.24	DFG	2017
Salt Marsh WMA	Sweet Apple Tree Ln	127.6	DFG	2017
Salt Marsh WMA	Ferry Rd	37.5	DFG	2017
Ram Island B Sanctuary	Ram Island	20	DFG	2017
Ram Island B Sanctuary	Carr Island	100	DFG	2017
Eagle Island/ Merrimack River WMA	Merrimac St	4.8	DFG	2017
Barberries Marshland	Barberries Marshland	44	DFG	2017
Barberries Marshland	Barberries Marshland	21	DFG	2017
Various Salt Marsh Lots	Old County Rd	60.64	DFG	2017
Salt Marsh WMA	Great Meadows	10.57	DFG	2017
Salt Marsh WMA	Barberries Marshland	60.71	DFG	2017
Salt Marsh WMA	Salisbury	25	DFG	2017
Salt Marsh WMA	Beach Rd	15	DFG	2017
Salt Marsh WMA	Old County Rd	4.8	DFG	2017
Salt Marsh WMA	Beach Rd	18	DFG	2017
Salt Marsh WMA	Beach Rd	4	DFG	2017
Salt Marsh WMA	Ferry Lots Ln	33	DFG	2017
Salt Marsh WMA	Old County Rd	5.5	DFG	2017
WMA Salisbury Salt Marsh	Dock Ln	16	DFG	2017
WMA Salisbury Salt Marsh	Great Meadows	10	DFG	2019
WMA Salisbury Salt Marsh	Beach Rd	7	DFG	2022
WMA Salisbury Salt Marsh	Corporal Patten Way	15.78	DFG	2023

Salisbury has also made a number of regulatory changes since 2016. The Town adopted a Stormwater Bylaw in 2023, and updated their Solar Bylaw in 2023 to allow for small-scale installations. The Town also amended the Salisbury Beach Overlay District in 2016. Recreational Marijuana Overlay District (2016). Additionally, two

(2) zoning changes were made since 2016. This includes: a base change in 2016 of 98 acres to Low Density Residential; and an overlay change in 2023 of ~35 acres from beach commercial to residential.

Since the last plan update, changes in development and land use in the Town have increased Salisbury's risk to natural hazards, especially from coastal and inland flooding. Developments in low-laying coastal areas, such as the Beach Commercial area along Beach Road, while complying with the Wetland Protection Act, have reduced the amount of pervious flood storage. Increased development has further exacerbated flooding challenges leading to increases in property damage and public safety during typical tidal events. In order to encourage development away from floodplain areas, Salisbury promotes building in already developed areas and smart growth strategies to concentrate development. The Town promotes its Open Space Residential Subdivision Bylaw which encourages the protection of open space by concentrating development. Salisbury has also conducted a substantial sewer main installation project to allow for increased density in areas away from hazard prone locations. Additionally, Salisbury has taken efforts to counteract impacts from development through conserving open space, which has enabled the Town to decrease the amount of disturbance to the wetlands. Finally, actions to move key services out of flood prone areas, such as relocating the Salisbury Police Station, has reduced risk through allowing access to vital resources during flooding, storms, and other natural hazard events.

Community Lifelines

Table 5.52 Select list of Salisbury's community lifelines (emergency operation centers, hospitals, and shelters).

Salisbury Emergency Operation Centers, Hospitals, and Shelters						
Facility Type	**Common Name**	**Street Address**	**Health Facility Type**	**Maximum Capacity**	**Feeding Capability**	**Emergency Generator Available**
Emergency Operations Center	Salisbury Fire Department	37 Lafayette Road	N/A	N/A	N/A	Yes
	Salisbury Police Station	181 Beach Road	N/A	N/A	N/A	Yes
Hospitals and Healthcare Centers	None					
Emergency Shelters	Salisbury Elementary School	100 Lafayette Road	N/A	210	Yes	Yes
	Salisbury Senior Center/DPW	39 Lafayette Road	N/A	40	Yes	Yes
	East Parish United Methodist Church	8 Lafayette Road	N/A	70	Yes	No
	Assisted Living Residence of Salisbury	19 Beach Street	N/A	40	Yes	No

A list of selected community lifelines (emergency operations centers, hospitals/healthcare centers, public shelters) is shown in *Table 5.52* and was derived and updated from the Town's Comprehensive Emergency Management Plan (CEMP) and from conversations with local personnel. The locations of these and other community lifelines in Salisbury were entered by MVPC into an Excel database and subsequently incorporated into MVPC's Arcview GIS for use in digital mapping. As part of the plan update, the full list of community lifelines was reviewed and amended to reflect current conditions, as well as to incorporate new facilities and resources. The full list of community lifelines is depicted in the Salisbury's map series that is presented in Appendix B.

Critical Infrastructure

Bridges: The Town of Salisbury has seven (7) bridges within its municipal borders.[151] Of these bridges, two (2) are municipally owned, with the remaining five (5) bridges owned and maintained by MassDOT. Two (2) bridges are categorized as waterway bridges, with the remaining intersecting roads or railways. There is currently one bridge classified as structurally deficient in Salisbury, the Bridge on Gerrish Road intersecting Smallpox Brook (*Table 5.53)*. Salisbury received a $100,000 grant as part of the Municipal Small Bridge Program in 2020 to aid in the replacement of the municipally owned bridge. However, the order of conditions identified for repair was significantly more than the Town had expected, halting further work on the project.

A second structurally deficient bridge has also been included on the list below, the Gillis Bridge owned by MassDOT. While the Gillis Bridge is considered within Newburyport's municipal borders, it connects Newburyport to Salisbury and is a significant transportation route in the region.

Table 5.53 List of Salisbury's structurally deficient bridges as identified by the Massachusetts Department of Transportation.

Salisbury Structurally Deficient Bridges					
Bridge Name	**Feature Intersected**	**Owner**	**Year Built**	**Structurally Deficient**	**Last Inspection Date**
Bridge on Gerrish Road	Smallpox Brook	Municipality	1850	Yes	2/25/2021
Gillis Bridge	Merrimack River	MassDOT	1976	Yes	9/7/2022

Dams: The DCR Office of Dam Safety includes only one Salisbury dam on its statewide dam classification list.[152] This is the "Little River Dam", a small, privately-owned and maintained dam located north of True Road. The Little River is a small, easterly-flowing tributary of the Blackwater River which courses northward through the northeastern part of Salisbury into Hampton Harbor in neighboring Seabrook, NH. DCR dam inspectors have not classified the Little River Dam as either "high hazard" or "significant hazard", so it is not considered to pose either a serious or a significant risk to downstream populations or properties in the community.

Hazardous Sites

In addition to community lifelines and critical facilities, Salisbury is in proximity to hazardous sites that are important to consider for hazard mitigation planning:

[151] MassDOT. 2024. Bridges. Bridges | Bridges | MassDOT Open Data Portal (arcgis.com)

[152] MassGIS. 2012. Dams. MassGIS Data: Dams | Mass.gov

Emergency Planning Zone (EPZ): Salisbury is part of the Seabrook Station 10-mile EPZ (Plume Exposure Pathway) - a circular geographic zone, centered on the nuclear power plant to protect the public against exposure to radiation, and the 50-mile EPZ. (Ingestion Pathway) - a circular geographic zone, centered on the nuclear power plant to protect the public from ingestion of contaminated water or foods. The Salisbury Radiological Emergency Response Plan and Massachusetts Radiological Emergency Response Plan cover planning and procedures for any potential incident at the Seabrook, New Hampshire facility. The Seabrook Nuclear Power Plant is significant to Salisbury due to the effects an evacuation related to an incident at the site would have on the adjacent region. The Emergency Management Director for the Seabrook Nuclear Power Plant has indicated the plant maintains the Salisbury Radiological Emergency Response Plan and Massachusetts Radiological Emergency Response Plan, as mentioned previously.

Community Specific Hazards

Salisbury's LHMPT reviewed the full range of natural hazards that impact Massachusetts, as identified through the State Hazard Mitigation and Climate Adaptation Plan. The majority of the natural hazards considered impact the Merrimack Valley Region in a similar way. For those that have a different or locally-specific impact on the Town of Salisbury, additional information has been supplemented in this section.

Flooding

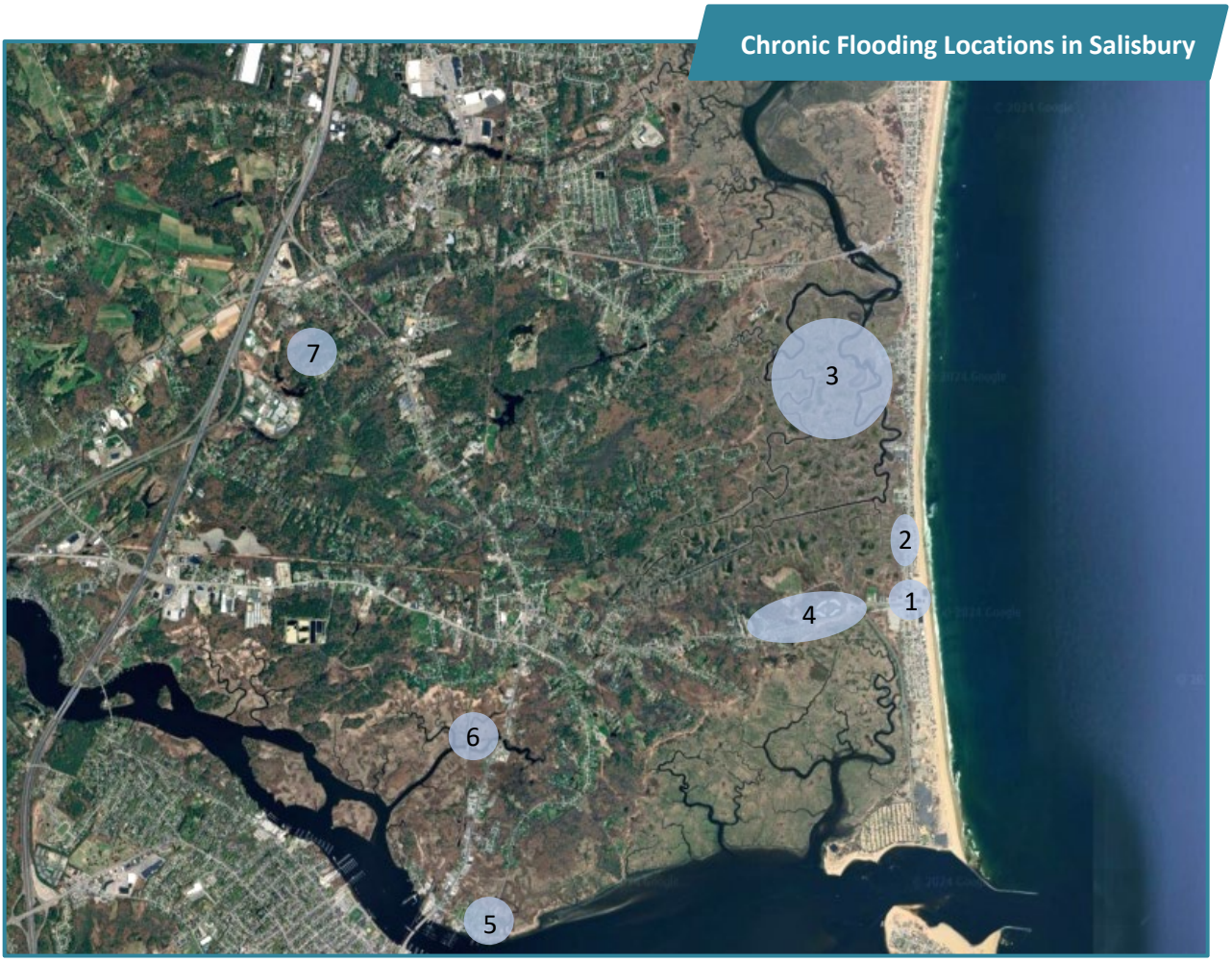


Figure 5.8 Chronic flooding locations across Salisbury identified by the Local Hazard Mitigation Planning Team.

The Town of Salisbury spans parts of two major watersheds, as defined by the Commonwealth of Massachusetts: the Merrimack River watershed (52.8% of town) and the North Coastal watershed (47.2%). Within these two watersheds, the Town is subject to both riverine and coastal flooding (including coastal storm surges) that chronically impact or place at risk a number of residential neighborhoods, businesses, and recreational and natural resource areas.

Areas of Flooding Concern: Special flooding problem areas have been identified by the LHMPT (*Figure 5.8)*. They include: 1) Salisbury beach Center, 2) North End Boulevard, 3) Blackwater River marshes, 4) State Route 1A (Beach Road), U.S. Route 1 South, 5) March Road and First Street, 6) U.S. Route 1 North at Town Creek, 7) Jak-Len Drive at Smallpox Brook.

- *Salisbury Beach Center:* The center of Salisbury Beach at Broadway and Ocean Front South is regularly flooded by overwash during ocean storms that are accompanied by higher than normal tides. Sacrificial dunes have been constructed across part of the area and have offered significant protection against flood damage. Dune restoration at this site is active and ongoing. There is a long-term plan to construct a boardwalk and deck across the part of the Beach Center that is not now protected by sacrificial dunes. To protect against overwash during coastal storms the sacrificial dunes near the Beach Center are being monitored and maintained by DCR under the Salisbury Beach Management Plan. In addition, as part of its emergency response plan, the Town DPW builds temporary sand barriers across the part of the Beach Center that is not protected by the sacrificial dunes. Further development in this area should account for and aim to manage risk due to overwash and flooding in this area.

- *Blackwater River Flooding:* The Blackwater River is a tidal river that drains a large area of saltmarsh west of Salisbury Beach and north of Beach Road, flowing under a bridge on Route 286 into Seabrook, Hampton Harbor, and the ocean. A Route 286 bridge renovation project (1948) constricted the tidal flow into the river and low-lying areas along the marsh in Salisbury were developed with housing. After the Route 286 bridge was rebuilt in 1991, the tidal restriction was largely eliminated, allowing a much greater tidal flow into the Blackwater River salt marsh. This has resulted in regular flooding of low-lying residential areas bordering the Blackwater River salt marsh during high lunar tides and coastal storms.

  Following the Blackwater River Flood Risk Management Project completed by the Army Corps of Engineers (ACOE), over 4 million dollars was awarded to the Corps and Mass Department of Conservation and Recreation to construct a floodwall. In 2018, work was completed on a 3,000 linear-foot floodwall, built to elevation 7.7 feet NAVD88, around a residential neighborhood adjacent to the Blackwater River tidal estuary. The Town has partnered with ACOE to continue native plantings along with floodwall. The Town received their certificate of compliance on the project and are now focused on the operation and maintenance of the area.

- *U.S. Route 1 North at Town Creek:* Town Creek is a tidal creek that enters the Merrimack River just west of the U.S. Route 1 highway bridge. The creek drains a large salt marsh area north of the river as well as an adjacent area of uplands. The mainstem of Town Creek is crossed by an MBTA-owned rail bed and US Route 1 (Bridge Road). A tide gate and culvert were installed in the rail bed in the late 1800's to help protect upstream areas against flooding from the Merrimack River. Subsequently, the low-lying area along US Route 1 was developed commercially. Coastal storms coupled with extreme high tides caused washouts of the rail bed, causing significant flood damage to commercial properties along US Route 1, and even in one instance, flooding of Ferry Road. After multiple events which required costly repairs in 2005, 2006, and 2007 the Town obtained a 99-year lease on the MBTA-owned rail bed and cooperated with MassDOT on the design and construction of an elevated rail trail on the bed, offering protection against future breaches and flood damage.

Following trail construction, additional work was done at the site in 2013 to install new culverts and modern tide gates to protect against tidal flooding and facilitate runoff as well as improve tidal flow to aid in salt marsh restoration. This work was done as part of funding received by the Town through a FEMA Flood Hazard Mitigation Grant and State Environmental Bond Bill funding.

The Town surveyed Ferry Road to determine the increase in elevation needed to protect the northern section of U.S. Route 1 from coastal storm flooding. The subsequent plan to increase the elevation of the roadway and install gates in culverts under Ferry Road was not completed due to a MEPA review which cited potential impacts to the surrounding salt marsh habitat.

- *U.S. Route 1 South; March Road and First Street:* In the Patriots Day Storm of 2007, a coastal storm surge and extreme astronomical tides combined to cause tide levels in the Merrimack River to reach the then 100-year flood stage (9 ft. NGVD). This raised the water level in the adjacent salt marshes above the level of Ferry Road and March Road at Ring's Island in Salisbury for several days during high tides, which resulted in flooding of a number of businesses along the southern end of Route 1 in Salisbury. Furthermore, the small size of the culverts under Ferry Road, March Road, and First Street limited drainage of the flooded area, thus prolonging the flooding conditions and causing additional flood damage. FEMA issued new Flood Maps during 2012 which increased the 100-year flood elevation in this area by an additional foot.

  Since the 2016 update, the Town has estimated increases in elevation needed to protect Ferry and March Roads from flooding, assess possible draining improvements, and work with property owners to explore improvement options for their properties. While this area is still a priority for the Town, actions are limited by MEMA regulations safeguarding saltmarsh habitat in the area.

- *State Route 1A (Beach Road):* State Route 1A (Beach Road) provides the only evacuation route from Salisbury Beach to the rest of the Town. This route is flooded frequently by coastal storms which not only prevents evacuation of the beach, but also restricts access to the beach by fire, police and emergency personnel. Normal flooding is made worse at this location due to undersized and blocked culverts that run under Beach Road. The increase in the FEMA Flood Map's 100-year flood elevation in the area in 2012 and expectations of continued increases in flood levels emphasize the importance of maintaining access to Salisbury Beach during coastal storm events. The Town is working with the Massachusetts Department of Conservation and Recreation as well as MassDOT to conduct surveys of the area and identify next possible steps. The LHMPT has identified that flood storage areas along beach road are diminishing as development and impervious surfaces expand, further exacerbating the problem along 1A.

- *Jak-Len Drive Flooding and Smallpox Brook Flooding:* In the May 2006 storm a low-lying part of Jak-Len Drive flooded and cut off access to the street. It also caused flooding of Smallpox Brook, washing out parts of Route 1 (Lafayette Road). Improvements have been and continue to be made to address flooding at these locations through the Route 1 sewer updates which were started in 2020. Specifically, the Route 1 sewer project includes installing new sanitary sewer lines on Lafayette Road (Rte. 1) from School House Lane to the New Hampshire border; on a section of Main Street from Rabbit Road to Toll Road; on a section of Toll Road from Lafayette Road to Jak-Len Drive; and on Bayberry Lane and Jak-Len Drive. The project will also include the replacement of an undersized water main on a section of Lafayette Road. It will include 3 pump stations – one at the intersection of Lafayette Road and True Road, and one each at the end of Bayberry Lane and Jak-Len Drive. Work is currently still underway.

- *North End Boulevard (Old Town Way to 18th Street):* Central Avenue and Old Town Way are subject to flooding due to an antiquated, undersized, and inefficient drainage system. During major storm events, this area continuously floods, at times causing complete closure of Old Town Way and Central Avenue. It

is anticipated that there will be substantial redevelopment of Salisbury Beach Center in future years. Redevelopment plans for the area need to take into account the drainage problems on Central Avenue and Old Town Way and provide a solution. The Planning Board should seek mitigation payments from developers to contribute to the drainage improvements.

Flooding Vulnerability Assessment: A geographic information system (GIS) analysis of the Town's most recent FIRM Flood Hazard Area maps by MVPC has determined that 4,779 acres (7.5 sq. mi.) is located within the 100-year floodplain and thus is vulnerable to flooding. An additional 23 acres lies within the 500-year floodplain. Together, these two flood zones constitute 44% of the total area of the community. Based on an additional analysis by MVPC, Salisbury has 1,903 structures in floodplains (100 and 500), accounting for 31.4% of Salisbury's infrastructure. The total assessed value of parcels with buildings in floodplains in Salisbury is $1,132,247,918. Nearly 20% of the building structures located within the floodplain in the Merrimack Valley region are in the Town of Salisbury. This underscores the need for vigorous enforcement of the Town's floodplain and stormwater management regulations, as well as the acquisition/preservation of flood-prone open space parcels as Town financial and personnel resources permit.

As part of the mapping analysis, MVPC also identified the critical facilities that are located within the floodplains. These facilities are considered to be at potential risk of future flood damage or loss. Salisbury has a total of13 critical facilities located within floodplains (*Table 5.54)*.

NFIP Information: Salisbury actively participates in the National Flood Insurance Program (NFIP). The Town's initial Flood Hazard Boundary Map (NHBM) was identified in 1974, and the initial Flood Insurance Rate Map (FIRM) was identified in 1977. The latest effective FIRM was adopted in 2012. The Flood Hazard Management Program anticipates a new FIRM and Flood Insurance Study (FIS) will be available for adoption in 2024. Salisbury intends to update their local regulations to adopt the new maps and study ahead of the effective date, anticipated in summer 2025. This will require updating Salisbury's Zoning Bylaw, where minimum floodplain management criteria appear. Salisbury implements and enforces local floodplain management regulations in Special Flood Hazard Areas (SFHAs) through their Planning Board. Salisbury's Building Inspector ensures compliance with the NFIP requirements. Following an event, substantial improvement/substantial damage provisions are addressed by the Building Inspector, who coordinates damage assessments.

Table 5.54 List of Community Lifelines located across Salisbury within the 100 and 500-year floodplain.

Salisbury Critical Facilities within Floodplain 100-Year Floodplain		
Feature	**Category**	**Generator**
Water Supply	Sewage Pumping Stn. 228 Beach Rd	No
Water Supply	Sewage Pumping Stn. 13 Lynne Ave	No
Water Supply	Sewage Pumping Stn. 139 No. End Blvd.	No
Water Supply	Sewage Pumping Stn. 180 Bridge Rd	No
Water Supply	Sewage Pumping Stn. 15 Second St.	No
Water Supply	Sewage Pumping Stn. Ferry Rd	No
Water Supply	Sewage Pumping Stn. 472 North End Blvd	No
Water Supply	Sewage Pumping Stn. Dock Ln	No
Water Supply	Water Storage Tank	No
Transportation	Bus Stop	No
Emergency Response	Salisbury Police Department	No
Subsidized Housing	Windgate at Salisbury	No
Subsidized Housing	Tidewater	No

There are forty (40) repetitive flood loss sites in Salisbury as of 2023 (up from 37 in 2016). These include 15-multi-family residences, 12-single-family residences, 10-non-residentail structures, and 3- other-residential structures. Altogether, flood incidents at these 40 loss sites have resulted in the payout of 126 National Flood Insurance Program (NFIP) claims totaling $3,340,307 since 1978. Additionally, Salisbury has eight (8) NFIP Severe Repetitive Loss sites which has resulted in the payout of 42 claims totaling $1,813,073. The repetitive loss sites include 4-multi-family residences, and 4-non-residential structures.

The total number of active NFIP policies in Salisbury is currently 821. The combined insurance value in-force for these properties is $202,007,000. An additional 463 policies are in-force within Special Flood Hazard Areas (SFHAs), with an insurance value of $101,436,000.[153]

Salisbury carries out a broad array of floodplain management activities in compliance with the requirements of the NFIP. They also began participating in the Community Rating System (CRS) program in 2016, and currently maintain a status as a Class 8 and receive a 10% discount on SFHAs and 5% on non-SFHAs. Based on the frequency, areal extent, and severity of historical floods and storm surges in Salisbury, especially on and around Salisbury Beach, Town emergency management officials consider the community to be at ***high risk*** from flooding.

Coastal Erosion

Salisbury Beach is a 3.8-mile long barrier beach. The beach is owned by the Massachusetts Department of Conservation and Recreation (DCR), but most of the beachfront located directly behind the primary dune is privately owned and densely settled. The southern portion of the beach closest to the Merrimack River remains undeveloped as part of DCR's Salisbury Beach State Reservation. The Beach has suffered significant erosion over many years and is subject to severe damage from coastal storms.

In the Patriot's Day 2007 Storm, the Beach sustained high winds and waves coupled with high spring tides that severely eroded the beach and caused significant damage to several beachfront homes while threatening many more. Long-term predictions of rising sea levels portend more erosion and property damage in the future. This event inspired the formation of the Merrimack River Beach Alliance (MRBA) by the Town of Salisbury in collaboration with the City of Newburyport and the Town of Newbury. MRBA includes elected state and federal representatives, state and federal agencies and community organization and is focused on barrier beach erosion and maintenance of the Merrimack River jetties. Over the years, MRBA's efforts have focused on repairs to the jetties, dredging in the lower Merrimack, and beach nourishment projects.

Since the 2016 update, erosion along the beach has continued. During the March 2018 storms, the beach experienced severe erosion and loss due to wind and precipitation from multiple nor'easter storms paired with extreme high tides. Tides wiped out 12-foot high sand dunes which were replenished following a MassDEP Emergency Declaration. A number of homes were also severely damaged along the southern end of Atlantic Avenue. Residents lost power for multiple days due to downed power lines. Again, in January 2024 two back-to-back storm events caused massive erosion along the beach, prompting citizens to organize and privately fund beach nourishment, bringing 14,000 tons of sand to restore primary dunes. However, just a week after the project was finished, a king tide swept the sand back out to sea. The short-term nature of this solution prompted the MRBA to propose a more substantial plan, to more substantially secure Salisbury beach's dunes through a $6 million dollar investment. This plan would take a multi-step approach to restore dunes up to 19 feet, and use a number of fencing and vegetative planting techniques to help maintain them over time. The Salisbury Beach Preservation Fund is one possible source for funding of this proposed project.

[153] Massachusetts Emergency Management Agency. 2023. *NFIP Summary Data Report* – 7/25/2023.

Based on the location, occurrence, severity/extent, and future probability of coastal erosion, Salisbury has assigned a ***high risk*** to the hazard of coastal erosion.

Rip Tides

As a coastal community, waves and currents also have an effect outside of coastal erosion and flooding. Strong and localized currents can pose public safety risks for residents and visitors to Salisbury's beaches. Rip currents have been a continuous hazard for coastal communities, with Salisbury conducting numerous rescues each year. This threat proved deadly in 2023 when a Methuen man drowned while trying to save a child from a rip current on Salisbury Beach. Salisbury increased beach patrols following the event, and provided additional education to the public by amplifying risk levels available through the National Weather Service. As a natural hazard, the community is interested in better understanding factors that could impact the occurrence and severity of this hazard, as well as implementing greater precautions to safeguard lives.

Wildfire/Brush Fires

In 2022, Salisbury firefighters have responded to 23 brush fires throughout the community. These fires have been small in scale and occurred primarily during the dry season. Based on the number, frequency, and areal extent of brush fires in the community, Town emergency management personnel have assigned a ***moderate risk*** to the hazard of brush fires in Salisbury.

Invasive Species

With an abundance of forest, salt marsh, and freshwater rivers and wetlands, Salisbury has a diversity of habitats that are at risk from invasive plant species. Efforts to control invasive species that adversely impact protected wetland resource areas such as Perennial pepperweed (Lepidium latifolium) and Common reed (Phragmites australis) have been underway for nearly two decades. Removal and treatment for both invasives have been conducted across the region through partnerships with federal, state, and local entities. Efforts have been substantial to reduce and manage monocropping of these invasive vegetative plants across Salisbury, allowing for native plant species to thrive, which in turn supports critical wildlife species. In addition to these two prolific invasive species, Salisbury has also identified a range of other invasive species including: Japanese knotweed (*Fallopia japonica*), Common buckthorn *(Rhamnus cathartica),* Multiflora rose *(Rosa multiflora);* Black locust (*Robinia pseudoacacia L.*), Oriental bittersweet (*Celastrus orbiculatus*), Autumn olive (*Elaeagnus umbellate*), Burning bush (Euonymus alatus) and many more which have an adverse effect on protected resource areas and may need control measures in the future.

Natural Hazard Management and Response

Planning for and responding to recurring incidents of flooding, coastal storm surges and erosion, and other natural hazards are an ongoing challenge for community officials. The following describes some of Salisbury's key facilities and personnel involved in local emergency management.

Salisbury Police Department: The Salisbury Police Department maintains a roster of 18 full-time sworn officers, four (4) part-time sworn officers, who are supplemented by ten (10) full-time civilian personnel. In 2022, the Police Department received 21,671 calls for service or responses, and responded to 1,828 incidents, an increase from 1,373 incidents in 2016. The average response time is 8.1 minutes, from call to arrival on scene-this is an average of total calls and does not take in to account available manpower, location of call, or weather conditions. The Police Department maintains an active outreach and education program, including Code RED Emergency Notification System, the Domestic Violence Rapid Response Team, The TRIAD Program,

and the Neighborhood Watch Program. In 2017, Salisbury completed work on their new Police Station, located at 181 Beach Road.

Salisbury Fire & Rescue: The Town employs 17 full-time firefighters, two (2) full-time administrators, and has 1 part-time/call firefighter. In 2022, the Salisbury Fire Department responded to a total of 2,062 calls, with the majority of them being medical calls. The average response time is 4 minutes. The Fire Department operates three (3) engines, one (1) ladder, two (2) utility vehicles, one (1) marine unit, one (1) haz-mat trailer, and two (2) command vehicles.

Salisbury Fire & Rescue responds to all calls for medical assistance as a three-tier system with Fire, Police, and Private Ambulance (Atlantic EMS). Engines are staffed by MA Certified EMT's, Intermediates or Paramedics, certified as Class V Ambulances and are stocked with Basic and Advanced Life Support Equipment. Vehicles are also equipped with Automated External Defibrillator's (AED's). Fire and Rescue responds to all calls and starts initial treatment of patients and patients are then transported by Private Ambulance.

Emergency Management: The Salisbury Emergency Management Agency is a department under the Town of Salisbury. They provide residents with vital information in the event of a serious storm or other emergency event. They work closely with other public safety agencies both within the Town as well as neighboring communities, State and Federal agencies. The agency provides planning for emergencies, guides residents on the proper actions to take should the need arise. In addition, the Salisbury Emergency Management Agency interfaces with both the Massachusetts Emergency Management Agency (MEMA) as well as the Federal Emergency Management Agency (FEMA). Through those agencies we can request additional resources if needed.

Town-wide sirens are available, mainly for emergencies and tests associated with the Seabrook Nuclear Power Plant. These sirens are operated out of the Police Department and can be used in a catastrophic emergency, not just for the power plant.

Public Works: The Salisbury Department of Public Works maintains all of the Town's buildings and facilities, as well as public roads and parks. Utilizing a Highway staff of seven employees, the DPW maintains over 50 miles of road and 30.25 acres of parks and green space, maintains approximately 730 public catch basins, which are cleaned annually. The Town's wastewater division has four Operates which operate the wastewater treatment plant, 22 pump stations as well as 120,000 LF of sewer main. The Town's water division of four employees operates, maintains and oversees the Town wells and distribution system. The majority of the Town is swept, concentrating on environmentally sensitive areas (like the beach). Most streets are swept at least once per year, and more than once at the beach and the Town center. The DPW is the department primarily responsible for implementing the Town's NPDES Phase II Storm-water Management Regulations.

Conservation Agent: Salisbury's Conservation Agent serves as the local representative for the Commonwealth's Coastal Storm Team. During and after coastal storms, the Agent surveys the affected areas and reports back to Coastal Zone Management (CZM) and/or Massachusetts Emergency Management Agency (MEMA).

Building Commissioner: Salisbury's Building Commissioner serves as the Town's Zoning Enforcement Officer, and National Flood Insurance Program (NFIP) Coordinator. The Building Commissioner's responsibilities are wide-ranging and include: 1) interpreting and enforcing the Massachusetts State Building Code and all applicable codes as they relate to it; 2) interpreting and enforcing the Town's zoning by-laws; 3) issuing building permits and assisting contractors and property owners in the permit application process; and 4) performing site inspections to ensure compliance with the State Building Code and permitted plans.

Chief Harbormaster: Salisbury's Chief Harbormaster is responsible for managing the Town's harbor and navigable waters, enforcing waterways by-laws and Massachusetts General Laws, and responding to

emergencies on the waterways. In addition to carrying out administrative duties, the Harbormaster participates in marine rescues, manages recovery and securing of boats lost or adrift, patrols the Town's shorelines and waterways enforcing local, state, and federal laws and regulations, and issues citations and warnings for violations of the law. The Harbormaster oversees maintenance of all Town piers, launching ramps, and docks, as well as the installation and maintenance of channel markers and all other aids to navigation.

Natural Hazards Risk Analysis

Through using the Town of Salisbury's previous Hazard Mitigation Plan, in association with other planning documents including Salisbury's Comprehensive Emergency Management Plan, and Municipal Vulnerability plan, natural hazards for the Town were considered. On the basis of this analysis, Salisbury considers itself to be at ***high risk*** from coastal flooding, coastal erosion, and severe winter storms; ***moderate risk*** from high winds/thunderstorms, inland flooding, drought, extreme temperatures, hurricane/tropical storm, wildfires, and invasive species; and ***low risk*** from earthquakes, tsunamis, tornadoes, and landslides.

Table 5.55 Salisbury's risk rating for the 15 natural hazards experienced in the Commonwealth.

Salisbury Natural Hazard Community Risk Rating	
Natural Hazard	**Community Risk Rating**
Coastal Flooding	High
Coastal/Riverine Erosion	High
Severe Winter Storms	High
Inland Flooding	High
High Winds/ Thunderstorms	Moderate
Drought	Moderate
Extreme Temperatures	Moderate
Hurricane/Tropical Storm	Moderate
Wildfires	Moderate
Invasive Species	Moderate
Earthquake	Low
Tsunami	Low
Tornadoes	Low
Landslide	Low

Continue to page 201 of the Plan to review Salisbury's next section: ***Town of Salisbury Natural Hazard Challenge Statements.***

5.2.10 Town of West Newbury Natural Hazard Risk Assessment

Community Profile


West Newbury Town Offices

The Town of West Newbury is a semi-rural community that is located approximately 40 miles north of Boston. It covers a total area of 14.6 square miles and a land area of 13.5 square miles. The landscape is characterized by rolling hills with broad valleys and a rural charm. The Merrimack River flows along the Town's northern border, providing scenic vistas and recreational boating and fishing.

The Town's current population is 4,500, an increase of 6.3% from 2010.[154] The population density is 334.6 people per square mile. There are 1,591 households in West Newbury, with an average of 2.8 people per household. The average age in West Newbury is 48.1, with 20% of residents under the age of 18, and 19% over the age of 65. The Donahue Institute projects that the population in West Newbury in 2030 will be 3,899, a decrease of 15.4%.[155]

West Newbury has one elementary school, Dr John C. Page School, and sends students to the regional middle and high school, Pentucket Regional School District. The Pentucket school campus spans West Newbury and Groveland, with the Middle/High School located in West Newbury and the stadium and ballfields located in Groveland. A total of 1,270 students are enrolled between the three schools. Some West Newbury students also attend Whittier Regional Vocational Technical High School in Haverhill, and Essex North Shore Agricultural & Technical School in Danvers.

The Town is not served by a centralized municipal sewerage system, but instead relies on individual on-site septic systems for wastewater treatment and disposal. Public water is supplied to approximately 63% of the Town, or about 1,000 dwellings, from two sources. The major source (72%) is the West Newbury Wellfield #1, located on the south side of Main Street (Route 113) in the northeastern corner of the town. The second source (28%) is water purchased from the neighboring City of Newburyport, which draws its water from the Artichoke Reservoir and Indian Hill Reservoir, both located in West Newbury, and from city wells. The inflow from Newburyport runs through the Wellfield #1 pump house. Currently, West Newbury's average daily water demand is 178,000 gallons per day (gpd). Its maximum daily demand during the height of the growing season (when lawn watering peaks) is 320,000 gpd.

The Water Department recognizes the need for additional town-owned water sources to meet present and future demands and has drilled numerous test wells in a search for a new source over the years. The Town's pursuit of a supplemental local water source continues to be an active initiative, and among the Select Board's highest policy priorities. In 2023, Town Meeting voters appropriated funding proposed by the Select Board to undertake a town-wide study to identify specific sites with potential to serve as new sources of public water. That study was completed in June 2024, and the Board secured additional funding at the April 2024 Town Meeting to undertake site evaluation/testing based on the potential sites as prioritized within the groundwater study. Work on this initiative will continue in FY2025.

[154] United States Census Bureau. 2023. QuickFacts. U.S. Census Bureau QuickFacts: United States

[155] UMass Donahue Institute. 2022. Massachusetts Population Projections. UMass Donahue Institute | Population Projections

In parallel with these efforts, the Select Board and Town Manager continue to lead an effort, including the Board of Water Commissioners, toward negotiating a new Intermunicipal Agreement with Newburyport to establish clear terms for the communities' relationship regarding public water. This effort, supported by legal counsel, is intended to replace the prior 1980 Intermunicipal Agreement which has not been in legal effect for many years (but which is largely honored).

Fields in West Newbury

The GIS analysis for the 2024 HMP reports both land cover and land use data derived from the State's most updated 2016 land cover layer.[156] Predominant *land cover* in West Newbury is forest (52%), followed by wetland (19%), open land (9%), agricultural land (9%), open water (7%), and developed impervious (5%). According to the assessor's data, *land use* in West Newbury is primarily residential (46%) and recreational/other (33%), followed by agricultural (9%), water (7%), transportation (4%), and commercial/industrial (1%).

Recent Development and Land Use Changes

According to the West Newbury Planning Board and the Town Planner, there have been three (3) noteworthy development projects in the community since the last 2016 Hazard Mitigation Plan update. All of these have been residential (*Table 5.56)*.

Table 5.56 Major development projects in West Newbury initiated since 2016.

West Newbury Major Development Projects 2016-2023				
Facility Type	**Common Name**	**Address**	**Square Feet/ Housing Units**	**2023 Status**
Residential (OSRD)	Drakes Landing	365 Main St	34	Complete
Residential (OSRD)	The Cottages at River Hill	Follinsbee Lane	30	Complete
Residential	Deer Run	519 Main Street	8	Construction

The preservation and management of open space and the Town's natural resources has been identified by the Town's Master Plan and Open Space and Recreation Plan as one of the Town's community goals. West Newbury is actively working to preserve and conserve open space within the Town. Since the 2016 update, ten parcels totaling 277 acres have been conserved or are in the process of being conserved within the Town. Those properties have been detailed in *Table 5.57*.

Two of these properties are actively in the process of being conserved: the Sawmill Brook/Austin property located off of Poor House Lane adjacent to the Mill Pond/Pipestave Recreation area, and Evergreen Farm located on Ash Street. During their spring 2023 meeting, West Newbury voted to allocate CPA funding, supported by funding committed by Essex County Greenbelt Association (ECGA), to acquire the Sawmill Brook/Austin property. In November 2023 the Town was awarded a Local Acquisitions for Natural Diversity (LAND) grant to offset the cost of acquiring this property, and the land was deeded to the Town on December 15, 2023. A Conservation Restriction (CR) on the land, to be held by Essex County Greenbelt Association, is currently being reviewed by the Commonwealth.

[156] MassGIS. 2019. 2016 Land Cover/Land Use. MassGIS Data: 2016 Land Cover/Land Use | Mass.gov

Evergreen Farm is a 36-acre Christmas tree farm and house lot located on Ash Steet. Greenbelt has entered a purchase and sales agreement with the sellers and has proposed selling 18 acres to Massachusetts Fish and Wildlife and the other 18 acres to an already identified private buyer with a CR to be held by the Town of West Newbury and Essex County Greenbelt Association on approximately 14 of the privately owned acres.

Since the last plan update, changes in development and land use in the Town have marginally increased West Newbury's risk to natural hazards. Development on sites with steep slopes, and with sole access from River Road, has increased risk to property damage by increasing exposure to natural hazard events such as landslides, and storm events.

Table 5.57 Newly conserved or preserved land in West Newbury since 2016.

West Newbury Newly Protected or Conserved Land 2016-2023				
Property Name	**Address**	**Area (acres)**	**Owner**	**Year Completed / Projected**
Coffin Street Conservation Parcel 1	0 Coffin Street Map 230 Lot 110	10.09	Owned by ECGA, CR held by Town	2022
Coffin Street Conservation parcel 2	0 Coffin Street Map 230 Lot 40	32.49	Owned by ECGA, CR held by Town	2022
Artichoke River Woods	430 Middle Street	38	Owned by ECGA, CR held by West Newbury, Newburyport, and Commonwealth of MA (DCR)	2020
River Road Reservation	River Road, Lot 2	31	Owned by ECGA, CR held by Town	2019
Sawmill Brook	0 Poorhouse Lane, 2 parcels	32.13	Owned by Town, CR to be held by ECGA (under review by State)	In Progress
Indian Hill Street	117 Indian Hill Street	6.1	Owned by Newburyport, CR held by ECGA	2021
Brown Spring Farm	866 Main Street	10	Privately owned, APR co-held by ECGA and Town	2019
Drakes Landing	365 Main Street	44.63	Owned by Homeowners Association, CR held by Town	2021
River Run Farm	540 Main Street	40.97	Privately owned, held by ECGA	2022
Ash Street	114 Ash Street	32	ECGA is entering a P&S with the sellers, CR will be co-held by Town and ECGA	In Progress

Community Lifelines

Selected community lifelines in West Newbury (emergency operations centers, health and medical aid facilities, emergency public shelters) are listed in *Table 5.58*. These were derived from the Town's current Comprehensive Emergency Management Plan (CEMP). The locations of these and other community lifelines in West Newbury were entered by MVPC into an Excel database and subsequently incorporated into MVPC's ArcGIS for use in digital mapping. As part of the plan update, the full list of community lifelines was reviewed and amended to reflect current conditions, as well as to incorporate new facilities and resources. The full list of community lifelines is depicted in the West Newbury's map series that is presented in Appendix B of this Plan.

Table 5.58 Select list of West Newbury's community lifelines (emergency operation centers, hospitals, and shelters).

West Newbury Emergency Operation Centers, Hospitals, and Shelters						
Facility Type	**Common Name**	**Street Address**	**Health Facility Type**	**Maximum Capacity**	**Feeding Capability**	**Emergency Generator Available**
Emergency Operations Center	West Newbury EMA/ Public Safety Complex	401 Main Street	N/A	N/A	N/A	Yes
Hospitals and Healthcare Centers	None					
Emergency Shelters	Town Office Building Annex	381 Main Street	N/A	50	Possible	Portable
	Public Safety Complex	401 Main Street	N/A	20	No	Yes
	Page School	694 Main Street	N/A	1,500	Yes	Yes
	Pentucket High School	22 Main Street	N/A	2,000	Yes	Yes

Critical Infrastructure

Bridges: The Town of West Newbury has two (2) bridges located completely within its municipal borders.[157] These are the bridge on Rogers Street over the Artichoke Reservoir and T Bridge on Middle Street over Beaver Brook. Both bridges are owned and operated by West Newbury and one (T Bridge) is currently listed as structurally deficient (*Table 5.59)*. West Newbury is actively working to address the structurally deficient bridge within their municipal borders. There are four additional bridges located on West Newbury's borders. Three are located on the eastern border of the Town crossing the Artichoke River and are owned and operated by the City of Newburyport (Route 113 Bridge, Middle Street Bridge, and the Rogers Street Bridge). The fourth bridge is located on the border with Haverhill (Rocks Village Bridge) and is owned by MassDOT. Of these four bridges, three are in operational order, while one (Middle Street Bridge) is currently closed.

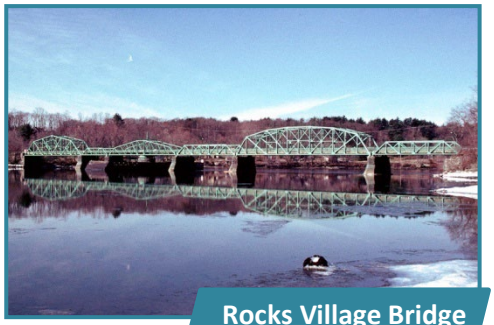
In 2018, the Middle Street Bridge, connecting West Newbury to Newburyport was closed to vehicles due to a failure in the spandrel wall. A structural inspection field report conducted by MassDOT in 2018 indicated the masonry stone wingwalls of the bridge are in poor condition, along with the bridge railings and approach guardrails. Since its closure, West Newbury and Newburyport have been working to address these deficiencies and reopen the bridge for vehicular use. Currently, Middle Street Bridge repair has been designed and is 100% permitted. The project has been supported by nearly $3.5M in State grant funding awarded to West Newbury and Newburyport. Negotiations are ongoing between the two communities regarding an Intermunicipal Agreement that will set out an agreed cost allocation for the remaining project expenses. The project is expected to be put out to bid for reconstruction in 2024, with work expected to begin in 2025.

[157] MassDOT. 2024. Bridges. Bridges | Bridges | MassDOT Open Data Portal (arcgis.com)

Table 5.59 List of West Newbury's structurally deficient bridges as identified by the Massachusetts Department of Transportation.

West Newbury Structurally Deficient Bridges					
Bridge Name	**Feature Intersected**	**Owner**	**Year Built**	**Structurally Deficient**	**Last Inspection Date**
T Bridge	Beaver Brook	Municipality	1980	Yes	6/22/2022

The Rocks Village Bridge, connecting West Newbury and Haverhill, has also experienced structural improvements since the last Plan update. The Bridge serves as a connection between Route 110 in Haverhill and Merrimac and Route 113 in West Newbury and Groveland. It is a major school bus route that connects the Town of Merrimac to the other Pentucket Regional School system communities of Groveland and West Newbury. This route also provides access to Whittier Vocational High School, which educates students from eleven (11) cities and towns within the region. In addition to carrying the school-related traffic, the bridge is also used by commuters from southern New Hampshire/eastern Haverhill/western Merrimac to access I-95 in Newburyport.



Rocks Village Bridge

Constructed in 1883 with major reconstruction in 1914, the bridge spanning the Merrimack was closed to heavy vehicles such as tractor-trailers as major bridge rehabilitation work took place from Summer 2012 through Fall 2013. A new bridge deck was installed along with stronger guardrails and new lighting. The bridge's piers and ice fenders were repaired as were components of the superstructure. The rehabilitated bridge opened to traffic in fall 2013.

In 2022, the bridge experienced significant structural damage following an over-height truck strike. After a series of emergency repairs by MassDOT crews, the bridge was re-opened 7 months later. Working closely with the Town of West Newbury and the City of Haverhill, MassDOT installed significant new signage and pavement striping both locally and regionally (including on I-95 and I-495) to provide notice of the height restrictions on the bridge. In addition, the Town is working with MassDOT to evaluate the feasibility of installing electronic advance detection and warning systems that could detect overhead vehicles approaching the bridge, and warning drivers, in order to minimize the potential for future collisions with the bridge.

The Town has also been working to address undersized and outdated culverts across West Newbury. In 2024, a stream crossing in the Town was selected as an Ecological Restoration Site by the Department of Fish & Game's Division of Ecological Restoration (DER). Through DER's program, West Newbury will receive direct guidance, technical assistance, grant opportunities, and training to renovate/replace the culvert. In addition, Town Meeting recently approved funds for design and permitting to replace two undersized culverts on Coffin Street. Increasingly larger storms have caused repeated overtopping at these locations and have damaged sections of the road. The project is underway and the next step will be to secure construction funding in the spring of 2025.

Dams: The DCR Office of Dam Safety (ODS) lists three (3) West Newbury dams on its statewide dam classification inventory.[158] These are: Walker Farm Pond Dam located along Indian Hill Road, Indian Hill Reservoir Dam and Dike which impound water from the Upper Artichoke Reservoir, and Mill Pond Dam which impounds water from Mill Pond adjacent to Main Street. The Mill Pond Dam is municipally owned by West

[158] MassGIS. 2012. Dams. MassGIS Data: Dams | Mass.gov

Newbury. The Walker Farm Pond Dam is privately owned. The Indian Hill Reservoir Dam and Dike are owned by the City of Newburyport. None of the dams are designated as “High” or “Significant” hazard. There are three additional dams on the border of West Newbury, all located along the Artichoke Reservoir: Artichoke River Dam, Lower Artichoke Reservoir Dam (an earthen berm dam and concrete spillway), and Upper Artichoke Reservoir Dam. None of these Artichoke Reservoir Dams are classified as high or significant hazards dams. West Newbury actively manages and ensures regular inspection of the one town-owned dam: Mill Pond Dam. The dam was most recently inspected in spring 2024, in compliance with ODS requirements.

Community Specific Hazards

West Newbury’s LHMPT reviewed the full range of natural hazards that impact Massachusetts, as identified through the State Hazard Mitigation and Climate Adaptation Plan. The majority of the natural hazards considered impact the Merrimack Valley Region in a similar way. For those that have a different or locally-specific impact on the Town of West Newbury, additional information has been supplemented in this section.

Flooding

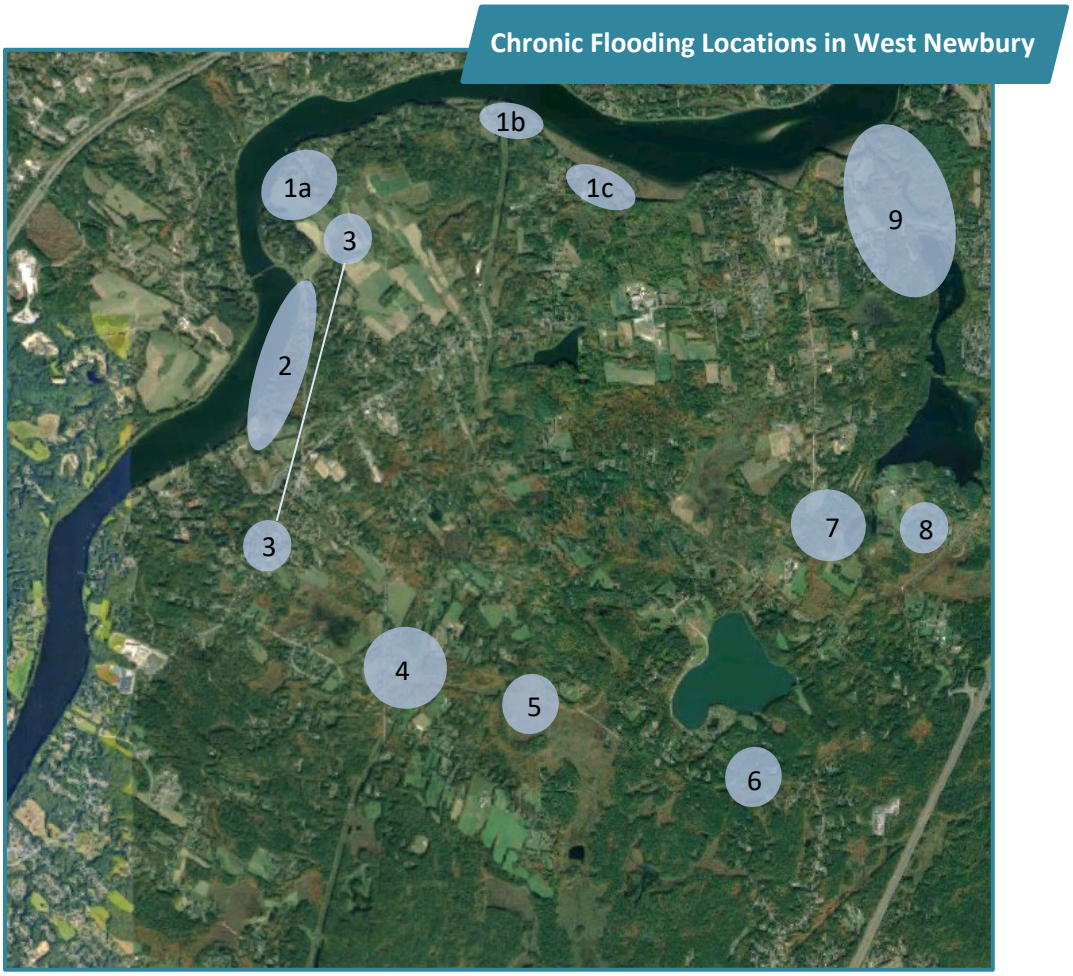


Figure 5.9 Chronic flooding locations identified across West Newbury by the Local Hazard Mitigation Planning Team.

West Newbury spans two major watersheds as defined by the Commonwealth of Massachusetts: the Merrimack River watershed and the Parker River watershed. The majority of the Town (76%) lies within the Merrimack watershed and drains northward to the Merrimack River mainstem, while the remaining 24% of the Town lies within the Parker River watershed. Flooding occurs periodically along the Merrimack River, as

well as along tributaries to both the Merrimack and Parker. Additional flooding occurs in dispersed locations (generally low points) in the community where groundwater intersects the surface and where wetlands expand during prolonged rainfall events. One issue of increasing concern is the frequency and degree to which significant rainfall events are stretching the capacity of existing local stormwater infrastructure. The Town has seen multiple major rain events in 2023 and 2024 that resulted in substantial local flooding, and damage to both private property and public infrastructure.

Areas of Flooding Concern: The LHMPT has identified 9 major flood prone areas within the Town: 1. Merrimack River along River Road near (a) the field, (b) east of the power lines, and (c) east of Coffin Street; 2. Merrimack River West of Bridge Street to Groveland town line; 3. Multiple locations along Main Street including Harrison Ave, Bridge Street, and Macey's Pond; 4. Artichoke River between Middle and Garden Streets including Kelly Brook Lane; 5. Ash Street; 6. Moulton Street and Spring Hill Road; 7. Wetland area between Crane Neck Street, Georgetown Road, and Middle Street including flooding into Tewksbury Lane; 8. Wetland area to the south and southeast of Upper Artichoke Reservoir between Indian Hill Street and the town line; 9. Upper and Lower Artichoke Reservoirs (*Figure 5.9)*. It has been noted that many of the main roads used for evacuation also experience frequent and at times significant flooding.

Flooding Vulnerability Assessment: A GIS analysis of the Town's most recent FIRM flood hazard area maps by MVPC has determined that 1,157 acres (1.81 sq. mi.) in West Newbury are located within the 100-year floodplain and thus is vulnerable to flooding. An additional 603 acres (0.94 sq. mi.) lie within the 500-year floodplain. Together, these two flood zones constitute nearly one-fifth (18.7%) of the total area of the community.

Flooding along River Road

As part of its mapping analysis, MVPC also investigated whether any of the community's existing community lifelines are located within either the 100-year or 500-year floodplain, thus placing them at risk of future flood damage or loss. A total of one (1) community lifeline identified by the Town's Emergency Management team, was determined by MVPC to be located in a mapped flood hazard zone. This feature is the municipal water service connection between Groveland and West Newbury, valued at $15.6 million (2023) and located in the 500-year floodplain. MVPC also examined *non*-critical facilities in flood hazard areas. This analysis revealed the presence of 150 structures (valued in 2023 at $122 million) within the floodplains. The number of buildings listed within floodplain is up from 41 from the 2016 update, and the number of community lifelines is up from zero. This is largely a reflection of the 2023 update considering both 100- and 500-year floodplains, as well as the expanded definition of community lifelines used, which include a broader range of services compared to the 2016 plan.

Based on the frequency, aerial extent, and severity of historical floods in West Newbury, Town officials consider the community to be at ***high risk*** from flooding.

NFIP Information: West Newbury actively participates in the National Flood Insurance Program (NFIP). The Town's initial Flood Hazard Boundary Map (NHBM) was identified in 1974, and the initial Flood Insurance Rate Map (FIRM) was identified in 1979. The latest effective FIRM was adopted in 2014. The Flood Hazard Management Program anticipates a new FIRM and Flood Insurance Study (FIS) will be available for adoption in 2024. West Newbury intends to update their local regulations to adopt the new maps and study ahead of

the effective date, anticipated in summer of 2025. This will require updating West Newbury's Zoning Bylaw (Section 8.1), where minimum floodplain management criteria appear. West Newbury implements and enforces local floodplain management regulations in Special Flood Hazard Areas (SFHAs) through their Building Commissioner, who serves as the Town's Floodplain Administrator. Following an event, all flood damage is evaluated by the Building Commissioner and subject to the NFIP Substantial Improvement Worksheet for Floodplain Construction and affidavits. Based on observations and outcomes of the assessment, the proper enforcement is followed.

According to data provided by the FEMA, there is one repetitive flood loss site in West Newbury, a single-family residence that has experienced three losses totaling $103,188 in damages. Town-wide, there are 20 flood zone properties covered by flood insurance policies, with a collective insured value of $6,079,000. There are an additional six (6) policies for properties within severe flood hazard areas, with a total insured value of $6,123,000.[159]

Riverine Erosion

Another major challenge stemming from intensive precipitation, coastal storm events and sea level rise is riverine erosion. Riverine communities have experienced bank erosion throughout their history. In recent years, West Newbury has experienced significant and acute erosion at a number of locations posing a threat to infrastructure. Heavy precipitation, flooding, and ice jams/flows have led to erosion of banks and undermining roadways. Along the banks of the Merrimack River, there is ever worsening erosion that is threatening specific locations along River Road, and has caused road closures and road repairs. In 2023, West Newbury applied for a Municipal Vulnerability Preparedness grant and was awarded $150,000 plus a $50,000 local match to study road stability and flooding along River Road. The Town completed the grant-funded work in June 2024, and is actively working toward next steps to improve the resiliency of River Road and the surrounding area. Given the nature and extent of challenges in these locations, the Town anticipates pursuing State and Federal funding to support its recent and ongoing appropriations of local funding. In April 2024, Town Meeting approved $40,000 to advance the Town's planning efforts in this regard. In addition to River Road, locations of erosion in Town have been identified along Route 113 near the Page School and the Town's DPW.

The August 18, 2023 storm provides an example of the impacts that a large rainstorm can have on the community with regard to erosion and flooding. Heavy rains caused localized flash flooding in West Newbury, causing damage to many properties. Reports from a Conservation Commission meeting following the storm document numerous impacts including: two landslides, one of which caused damage to a home on Main Street; culvert failures; basement flooding; and bank erosion leading to sediment movement/deposition. Due to the increased occurrence of erosion along the Merrimack River, West Newbury has determined riverine erosion to be ***high risk***.

Wildfires/Brushfires

Over half of the Town's land area is woodland. While recently the incidence of brush fire has been relatively low, the West Newbury Fire Chief has acknowledged that "any open space areas are at risk for brush fire." Given the increased incidents of extreme temperature and drought, and the extent of brush/forest coverage, the Town has determined brush fire to be a ***high risk***.

[159] Massachusetts Emergency Management Agency. 2023. *NFIP Summary Data Report* – 7/25/2023.

Snow Drifts

West Newbury has identified severe winter storms as a ***moderate*** hazard for their community. One specific associated event with these storms that uniquely impacts West Newbury is the occurrence of snow drifts. Snow drifts occur when winds influence the movement and deposition of snow, allowing for deep deposits to form along roadways or structures. West Newbury's LHMPT has identified a number of locations where snow drifts are common: River Road, Church and Main Street, Moody and Main Street, and Garden Street from Browns Lane to Rogers Street.

Invasive Species

The Town of West Newbury has noted impacts from a range of invasive species in recent years. As a heavily forested community, dotted with ponds and waterways, the Town is susceptible to invasive species including Oriental bittersweet, swallow-wort, burning bush, barberry, buckthorn, Japanese knotweed, garlic mustard, multiflora rose, autumn olive, and tree of heaven. Invasive insect species have also posed a risk for forest health in West Newbury. In recent years, the Emerald Ash Borer and other invasive insect species have caused structural decline of trees, impacting forest health and posing challenges for utilities and infrastructure due to downed trees.

To address these invasive species and manage their impacts, West Newbury has undertaken a number of initiatives in recent years. West Newbury Wild and Native (WN2) is a group of residents from West Newbury and adjacent towns that was formed in 2020 from a need identified in the Town's Municipal Vulnerability Planning Process. The group is passionate about promoting native plants, pollinator and wildlife-friendly gardening, and controlling invasive plants. To support its mission, WN2 provides education and leads workshops and workdays in West Newbury to manage invasives. Additionally, for the last two years (2022 and 2023) the Town has hired two summer interns focused on mapping and managing invasive species on town owned land. This past summer, West Newbury also engaged a contractor to professionally manage invasive plants on town owned land. This work is set to continue into 2024. Due to the Town's susceptibility to invasive plant species, and the challenge of managing these invasives, they have assigned a ***moderate*** risk to the hazard of invasive species.

Response Management Capacity


Stand of Invasive Phragmites

West Newbury has an active emergency management agency led by the Town's Emergency Management Director. Emergency Management planning and response team includes participation by Police Department, Fire Department, Town Manager's office, Health, Inspectional Services, Communications, Senior Center, DPW Transportation, and the Water Department.

The Town formed a Municipal Vulnerability Committee in 2019 when actively writing their community plan. The committee has since continued to convene regularly as the Climate Change Resiliency Committee and is working on a number of initiatives to address climate-related hazards in West Newbury.

West Newbury uses Code Red (Reverse 911) as their Town-wide emergency alert system. The Town also owns and operates a range of emergency response equipment including portable and field deployable communications equipment, emergency lighting/generators, portable water pumps, traffic control equipment, rehab equipment, command trailer and Emergency Operations Center/back up dispatch site.

Natural Hazards Risk Assessment

Through using the Town of West Newbury's previous Hazard Mitigation Plan, in association with other planning documents including West Newbury's Comprehensive Emergency Management Plan, and Municipal Vulnerability Plan, natural hazards for the Town were considered. On the basis of this analysis, West Newbury considers itself to be at ***high risk*** from wildfires, drought, and extreme temperature, coastal flooding and inland flooding; ***moderate risk*** from severe winter storms, erosion, high winds/thunderstorms, invasive species, hurricane/tropical storm; and ***low risk*** from earthquakes, tornadoes, tsunamis, and landslides.

Table 5.60 West Newbury's risk rating for the 15 natural hazards experienced in the Commonwealth.

West Newbury Natural Hazard Risk Rating	
Natural Hazard	**Community Risk Rating**
Wildfires	High
Drought	High
Extreme Temperatures	High
Coastal Flooding (tidally influenced)	High
Inland Flooding	High
Coastal/Riverine Erosion	High
Severe Winter Storms	Moderate
High winds/thunderstorms	Moderate
Invasive Species	Moderate
Hurricane/Tropical Storm	Moderate
Landslide	Low
Earthquake	Low
Tornadoes	Low
Tsunami	Low

Continue to page 202 of the Plan to review West Newbury's next section: ***Town of West Newbury Natural Hazard Challenge Statements.***

5.3 Natural Hazard Risks for the Merrimack Valley

5.3.1 Regional Risk Assessment

In order to assess the relative risk of these hazard events on a ***regional level*** (i.e., across all 10 participating communities), a similar process used by each community to analyze the Area of Impact, Severity/Extent, Previous Occurrence, and Future Probability of the 15 natural hazards was completed for the entire Merrimack Valley region. The information in this table was formed with input from best available scientific data for the Merrimack Valley region (outlined in Section 4: Natural Hazard Identification), as well as local risk assessments completed by each LHMPT (outlined in Section 5: Risk and Vulnerability Assessment).

Table 5.61 Comprehensive Hazard Assessment for the Merrimack Valley Region.

HAZARD	AREA OF IMPACT				SEVERITY/EXTENT				PREVIOUS OCCURRENCE				FUTURE PROBABILITY				
	Negligible	Limited	Significant	Extensive	Weak	Moderate	Severe	Extreme	Rarely	Occasionally	Often	Very Often	Unlikely	Occasional	Likely	Highly Likely	Hazard Ranking
Inland Flooding			X				X					X				X	High
Riverine Erosion		X				X						X				X	Moderate
Drought				X		X					X				X		High
Landslide	X					X				X				X			Low
Coastal Flooding		X						X				X				X	Moderate
Coastal Erosion		X					X					X				X	Moderate
Tsunami		X					X		X				X				Low
Earthquake				X			X		X				X				Low
Extreme Temperature				X			X					X				X	High
Wildfire/Brush fire			X			X					X				X		Moderate
Invasive Species				X		X						X				X	High
Hurricane/Tropical Storm				X		X					X				X		High
Severe Winter Storm				X		X						X				X	High
Tornado		X					X		X				X				Low
Other Severe Weather				X		X						X				X	High

KEY:

AREA OF IMPACT

The area of potential impact within the region in which the hazard occurs.

Negligible: Less than 10% of planning area or isolated single-point occurrences
Limited: 10-25% of the planning area or limited single-point occurrences
Significant: 25-75% of planning area or frequent single-point occurrences
Extensive: 75-100% of planning area or consistent single-point occurrences. You can also list specific locations within your

SEVERITY/EXTENT

The extent or magnitude of a hazard, as measured against an established indicator (e.g., Richter Scale, Saffir-Simpson Hurricane Scale, or

Weak: Limited classification on scientific scale, slow speed of onset or short duration of event, resulting in little to no
Moderate: Moderate classification on scientific scale, moderate speed of onset or moderate duration of event, resulting in
Severe: Severe classification on scientific scale, fast speed of onset or long event duration, resulting in devastating damage
Extreme: Extreme classification on scientific scale, immediate onset or extended event duration, resulting in catastrophic

PREVIOUS OCCURRENCE

How often the hazard has occurred in your community.

Rarely: Has occurred once in last 100 years
Occasionally: has occurred once every 10-99 years
Often: Has occurred once every ten years
Very Often: Has occurred every year

FUTURE PROBABILITY

The likelihood of this hazard occurring in your community in the future.

Unlikely: Likely to occur once every 100 years or more
Occasional: Likely to occur once every 10-100 years
Likely: Likely to occur once every 10 years
Highly Likely: Likely to occur once every year

The Comprehensive Regional Hazard Assessment (*Table 5.61),* was used in tandem with individual community Natural Hazard Risk Rating tables (at the end of each Community Profile) to develop the Merrimack Valley Regional Natural Hazard Risk Assessment (*Table 5.62).* Each communities' natural hazard risk ratings were integrated by taking a weighted aggregation using the following point scale:

- Communities identified a natural hazard as "not applicable": 0 points were assigned;
- Communities identified a natural hazard as "Low" risk: 1 point was assigned;
- Communities identified a natural hazard as "Moderate" risk: 2 points were assigned;
- Communities identified a natural hazard as "High" risk: 3 points were assigned.

Therefore, the lowest possible regional score a natural hazard could tally would be "0" and the highest possible score a natural hazard could achieve regionally would be "30" (3 points per community x 10 communities). *Table 5.62* represents the overall natural hazard risk rating for the Merrimack Valley Region and serves as a tool for focusing attention on key regional issues.

Table 2.62 Regional natural hazard risk assessment for Merrimack Valley determined using a weighted aggregation of individual communities' risk ratings. Low risk includes composite scores from 0-10, Moderate risk includes composite scores from 11-20, and High risk includes composite scores from 21-30.

Merrimack Valley Regional Natural Hazard Risk Assessment (10 communities)		
Natural Hazard	**Composite Score**	**Regional Risk**
Severe Winter Storm	**29**	**High**
Inland Flooding	**28**	**High**
Extreme Temperature	**25**	**High**
Drought	**25**	**High**
High Wind/ Thunderstorm	**24**	**High**
Invasive Species	**23**	**High**
Hurricane/Tropical Storm	**22**	**High**
Coastal/Riverine Erosion	**20**	**Moderate**
Wildfire	**19**	**Moderate**
Coastal Flooding	**14**	**Moderate**
Earthquake	**10**	**Low**
Landslide	**10**	**Low**
Tornado	**10**	**Low**
Tsunami	**7**	**Low**

Notable differences between the 2016 and 2024 Regional Natural Hazard Risk Assessment are the elevation of "Drought" and "Hurricane/Tropical Storm" from Moderate to High Risk, as well as the addition of "Coastal/Riverine Erosion," "Tsunami," "Invasive Species" and "Extreme Temperatures" during this plan update. The 2024 update also divided flooding into "Inland Flooding" and "Coastal Flooding" which differed from the 2016 plan. Lastly, the 2024 update removed "Power Outages" and "Dam Failures", as they were considered impacts of Natural Hazard Events, and not natural hazard events themselves.

Section 5.3.2 Disaster Declarations for Essex County

Previous sections of this Multi-Hazard Mitigation Plan identify and describe the natural hazards that have occurred, or are most likely to occur, in the Merrimack Valley region. From 2000 through 2023, there have been 24 Presidential Disaster Declarations involving natural hazards in Essex County. [160] Between 2011-2023, there have been seven (7) Massachusetts Emergency Declarations involving natural hazards in Essex County.[161] Together, these events are summarized in *Table 5.63*. Since 2016, when the region's last Hazard Mitigation Plan was prepared, there have been three Presidential disaster declarations in Essex County, and two Massachusetts disaster declarations.

Table 5.63 Natural Disaster Declarations for Essex County between 2000-2023.

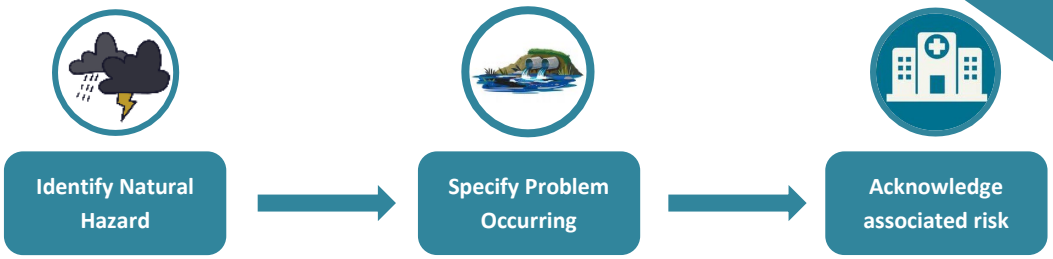
Natural Disaster Declarations for Essex County (2000-2023)				
Date	**Disaster Name**	**FEMA Disaster Number**	**Type of Assistance**	**Total Assistance Provided**
3/28/2001	Snow	EM-3165-MA	PA	$21,065,441.93
4/10/2001	Severe Winter Storms and Flooding	DR-1364-MA	IA, HMGP	None listed
3/11/2003	Snow	EM-3175-MA	PA	$28,844,937.02
1/15/2004	Snow	EM-3191-MA	PA	$35,683,865.83
4/21/2004	Flooding	DR-1512-MA	IHP, IA, HMGP	$2,728,345.06
2/17/2005	Record/Near Record Snowfall	EM-3201-MA	PA	$49,945,087.29
9/13/2005	Hurricane Katrina Evacuation	EM-3252-MA	PA	$5,854,973.22
11/10/2005	Severe Storms and Flooding	DR-1614-MA	HMGP	$10,848,340.44
5/25/2006	Severe Storms and Flooding	DR-1642-MA	IHP, IA, PA, HMGP	$37,488,493.57
5/16/2007	Severe Storms and Inland/Coastal Flooding	DR-1701-MA	PA, HMGP	$8,293,666.78
12/13/2008	Severe Winter Storm	EM-3296-MA	PA	None listed
1/5/2009	Severe Winter Storm and Flooding	DR-1813-MA	PA, HMGP	$51,847,902.76
3/29/2010	Severe Storms and Flooding	DR-1895-MA	IHP, PA, HMGP	$84,775,270.87
5/3/2010	Water Main Break	EM-3312-MA	PA	None listed
9/2/2010	Hurricane Earl	EM-3315-MA	PA	$741,694.21
3/7/2011	Severe Winter Storm and Snowstorm	DR-1959-MA	PA, HMGP	$25,955,715.57
8/26/2011	Hurricane Irene [F,S]	EM-3330-MA	PA	$5,366,361.92
11/1/2011	Severe Storm [F,S]	EM-3343-MA	PA	None listed
10/28/2012	Hurricane Sandy [F,S]	EM-3350-MA	PA	None listed
4/19/2013	Severe Winter Storm, Snowstorm, and Flooding [F,S]	DR-4110-MA	PA, HMGP	$61,728,615.78
4/13/2015	Severe Winter Storm, Snowstorm, and Flooding [F,S]	DR-4214-MA	PA, HMGP	$84,641,473.10
6/25/2018	Severe Winter Storm and Flooding [F,S]	DR-4372-MA	PA, HMGP	$31,059,109.03
7/19/2018	Severe Winter Storm and Snowstorm [F]	DR-4379-MA	PA, HMGP	$40,738,574.13
9/15/2023	Hurricane Lee [F,S]	EM-3599-MA	PA	None listed

Key:
F,S (*superscripts*)- "F" indicates Federal Natural Disaster Declaration/ "S" indicates State Natural Disaster Declaration
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.
IHP – Individual Household Program: Provides grants and loans to individual disaster victims to address serious needs and necessary expenses.
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.

[160] Federal Emergency Management Agency (FEMA).2024.Disasters and Other Declarations.https://www.fema.gov/data-visualization/disaster-declarations-states-and-counties
[161] Massachusetts Emergency Management Agency (MEMA). 2024. State of Emergency Information. State of Emergency Information | Mass.gov

Section 6. Natural Hazard Challenge Statements

This section of the Hazard Mitigation Plan outlines specific natural-hazard related challenges for each of the ten participating communities. Following the vulnerability assessment, LHMPTs reviewed the list of natural hazards that occur within their municipality. For each natural hazard, the group developed 1-3 challenge statements based on the impacts the community is experiencing and/or expect to experience from that hazard. In creating these statements, communities also consulted their Municipal Vulnerability Plans. This process allowed communities to reflect on the top hazards of concern for their municipality and identify specific problems occurring and the associated risk/vulnerability.



Challenge statements identify the natural hazard occurring, lay out the problem(s) caused, & acknowledge the vulnerability/ risks posed

...r

Example Challenge Statement: Heavy and frequent precipitation is causing combined sewage overflow (CSO) events, leading to contamination of waterways used for potable drinking water and recreational activity for residents. This occurrence poses a risk for the health and safety of residents.

6.1 Natural Hazard Challenge Statements by Community

6.1.1 City of Amesbury Natural Hazard Challenge Statements

Through their challenge statements, the City of Amesbury identified the following natural hazards as causing problems and increasing risk/vulnerability for their community: Flooding, earthquakes, tornadoes, extreme erosion, invasive species, high winds, severe winter storms, precipitation, severe winter storms, drought, riverine erosion, and extreme temperatures.

1. *Flooding* can cause numerous locations in the City to become isolated from emergency response. This is especially concerning for locations that have only one access route such as Kimball Road and Amesbury Landing. This occurred during the Mother's Day Flood in which residents near the Kimball Road culvert had to be evacuated due to flooding.

2. *Flooding* also poses a risk to the City's infrastructure (culverts, dams, and bridges). In many cases, the infrastructure in Amesbury is outdated, undersized, and in need of repair. Major storm events pose a risk to the stability and functionality of these features, ultimately increasing risk for public access and safety.

3. Critical water infrastructure such as sewer lines and pump stations are located within floodplains susceptible to common and extreme *flooding* events. Placement of key utilities in vulnerable areas could

lead to loss of services to residents and damage to infrastructure. Additionally, as Amesbury manages their own wastewater system, major disturbance to the system would substantially impact public and environmental health.

4. The location of a key cable line (serving multiple communities) under the Merrimack River is susceptible to damage from less common but damaging natural hazard events such as *earthquakes, tornados, and extreme erosion*. Loss of this utility would impact thousands of people.

5. Changes in climate are further exacerbating *invasive species* (plant and insect species). Increased growth/proliferation of invasives poses a risk for vulnerable trees in the community (potentially impacting occurrence and intensity of wildfires, as well as critical infrastructure such as powerlines). Additionally, aquatic invasives also pose a threat to drinking water sources and recreational activity.

6. *High winds* can cause numerous impacts to Amesbury. Tree damage caused by high winds poses threats to utility lines across the City. Additionally, high winds may exacerbate structural fires in Amesbury which can occur in more historic and densely populated parts of the community.

7. *Severe winter storms* can cause steeper and isolated locations of Amesbury to become inaccessible, limiting emergency access.

8. Significant and High Hazard Dams, and other water management infrastructure pose a risk to populated/developed locations that may experience significant and damaging flooding and high flow volumes in the case of failure due to *precipitation from major storm events and high snowmelt from severe winter storms*.

9. *Drought* can have an impact on the natural ecosystem and influence availability of the local water supply. With reduced rainfall, native vegetation can be stressed leading to increases in invasive species, and occurrence of brush and forest fire. Additionally, drought can impact the availability of local water supply.

10. *Riverine erosion*, caused by extreme precipitation events, flooding, and ice rafting, can pose a risk to adjacent buildings, infrastructure, and public spaces in Amesbury, such as the Lower Mill Yard.

11. *Extreme fluctuations in temperature* can further exacerbate other natural hazard challenges identified above, including high wind, flooding, invasive species, erosion, and storm events.

Continue to page 205 of the plan to review Amesbury's next section: City of Amesbury Existing Resource Matrix

6.1.2 Town of Boxford Natural Hazard Challenge Statements

Through their challenge statements, the Town of Boxford identified the following natural hazards as causing problems and increasing risk/vulnerability for their community: Severe winter storms, hurricanes/tropical storms, inland flooding, heavy precipitation, drought, invasive species, changes in temperature, and wildfires.

1. *Major storms (severe winter storms/hurricane/tropical storms)* coupled with antiquated and failing infrastructure cause accessibility challenges for emergency use, as well as power outages, posing a health and safety risk for our most vulnerable populations including those living in secluded locations, the elderly, or those without access to emergency communications.

2. *Inland flooding* causes accessibility issues, road closures, infrastructure damage, and septic system failure, leading to public health concerns.

3. *Heavy precipitation and flooding* may pose a risk for man-made dams, many of which need repair and capacity improvement to address the threat to nearby and downstream homes and structures. The Great Marsh Barriers Assessment (which assessed dams in the Parker, Ipswich, and Essex Watersheds) also noted removal may address current obstacles for some aquatic species. Many dams within Boxford, however, are privately owned, requiring communication and cooperation between the Town, neighbors, and dam owners.

4. Periods of *drought* coupled with impacts from *invasive species* stress and kill trees, which in turn cause downed trees and limbs leading to outages and hazardous conditions across the Town. This challenge is further exacerbated by climate change, causing more intense and frequent storm events (rainfall, hurricanes, and wind events).

5. *Drought* can impact other critical systems including private wells, in which a home's water supply is vulnerable to power disruption and the potential for a dry well during drought conditions.

6. *Warming and wetter conditions* have been linked to increases in the population of mosquitos and ticks. The Town has already experienced a significant increase in ticks and associated diseases. As the climate shifts, the same pests may carry new types of disease. For example, mosquitos may carry Zika or West Nile Virus. There is also concern regarding new pests and the diseases associated with them.

7. *Wildfires* can cause structural losses, air pollution, and erosion from tree/brush loss.

Continue to page 209 of the plan to review Boxford's next section: Town of Boxford Existing Resource Matrix

6.1.3 Town of Groveland Natural Hazard Challenge Statements

Through their challenge statements, the Town of Groveland identified the following natural hazards as causing problems and increasing risk/vulnerability for their community: Severe winter storms, hurricanes/tropical storms, inland flooding, heavy precipitation, drought, invasive species, changes in temperature, and wildfires.

1. *Inland flooding* is undermining roads and overwhelming drainage, causing dwellings to flood, septic systems to fail, well and wetland contamination, and road closure. This strains emergency response and Highway Department resources and puts residents at risk (at least 50%).

2. *Heavy precipitation and flooding* may pose a risk for stormwater management systems leading to the degradation of infrastructure and key transportation routes. This is especially true for outdated and/or undersized infrastructure. Specific areas of concern include: the intersection of Main Street and Washington Street, Center Street, and stormwater outfalls along the Merrimack, as well as significant/high hazard dams.

3. *Extreme precipitation, or lack of*, can impact Groveland's water supply. The Town's water supply is provided by public town wells, including wells located adjacent to the Merrimack River. This proximity to the river poses flooding risks that could compromise pumping station components. Additionally, high iron and manganese levels in one of the Town's wells require mixing with an unimpacted well before distribution. Potential climate-induced drought or increases in future pumping could further elevate iron and manganese levels and limit the Town's ability to reliably deliver clean water to customers.

4. *Droughts* cause increased brush fires, failure of private/public wells, kill native vegetation, and allows for an increase in invasive species (48% of Town is forested). Addressing these hazards are time and resource-intensive, causing a strain on the Town and putting residents at risk due to multiple impacts.

5. *Severe winter storms* strain emergency response. Because residents have no official location to shelter within Town, this poses a dangerous risk.

6. *Invasive insect species* cause deterioration of tree health and pose a risk for utility lines, road closures, and damage to private residences.

7. *Invasive plant species* can outcompete native species, leading to possible erosion and increased brush fires (due to standing dead vegetation). These in turn can pose a risk for landslides in Groveland.

8. *Severe winter storms/ hurricanes/tropical storms/high winds/thunderstorms* can cause downed utilities, road closures, and damage. This puts a strain on emergency responders and causes greater risk for residents and built infrastructure.

9. *Winter storm events* pose a risk due to snow storage and pollutant run-off. Snow storage areas and de-icers can cause polluted runoff to enter receiving waters, contributing to impaired water quality and decreased flood conveyance capacity due to sediment build-up. A town-wide examination of designated snow storage areas could benefit protection of water quality, compliance with Massachusetts Wetlands Protection Act regulations, and long-term climate resilience. Appropriate snow storage practices will serve to prevent localized flooding as freeze/thaw cycles shift due to climate change. Additionally, fluctuating temperatures between precipitation events may cause an increase in runoff contaminated with de-icers and sediment, affecting water quality.

10. *Aging building infrastructure* that is subject to the elements can cause a decline in resources and financial hardship to the Town. An example is that the PD generator is old/failing, and if it fails due to bad weather conditions, emergency responses would be delayed, and replacing it would be very costly.

Continue to page 212 of the plan to review Groveland's next section: Town of Groveland Existing Resource Matrix

6.1.4 City of Haverhill Natural Hazard Challenge Statements

Through their challenge statements, the City of Haverhill identified the following natural hazards as causing problems and increasing risk/vulnerability for their community: Extreme precipitation, flooding, high winds and thunderstorms, extreme temperatures, hurricanes/tropical storms, winter storms.

1. *Heavy and frequent precipitation* can lead to high volumes of water entering combined sewer and stormwater systems which can cause CSOs. The release of bacteria into waterways leads to contamination of systems used for public water supply as well as recreation, which pose a public health and safety concern to residents.

2. More *intense storms* delivering higher volumes of precipitation in a single event have caused, and are expected to continue causing, significant pressure on the City's infrastructure, including sewers, dams—especially the high hazard Millvale Reservoir Dam, culverts, and drainage infrastructure that were designed to handle smaller and more consistent distributions of precipitation and flow. This is leading to impacts on City infrastructure, as well as private property.

3. *High winds and thunderstorms* pose risks to community lifelines including electrical infrastructure (powerlines, transformers, transmission lines). Loss of power could cause health and safety risks to residents, especially in locations where generators are not available. For example, the Citizen Center does not have a generator, and elderly housing facilities are not all equipped with generators.

4. *Extended extreme temperatures* can cause or further exacerbate drought, impacting water supply and increasing risk for brushfires.

5. Major storm events have been a recurring threat to Haverhill throughout its history, from *hurricanes/tropical storms* bringing wind*, intense precipitation, and localized flooding,* to *winter storms* delivering ice and snow. These events have caused *extensive flooding* when successive bouts of heavy precipitation led to flooding of water bodies and rivers. During the Mother's Day flood of 2006, the Merrimack River rose to within two feet of the top of the floodwall protecting downtown.

6. The Merrimack River is also experiencing a rapid increase in *erosion* along its banks, which is believed to be due to *increased heavy precipitation*. Sewer interceptors that run along the riverbank could be at risk.

7. *Extreme temperatures* are negatively impacting the City's infrastructure, which is prone to bursts and leaks during freezing temperatures and flooding events. Extreme temperatures have also had social impacts on the City, leading to greater usage of cooling and warming shelters, which are especially critical for the high percentage of vulnerable populations in the City. The Haverhill Public Library and the Citizen Center have both served as cooling shelters in recent years. In 2019 the Council on Aging opened as a cooling shelter for seven days. The City has had to open neighborhood fire hydrants to create opportunities for kids to cold won, since the City lacks adequate opportunities for swimming and cooling off.

8. *Extreme weather and storm events* pose a risk to residents in the City who may need to seek emergency shelters or services. Capacity to house people during emergencies is limited within the City.

Continue to page 215 of the plan to review Haverhill's next section: City of Haverhill Existing Resource Matrix

6.1.5 City of Lawrence Natural Hazard Challenge Statements

Through their challenge statements, the City of Lawrence identified the following natural hazards as causing problems and increasing risk/vulnerability for their community: Intense precipitation, flooding, winter storms, erosion, extreme temperatures, invasive species, and all natural hazards at large.

1. *Intense precipitation events* can cause widespread and frequent flooding due to Lawrence's location between the Merrimack, Spicket, and Shawsheen Rivers. Flooding can cause street closures, evacuations, property damage, as well as limit emergency response. Repetitive flooding is common especially in developed parts of the community in which impervious surfaces exacerbate runoff and pooling.

2. *Extreme flooding* poses a risk to critical infrastructure located in or near the floodplain, including nursing homes, Water Treatment Plant at Water Street, the Riverwalk along the Merrimack, and the DPW Yard. The City's DPW yard at Auburn Street is a critical facility for public works operations and emergency management. It is the base for City maintenance equipment and includes fuel pumps for City vehicles. The 3- acre yard is within the floodplain of the Spicket River and during major flood events, including the 2006 Mother Day Flood, flood waters have prevented access to the site and hampered City response.

3. *Intense precipitation* events pose a risk to the City's aging and undersized and antiquated infrastructure which was built in the 19th century. Specifically, high volumes can cause infrastructure failure as well as pollution of waterways due to Combined Sewer Overflow (CSO) events.

4. The Stevens Pond Dam (identified as a High Hazard Dam) and other water management infrastructure pose a risk to populated/developed locations that may experience significant and damaging flooding and high flow volumes in the case of failure due to *precipitation from major storm events* and high snowmelt from severe winter storms.

5. *Winter storms* bringing winds, heavy snow and sleet can impact utilities lines causing extended power outages and complications for emergency management and communicating with the public. Street clearing following major snow events can be challenging especially in areas of dense development, complicating emergency vehicle access and services to residents.

6. *Erosion* can pose challenges in locations such as Prospect Hill and Tower Hill, where slopes are steeper.

7. *Rising temperatures* along with impacts from *invasive species*, such as the ash boring beetle, can be detrimental to forest health, increasing risks for downed powerlines and brush fires. Den Rock Park is one location that has been identified as high risk for brush fires, due to its proximity to existing residential property.

Continue to page 218 of the plan to review Lawrence's next section: City of Lawrence Existing Resource Matrix

6.1.6 City of Methuen Natural Hazard Challenge Statements

Through their challenge statements, the City of Methuen identified the following natural hazards as causing problems and increasing risk/vulnerability for their community: Extreme storms, high wind, extreme precipitation, flooding, extreme temperatures, drought, and all natural hazards at large.

1. *Extreme Storms/High Winds* pose a risk to Methuen's electricity infrastructure including substations and overhead wires, particularly in older neighborhoods. These types of storm events make Methuen susceptible to more frequent outages, impacting residents during extreme conditions (cold and heat) as well as posing a risk to more vulnerable groups.

2. Capacity of storm drain infrastructure, particularly in older neighborhoods of central Methuen where mains were built more than 100 years ago, is inadequate to handle runoff from *extreme precipitation events*. Methuen has a combined sewer/drain network in the central Arlington District neighborhood connected to the regional drain network with outfalls in Lawrence. The combined system is inadequate in handling flow capacity from the more frequent extreme precipitation events and contributes to CSO events occurring in the Spicket and Merrimack rivers. In other areas of Methuen undersized pipes and other constraints create localized flooding. These areas include Swan St/Jackson area, Broadway and Hampshire Road/Cross Street along the Spicket, Armory Street and Merrimack Street along the Merrimack, and North Street along Hawkes Brook resulting in *flooding events*.

3. *Extreme high temperatures* and lack of open space and shading in densely developed neighborhoods contributes to heat island effects with impacts to health/safety/welfare of residents, particularly in low-income areas with older housing stock lacking efficient air conditioning. On the other end of the spectrum, unexpected *cold snaps* have proven to be harmful to local agriculture such as the peach crop which was devastated in both 2016 and 2023 following periods of mild winter weather.

4. *Drought* can have wide-reaching impacts on Methuen, a water-rich community, by stressing natural riparian and wetland habitat, as well as impacting agricultural systems within the City.

5. Increasing frequency and intensity of *natural hazard events* compel improved communication and coordination regarding emergency management, early warning systems, media, shelter infrastructure and operations, and mitigation activities.

6. *All natural hazards* pose risk to the larger community and prove especially impactful to vulnerable populations such as low-income, environmental justice, and elderly residents. Loss of access to key utilities (heat, electricity, water) during storm events, and impacts from extreme heat for residents without access to climate control can pose a public health and safety concern. Additionally, for residents who need to seek shelter outside of their residence, the Methuen shelter system is outdated and ill equipped. Methuen does not have staff capacity or resources to run an overnight shelter, and currently relies on the Red Cross if available.

Continue to page 222 of the plan to review Methuen's next section: City of Methuen Existing Resource Matrix

6.1.7 Town of Newbury Natural Hazard Challenge Statements

Through their challenge statements, the Town of Newbury identified the following natural hazards as causing problems and increasing risk/vulnerability for their community: Extreme precipitation, coastal and inland flooding, coastal and riverine erosion, drought, extreme temperatures, severe winter storms, and hurricanes/tropical storms.

1. The Olga Way Sewage Pump Station on Plum Island is located in the 100-year floodplain and is located near several repetitive loss sites. It plays a critical role in serving 741 customers in Newbury (as well as additional Newburyport residents) and is tied in to the Newburyport Wastewater Treatment Plant which is also located in the floodplain along the Merrimack in downtown Newburyport. *Extreme precipitation and flooding events* pose a risk to this critical infrastructure.

2. Plum Island Turnpike and several other roads at the entrance to the island, which is the only access to Plum Island and the evacuation route, currently *flood* at astronomical high tides and during other high tides (impacted by *Sea Level Rise*) and/or *major storm events*, blocking access on or off the island for residents and emergency responders.

3. Many neighborhoods in the Town's coastal areas are low-lying and regularly see severe impacts from *coastal flooding* today. Both residential areas, (including but not limited to Pine Island Road, Plumbush Downs, and homes on Plum Island, especially those near the Basin on the backside of Plum Island) and businesses, such as those on Plum Island Boulevard, have seen repetitive losses and significant issues related to extreme flooding.

4. The barrier beaches and dunes along the ocean-facing side of Plum Island have experienced *severe erosion* and accretion over the past decades, putting homes and infrastructure at risk. Since 2007, at least seven homes have been lost to erosion during storm events. There have been numerous efforts by Plum Island residents, the Town, and Newburyport to the north, to replenish the dunes, protect private property, and consider a range of mechanisms to mitigate the risk to public infrastructure and private property.

5. The banks of the Parker River and tributaries are experiencing *erosion* caused by storm events which bring both coastal storm surge as well as *heavy precipitation* and stormwater. This erosion affects the health of the salt marsh and its associated habitats, impacting the resources' ability to provide critical ecological services.

6. The Town has experienced multiple *severe droughts* in recent years (2016, 2018, 2022) that have challenged the public water supply (both Byfield Water District as well as the supply from Newburyport water system) as well as the hundreds of private wells in town (approximately 569 private wells in 2024). Drought also impacts agriculture and the health of all of the Town's natural resources, and increases the risk of wildfires.

7. Issues related to *extremely high temperatures*, particularly for extended periods of time, include human health and safety impacts, impacts on crop cultivation and health, and stress on the electric grid which can cause power outages. (High or low humidity also causes problems.)

8. Issues related to *extremely low temperatures* can include human health and safety, freezing of sewer system infrastructure which can cause backups, and power outages due to extreme weather resulting in safety issues.

9. Newbury has experienced *severe winter storms*, which can include high winds, snow and ice, and other extreme conditions, cause a multitude of issues, including exacerbation of coastal erosion, coastal and inland flooding, ice- and snow-covered roads that cut off access for safety and other transportation access for many critical roads, including Plum Island Turnpike, Newman Road, Route 1, and others. Extreme storm events can also cause widespread power outages across Newbury and the region. Much of Newbury's electrical wires are above ground, and many suffer damage from trees and limbs during storm events.

10. *Hurricanes and tropical storms* bring many of the same impacts as winter storms, most significantly high wind and coastal flooding and storm surge. Plum Island beaches as well as the low-lying roads, such as Plum Island Turnpike, and low-lying neighborhoods such as along the river near Cottage Road, are highly vulnerable.

11. Several areas of Newbury experience destructive *inland flooding caused by precipitation events*, often combined with local drainage problems. Impacts from flooding are exacerbated by undersized culverts and poor stormwater management systems in several parts of town. The most vulnerable inland (non-tidally influenced) areas are located in Byfield west of the Central Street dam, including Larkin Road, River Street, and Moody Street near Ash Street intersection, where freshwater flooding is common.

Continue to page 226 of the plan to review Newbury's next section: Town of Newbury Existing Resource Matrix

6.1. 8 Town of Rowley Natural Hazard Challenge Statements

Through their challenge statements, the Town of Rowley identified the following natural hazards as causing problems and increasing risk/vulnerability for their community: Storm events, high winds, extreme temperatures, major precipitation events, flooding, drought, invasive species, and all natural hazards at large.

1. *Storm events* including *high wind*, as well as *extreme temperature* cause risks for electrical infrastructure. The Rowley Municipal Light Plant (RMLP) is the electricity distributor for Rowley and maintains a network that includes a substation, limited underground conduit and extensive overhead wires considered vulnerable to intense storms and associated winds as well as extreme heat. The RMLP expressed concern for poles located in areas subject to coastal inundation but has the equipment to access them in emergency situations. Most of the existing above ground lines utilize a spacer-cable system which improves resistance to high winds and fallen trees. The Rowley Municipal Light Company will continue to maintain tree maintenance along power lines.

2. *Heavy precipitation events can cause flooding* which can pose risks to roadways. In locations where culverts are incorrectly sized or operate improperly, roads are prone to over-topping and possible washouts. Bridges and undersized culverts can act as choke points restricting stream flow. Low-lying, flood-prone areas considered particularly vulnerable to flooding are Route 133 at Bachelder Brook (undersized culvert), Mill River Crossing on Haverhill Street near Boxford Road(undersized culver t), stackyard Road and Route 1A North into Newbury (coastal flooding) the Glen Street bridge, Central Street at Church Street (Ox Pasture Brook), Route 1A near the Seaview Nursing Home, and culverts on Route 1 and Route 133 near Off the Vine and a new physicians building. All of these areas were prev iously identified as vulnerable in the 2017 Great Marsh Coastal Adaptation Plan.

3. *Flooding* also poses a risk to community lifelines located within floodplains. Stakeholders indicated Rowley Town Well #3 is located in the 100-year floodplain. According to the Great Marsh Coastal Adaptation Plan, water from the well is pumped through a 10-inch transmission water main to the Town's filtration plant where it is treated and released into the Town's distribution lines. Flooding has the potential to make the well's pumping equipment vulnerable and possibly interrupt the drinking water supply. The pump station building, and access are additional vulnerabilities. Additionally, the Lower Mill Pond Dam, a privately-owned dam, is also considered a vulnerability to extreme precipitation and flooding. If the dam were to fail, it would also pose a risk to the downstream Glen Road Bridge, listed as structurally deficient.

4. *Drought* can impact local water supply. As the Town continues to grow, water supply is a concern for community members. Rowley is looking for a new well to accommodate growth and ensure supply into the future. And is currently exploring drilling an additional well in the area of Well #2 to help mitigate future issues.

5. As a heavily forested community (40% if land), changes in climate also pose threats to Rowley's trees, including *invasive pests* such as Gypsy moths, Winter months, and the Emerald Ash Borer. Forests provide many services including carbon storage, stormwater uptake and cooling. Threats from invasive species (both insect and plant) coupled with damage from *severe storm events* can dramatically affect forest ecosystem health.

6. *Storms and extreme heat* events are a challenge for the Town's shelter system. The Senior Center, while considered a town strength, lacks a backup generator and currently relies on window air conditioners. A lack of overnight/long-term sheltering was identified as a vulnerability. A sheltering plan was identified as a need to address this challenge.

7. *All natural hazard* events pose a risk to vulnerable populations within Rowley. The Town has a number of residents considered vulnerable to hazard events and climate change including an increasing senior population as well as community members with disabilities. The Plantation Drive Community was also identified as a vulnerable population. A mitigation factor to consider is to provide an adequate communication system for vulnerable areas and citizens.

Continue to page 230 of the plan to review Rowley's next section: Town of Rowley Existing Resource Matrix

6.1.9 Town of Salisbury Natural Hazard Challenge Statements

Through their challenge statements, the Town of Salisbury identified the following natural hazards as causing problems and increasing risk/vulnerability for their community: Coastal erosion, coastal and inland flooding,

severe storms, drought, invasive species, and rip tides.

1. *Coastal erosion* is causing instability and shifting sediment, endangering public infrastructure and private resources, as well as loss of public utilities. This puts health and public safety at risk. This is particularly concerning for properties on Salisbury Beach which are impacted during frequent winter coastal storms.

2. *Storm surge* pushes saltwater inland, causing challenges such as salt marsh migration, habitat loss, as well as *inland flooding*, infrastructure damage, and well contamination. This can impact environmental and human health.

3. *Coastal and riverine flooding, severe storms, and storm surge* cause extreme flooding of access and egress roads. This restricts access to properties and causes major problems for police and fire response personnel, limiting emergency services and putting the public in danger. This is especially evident on Beach Road/ Route 1. In 2018, the National Guard had to bring in highwater vehicles to assist with evacuations.

4. *Extreme drought* has also impacted Salisbury, leading to town-wide water restrictions. Droughts pose a risk to human health as it limits available potable water, and it also can exacerbate bush/wildfire conditions in the region.

5. *Invasive species* exacerbate current natural hazards, such as phragmites which grow in abundance along main roads and can provide ample fuel for local *brush fires* especially during periods of extreme heat and drought.

6. Increased occurrence of *rip tides* causes unforeseen dangers to the public which can cause injury and event death, as was the case in 2023. Without increased education, signage, and staff training, the public remains at risk from these events.

Continue to page 232 of the plan to review Salisbury's next section: Town of Salisbury Existing Resource Matrix

6.1.10 Town of West Newbury Natural Hazard Challenge Statements

Through their challenge statements, the Town of West Newbury identified the following natural hazards as causing problems and increasing risk/vulnerability for their community: Coastal and inland flooding, riverine erosion, extreme storm events, extreme temperatures, changes in precipitation, drought, sea level rise, and invasive species.

1. *Flooding and erosion* of roadways due to heavy rains coupled with undersized and outdated infrastructure such as culverts pose vulnerabilities across the Town. Multiple neighborhoods are made vulnerable by repeated road flooding and erosion of roadway edges, including along River Road, at the Route 113 Bridge, Crane Neck Street, and River Meadow Drive. These issues highlight the need to improve the overall stormwater planning and maintenance for West Newbury.

2. Most of West Newbury's electrical wires are above ground, and many suffer damage from trees and limbs during *storm events* which leads to frequent power outages. The repeated power outages experienced in West Newbury bring to light the need for reliable backup power for the Town and for additional shelters for warming and cooling during an outage that have access to backup power.

3. *Extreme weather and storm events* described above further raise concerns about preparations and impacts to emergency response personnel and access to vulnerable populations. The communication infrastructure in West Newbury requires improvements. Town departments – including public safety, the

Health Department, and the Council on Aging – maintain a list of vulnerable populations to ensure communications and outreach/support in times of emergency, which needs to be maintained on an ongoing basis. In addition, the Code Red service used to communicate to residents in an emergency needs to be evaluated for efficacy. Coupled with this is the need to educate the public on ways they can prepare for climate change impacts.

4. While housing development within the Town has been modest, each proposal sparks a concern for the protection of existing open space and better planning for where future developments will be sited, and how development occurs in terms of impacts on drainage, trees, water supplies, and other factors. As part of this, there is recognition that West Newbury needs improved land controls to manage forests and wetlands which provide key services to address *climate change and extreme weather/storm impacts*.

5. A *changing climate and increased temperatures* have led to increased rates of diseases caused by insects in West Newbury in recent years. In addition, recent increases in mosquitos transmitting EEE and West Nile have led to event closures and disruptions to evening activities, such as in the Fall of 2019. There is a need for public education on insect-borne disease prevention and detection.

6. During *heavy rainfall* events, the Merrimack River is increasingly contaminated by stormwater runoff as well as discharges of untreated sewage from overflows at upstream wastewater treatment facilities, referred to as combined sewer overflows (CSOs). The contaminated water can impact the public drinking water supply the Town purchases from Newburyport if the river overtops the Lower Artichoke Reservoir Dam. The contaminated river water can also hinder the recreational opportunities for residents and impact the health of those who come into contact with the water. CSOs and changing land development have demonstrated the need for a water supply protection plan, including modifications of the Lower Artichoke Reservoir Dam.

7. West Newbury-owned water supply wells are susceptible to *drought* and are insufficient to supply the Town's current needs. This threat also highlights the Town's need to identify and secure additional sources of public water supply and manage existing resources through practices such as conservation measures and responsible development, particularly in light of increasing risk of drought due to climate change.

8. *Increased sea level paired with more frequent coastal storms and increased precipitation* leads to additional flooding and erosion from the Merrimack River along River Road threatening infrastructure, lives, and property and exacerbating erosion.

9. *Invasive species* including invasive insects such as the emerald ash borer which have killed many ash trees townwide and tent caterpillars which have killed many of the Town's oak trees in certain areas have increased the mass of available fuel for wildfires. Invasive shrubs including, but not limited to, honeysuckle, winged euonymus, and buckthorn act as fire ladders in forested areas allowing wildfires to spread from the landscape into trees. This coupled with *more continuous dry days* leads to a higher likelihood of larger and more frequent wildfires which threaten lives and property. This problem is further exacerbated by limited funding for fire response resources and limited funding and staff time to eradicate invasive plants or manage fuel sources on town owned lands.

Continue to page 236 of the plan to review West Newbury's next section: Town of West Newbury Existing Resource Matrix

SECTION 7. EXISTING RESOURCES

This section of the Plan presents an Existing Resource Matrix for each of the ten participating communities. Each matrix is an inventory of current measures already in place that are related to natural hazard mitigation. Compiling such an inventory allows current strengths to be inventoried, and gaps and deficiencies to be identified.

7.1 Updating Existing Resource Matrices

As part of the plan updating process, the 2016 information was reviewed and revised through a series of email communications and conversations with Local Hazard Mitigation Planning Teams and other municipal staff. To ensure a comprehensive update was conducted, local zoning bylaws, subdivision rules and regulations, community plans (Open Space and Recreation, Municipal Vulnerability, Watershed Based Plans) and municipal websites were reviewed and consulted. The updated existing resource inventory reflects current conditions and incorporates new measures that have been put in place since the 2016 Plan update, as shown in the following matrices.

Each matrix is broken down into three sections:

- *Policy, plans and Regulations:* Including municipal codes, and local and regional plans
- *Programs and Activities:* Including groups, committees, initiatives, and programs
- *Maintenance Programs:* Including services, general or preventative maintenance, inspections and upkeep.

Following each Existing Resource Matrix is information on how the existing measures could be improved or expanded to further reduce risk and vulnerability for the community.

Examples of Local Hazard Mitigation Measures

Policies, Plans & Regulations

Wetland Protection Regulations

Programs and Activities

Emergency Communication Systems

Maintenance Programs

Stormwater Infrastructure Maintenance

7.2 Existing Resource Matrices by Community

7.2.1 City of Amesbury Existing Resource Matrix

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Amesbury Policies, Plans, and Regulations- Building codes, land use, development ordinances, community plans/policies						
National Flood Insurance Program (NFIP)	Regulates development activity and provides flood insurance for structures in flood-prone areas	FEMA flood zones	Effective	Last updated 2012	New FIRM maps must be adopted in 2025	Flooding
Local Wetland Protection Bylaw and Regulations	Regulates building on: Wetland Resource Areas; 100-ft buffer zones; 200-ft riverfront protection areas	City-wide	Effective	Established 2009, updated 2012	Climate resiliency and flood management criteria should be expanded and outlined in project review at the local level.	Flooding
Stormwater Management Regulations	Addresses regulations around Site Plan Review and Inspection, and Enforcement.	City-wide	Somewhat effective	2020	Update required by EPA to maintain compliance with MS4 permit. This update will lead to the development of a new Stormwater Bylaw for the City.	Flooding
Subdivision Rules & Regulations	Determines manner in which land parcels may be divided, and outlines specific stormwater/ flooding mitigation and erosion mitigation requirements	City-wide	Effective	Adopted 1954, amended in 2020	None	Flooding
Zoning Bylaw	Establishes regulations around land use within the City. Includes Wetlands and Floodplain Protection District and Water Resources Protection District.	City-wide	Effective	Adopted 1971, amended 2023	Floodplain Protection District regulations are being updated to be consistent with state and federal regulations.	All Hazards
Smart Growth Overlay District (SGOD)	Promotes smart growth that advances compact design, preservation of open space, and a variety of transportation options	Multi-locations	Effective	AGV-SGOD est. 2007/ EE-SGOD est. 2023	None	Multi-hazard
Master Plan	Provides guidance for community growth and preservation of open space and natural resources	City-wide	Somewhat effective	2004	The City is currently conducting a plan update	All Hazards

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Continued **Amesbury Policies, Plans, and Regulations-** Building codes, land use, development ordinances, community plans/policies						
Community Development Plan	Provides guidance for community growth and preservation of open space and natural resources	City-wide	Somewhat effective	2004	None	All Hazards
Open Space & Recreation Plan	Provides guidance for community growth and preservation of open space and natural resources	City-wide	Effective	2020	None	All Hazards (focus on flood/drought)
Comprehensive Emergency Management Plan (E-CEMP)	Details procedures to be followed in the event of an emergency of any type	City-wide	Somewhat effective	2010	The CEMP is in need of an update to ensure information and plans stay relevant.	All Hazard
Municipal Vulnerability Plan	Community-based plan to assess vulnerability to climate change and extreme weather events and to identify adaptation options for infrastructure and other assets	City-wide	Effective	2019	MVP 2.0 will be completed by the City in the next 1-2 years	Multi-Hazard
Lake Attitash Watershed-Based Plan	Identified causes of impairments and pollution sources, and lays out a plan for water quality improvement	Lake Attitash	Effective	2017	None	Multi-Hazard
Amesbury Water Body Assessment	Summarizes Amesbury's major water bodies, current conditions, and recommends improvements and protections	City-wide	Effective	2022	None	Multi-Hazard
Green Community Designation	Amesbury has been designated as a Green Community, making them eligible for annual grant opportunities.	City-wide	Effective	2020	The City continues to work towards 20% municipal energy reduction	Multi-Hazard
Lake Gardener Watershed-Based Plan	Identified causes of impairments and pollution sources, and lays out a plan for water quality improvement	Lake Gardner	Effective	2010	None	Multi-Hazard
Ways to improve and/or expand current policies, plans, and regulations: Amesbury is currently conducting a number of updates/improvements to policies and plans that will better position them to manage and reduce future risk. These updates include adoption of new FIRM maps, development of a Stormwater Bylaw, and Master Plan update. Additional updates have been identified including the Comprehensive Emergency Management Plan (CEMP) and Municipal Vulnerability Plan.						

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Amesbury Programs and Activities -Groups, committees, initiatives, programs, etc.						
Smart911 phone notification capability	Free service that allows individuals to receive notifications sent from Amesbury authorities	City-wide	Very effective	2023	None	Multi-Hazard
Chapter 61, Agricultural Preservation Restrictions & Purchase of Development Rights	Protection of agricultural and open space properties	City-wide	Somewhat effective	Various	None	Multi-Hazard (focus on floods/drought)
Amesbury MIMAP	Amesbury maintains critical data on City infrastructure, operations, and maintenance using MVPC MIMAP database	City-wide	Very effective	Updated in 2024	None	Multi-Hazard
Seabrook Emergency Warning and Safety Information	Emergency Alert system for region, including Amesbury Residents, for Seabrook Station Nuclear Power Plant.	City-wide	Effective	2021	Once CEMP is updated, plan will be shared with Seabrook Station Nuclear Power Plant.	Multi-Hazard
Amesbury Open Space, Natural Resources, and Trails Committee	Volunteer groups that acts as an advisory committee to the Mayor, City Council, Municipal Boards and the public.	City-wide	Effective	2016	None	Multi-Hazard
Ways to improve and/or expand current programs and activities: Amesbury is currently updating their CEMP. Once it is updated, it needs to be shared with the Seabrook Station Nuclear Power Plant to be integrated into their emergency plans.						

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Amesbury Maintenance- Regular maintenance/programs						
Invasive Species Management	Manage invasive freshwater species in City Ponds and waterways	City-wide	Somewhat effective	ongoing	Currently, invasive species management is driven by community groups (e.g. Lake Attitash Association) who work with the City to conduct work. This can be sporadic, and reactionary. Developing a City-led effort, especially for drinking water sources, is important for future management.	Flooding
Municipal maintenance	Maintenance of storm drain systems, street sweeping, catch basin cleaning, roadway treatment, tree trimming, snow disposal	City-Wide	Effective	ongoing	Most of this work is contracted out. Increased funding allowing for the purchase of equipment and the hiring of staff would allow this to be done internally and increase frequency of maintenance.	Multi-Hazard
Ways to improve and/or expand current maintenance programs: Amesbury needs increased funding for maintenance programs which would allow the City to purchase more equipment directly (e.g. street sweeping and catch basin cleaning) as well as hire more staff, resulting in more reliable and continuous services.						

Continue to page 246 of the Plan to review Amesbury's next section: City of Amesbury Mitigation Action Plan

7.2.2 Town of Boxford Existing Resource Matrix

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Boxford Policies, Plans, and Regulations- Building codes, land use, development ordinances, community plans/policies						
National Flood Insurance Program (NFIP)	Regulates development activity and provides flood insurance for structures located in flood-prone areas	FEMA flood zones	Effective	2012	Must adopt new FIRM maps and flood insurance study by June/July 2025	Flooding
Local Wetlands Protection Bylaw and Regulations	Regulates building on: Wetland Resource Areas; 100-ft buffer zones; 200-ft riverfront protection areas	Town-wide	Effective	1994/2023	None identified at this time	Flooding
Stormwater Management Bylaw and Regulations	Regulates development activity encompassing one acre or more within Urban Areas, consistent with National Pollutant Discharge Elimination System permit program	Urbanized Areas of Boxford as identified by U.S. Census	Effective	2007/ 2021	None identified at this time	Flooding
Subdivision Rules & Regulations (stormwater)	Determines manner in which land parcels may be divided, and the specific stormwater/flooding mitigation that is required	Town-wide	Effective	1996/2020	None identified at this time	Flooding
Town Zoning Bylaw	Sets regulations around land use within the Town. Cited sections detail the requirements relating to lot size, setbacks, contiguous buildable areas, site plan review, and lot/slope requirements. Includes mapped Conservation Overlay District for wetlands and flood prone areas	Town-wide	Effective	1946/2020	None identified at this time	All Hazards
Master Plan	Provides guidance for community growth and preservation of open space and natural resources	Town-wide	Effective	Updated 2008	Update necessary and is included in capital budgeting plan	All Hazards

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
***Continued* Boxford Policies, Plans, and Regulations-** Building codes, land use, development ordinances, community plans/policies						
Open Space & Recreation Plan	Provides guidance for community growth and preservation of open space and natural resources	Town-wide	Effective	Updated 2016	Update underway, completion expected in 2024	All Hazards (focus on flood/ drought)
Comprehensive Emergency Management Plan (E-CEMP)	Details procedures to be followed in the event of an emergency of any type	Town-wide	Effective	2019	Review planned for 2024 and updates will be addressed as necessary.	All Hazard
Municipal Vulnerability Plan	Community-based plan to assess vulnerability to climate change and extreme weather events and to identify adaptation options for infrastructure and assets	Town-wide	Effective	2019	MVP 2.0 program expected for 2019 communities in next few years	Multi-Hazard
Ways to improve and/or expand current policies, plans, and regulations: Boxford is currently conducting updates to its Open Space and Recreation Plan. Additionally, the Town has identified their Master Plan and Comprehensive Emergency Management Plan are in need of updates which are forthcoming. Updating all of these plans will allow for comprehensive evaluation and identification of goals to further address vulnerability.						
Boxford Programs and Activities -Groups, committees, initiatives, programs, etc.						
Reverse 911 phone notification capability	Town has ability to contact residents en mass or individually	Town-wide	Effective	2006/ 2024	Update database with new contact information as necessary	Multi-Hazard
Community Preservation Act	As opportunities arise, CPA funds are used to purchase and protect key open space parcels	Town-wide	Effective	Committee formed 2001	Updates to application procedures currently under contemplation	Multi-Hazard (floods/ drought)
Green Community Designation	Boxford has been designated as a Green Community, making them eligible for annual grant opportunities.	Town-wide	Effective	2018	The Town continues to work towards 20% municipal energy reduction	Multi-Hazard
Public Education & Awareness	Reverse 911 system in place and emergence management info page on Town website & local cable tv provides preparedness information	Town-wide	Somewhat effective	2024	New Town website is being launched in 2024	Multi-Hazard
Ways to improve and/or expand current programs and activities: Boxford is working to establish one centralized method for conducting municipal website updates to improve public education and awareness. Streamlining this approach to establish one point of contact through the Town Administrator's office will ensure that consistent and timely information is provided to residents.						

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Boxford Maintenance- Regular maintenance/programs						
Beaver mitigation measures	Boxford's beaver population has significantly influenced flooding risks. The Town implements several measures, such as "Beaver Deceivers", to mitigate beaver-related flooding	Town-wide	Effective	NA	None identified at this time	Flooding
Municipal maintenance	Maintenance programs including storm drain systems, street sweeping, catch basin cleaning, roadway treatment, tree trimming, snow disposal	Town-wide	Effective	2023	None identified at this time	Multi-Hazard
Ways to improve and/or expand current maintenance programs: Boxford has identified a need to develop a tree maintenance and vegetation plan for the town. Currently tree trimming and maintenance is conducted on an as-needed basis. A comprehensive inventory has not yet been established. A full plan would well position Boxford to seek funding for future planning to address this risk proactively.						

Continue to page 255 of the Plan to review Boxford's next section: Town of Boxford Mitigation Action Plan

7.2.3 Town of Groveland Existing Resource Matrix

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Groveland Policies, Plans, and Regulations- Building codes, land use, development ordinances, community plans/policies						
National Flood Insurance Program (NFIP)	Regulates development activity and provides flood insurance for structures located in flood-prone areas	FEMA Flood Zones	Effective	1974	Adopt new FIRM maps and flood insurance study by June/July 2025	Flooding
Floodplain zoning district bylaw and regulations in place	Floodplain bylaw requires all development, including structural and nonstructural activities, be in compliance with state building code requirements for construction in floodplains	FIRM Flood Zones, as mapped by FEMA	Effective	2022	New bylaw, updating again 2025	Flooding
Stormwater management policy and program	Planning Board and Conservation Commission review projects for consistency with MA DEP stormwater standards. Peak runoff rates for new development must not exceed pre-development rates	Town-wide	Somewhat effective	2020	Could be clearer on avenues/ procedure of enforcement	Flooding
Local wetlands protection bylaw	Local bylaw outlines stricter regulations than State WPA	Town-wide	Very effective	2021	Periodic Board training would aid project reviews and enforcement	Flooding
Local Open Space & Recreation Plan	Proactive plan to preserve and protect Town's open space and natural resources, but does not focus on flood hazard areas specifically	Town-wide	Somewhat effective	2019	None needed. Effective through 2027	All Hazards (focus on flood/ drought)
Comprehensive Emergency Management Plan (CEMP)	Details procedures to be followed in the event of an emergency of any type	Town-wide	Effective	2018	In the process of updating plan	All Hazards
Subdivision Rules & Regulations	Determines manner in which land parcels may be divided, and the specific stormwater/flooding mitigation that is required	Town-wide	Somewhat effective	2020	Revise language to improve development techniques (e.g. LID)	Flooding

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
***Continued* Groveland Policies, Plans, and Regulations-** Building codes, land use, development ordinances, community plans/policies						
Town Zoning Bylaw	Sets regulations around land use within the Town. Select sections detail the requirements relating to lot size, setbacks, contiguous buildable area, site plan review, and lot/slope requirements	Town-wide	Very effective	2023	Currently, none needed. Updates ongoing.	All Hazards
Aquifer Protection Overlay District Bylaw	Regulates construction and use activities in groundwater supply recharge zones to protect drinking water	Aquifer recharge areas	Effective	1997	Consider plan review due to original creation date	Flooding/ Drought/ Hazardous Waste
Conservation Subdivision Design Bylaw	Promotes "cluster" style development for new subdivisions where appropriate, in order to preserve open space (50% of site) and natural hydrology, minimize impervious surface cover, and protect natural resources	Town-wide	Not effective	2002	Revise bylaw to better incentivize adoption by developers and promote smart growth. Additionally, increase education regarding cost-savings of this approach.	All Hazards (focus on flood/ drought)
Master Plan	Provides guidance for community growth and preservation of open space and natural resources	Town-wide	Effective	2023	None needed	All Hazards
Municipal Vulnerability Plan	Community-based plan to assess vulnerability to climate change and extreme weather events and to identify adaptation options for infrastructure and assets	Town-wide	Effective	2020	Need to focus on physical project construction and enhancement	All Hazards
Ways to improve and/or expand current policies, plans, and regulations: Groveland has identified a number of improvements. The Town is actively updating their Floodplain Bylaw and Comprehensive Emergency Management Plan, and identified needed updates to their Subdivision Rules and Regulations, Aquifer Protection Overlay District, and Conservation Subdivision Design Bylaw. They also identified further action around enforcement and implementation would advance their Stormwater Management Policy/Program and Municipal Vulnerability Plan. Lastly, board training was identified as a need for the Conservation Commission and Planning Board. Beyond these improvements/ expansions, Groveland also identified a desire to develop a Summary of Findings for all community plans to ensure all plans are working in tandem towards community resiliency.						

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Groveland Programs and Activities -Groups, committees, initiatives, programs, etc.						
Community Preservation Act	As opportunities arise, CPA funds are used to purchase and protect key open space parcels	Town-wide	Effective	2004	Need to identify ways in which to enhance protections on acquired properties.	Multi-Hazard (focus on floods/ drought)
CodeRed	Emergency Alert System	Town-wide	Effective	2004	Expand to other hazards: flooding, wind, outages, etc.	Multi-Hazard
Ways to improve and/or expand current programs and activities: Groveland identified the potential benefit of considering alternative emergency alert systems that could be more widely used for communication across the Town.						
Groveland Maintenance- Regular maintenance/programs						
Municipal drainage system maintenance and repair program	Town strives to keep municipal drainage facilities (storm drains swales, culverts, stream channels, etc.) open and in good working condition	Town-wide	Somewhat effective	Ongoing	More public works personnel and funds would increase overall effectiveness of program	Flooding
Street sweeping and catch basin cleaning program	Highway Dept. sweeps the Town streets and cleans catch basins on a regular basis	Town-wide	Somewhat effective	Ongoing	More public works resources would increase overall effectiveness of program	Flooding
Hazardous Tree and Limb Removal	Inspection and removal of hazardous trees and limbs in collaboration with power company and upon notification by property owners	Town-wide	Effective	Plan in development for 2024	Highway Department and GMLD working together to develop a plan for preventative maintenance	Multi-Hazard
Ways to improve and/or expand current maintenance programs: Groveland identified that more funding and capacity are needed for the above listed items to be more effective at reducing risk. Additionally, Groveland is in the process of starting a Hazardous Tree and Limb Removal Program. The Highway Department and Groveland Municipal Light Department (GMLD) are working together to develop a plan for preventative maintenance. This will help to reduce power outages and downed limbs/trees across the Town.						

Continue to page 259 of the Plan to review Groveland's next section: Town of Groveland Mitigation Action Plan

7.2.4 City of Haverhill Existing Resource Matrix

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Haverhill Policy, Plans, and Regulations- Building codes, land use, development ordinances, community plans/policies						
National Flood Insurance Program (NFIP)	Regulates development activity and provides flood insurance for structures located in flood-prone areas	FEMA flood zones	Very Effective	1992/2023	Must adopt new FIRM maps and flood insurance study by June/July 2025	Flooding
Floodplain Overlay District	Floodplain overlay district requires all development, including structural and nonstructural activities, be in compliance with state building code requirements for construction in floodplains	Covers FIRM zones A, AO, AH, A1-30, AE, A99, VO, V1-30, VE and V (100-year floodplain)	Very Effective	Amended in 2020	Clarification on defining qualifications for "substantial improvement" are needed for building code enforcement.	Flooding
Stormwater Management Policy and Regulations	Planning Board and ConCom review projects for consistency with MA DEP stormwater standards. Peak runoff rates for new development must not exceed pre-development rates.	City-wide	Effective	Stormwater Management Ordinance passed in 2018.	Reviewed by MVPC in 2022. Feedback to be integrated to update ordinance and maintain compliance with MS4.	Flooding and runoff
Local Wetlands Protection Ordinance	Local ordinance mandates stricter regulations than State WPA	City-wide	Very Effective	1996	Additional staffing would improve enforcement	Flooding
Local Open Space & Recreation Plan in place	Seeks to preserve and protect City's natural resources, but does not focus on flood hazard areas specifically	City-wide	Very Effective	Updated in 2016	5-year plan update in progress.	All Hazards (focus on flood/drought)
Phase II Storm Water Management Plan (SWMP)	City departments work collaboratively to implement array of stormwater BMPs, including drainage facilities inventorying, mapping, and maintenance; runoff and erosion control; illicit discharge detection and elimination; municipal "good housekeeping" practices; and public education/involvement.	City-wide	Generally effective	Completed 2016	Program review needed to determine progress and current status	Flooding and pollutants from stormwater runoff

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
***Continued* Haverhill Policy, Plans, and Regulations-** Building codes, land use, development ordinances, community plans/policies						
Master Plan	Provides guidance for community growth and preservation of open space and natural resources	City-wide	Very Effective	Updated in 2020	None needed	All Hazards
Comprehensive Emergency Management Plan (CEMP)	Details procedures to be followed in the event of an emergency of any type	City-wide	Very Effective	Updated in 2023	Will be updated in 2028 or sooner if needed	All Hazards
Municipal Vulnerability Plan	Community-based plan to assess vulnerability to climate change and extreme weather events and to identify adaptation options for infrastructure and assets	City-wide	Effective	Created in 2020	None needed	Multi-Hazard
Water Supply Protection Overlay District	City prohibits or strictly regulates land uses deemed potentially harmful to drinking water supply quantity and quality	Drinking water supply watersheds	Effective. Chapter 255, Section 9.2	2000 / 2021	Under review for minor proposed updates	Flooding/ Drought/ Pollution
Downtown SMART Growth Overlay District	Encourages smart growth by promoting compact design, preservation of open space, and access to transportation	Downtown (58 acres)	Effective	2015	None needed	Multi-Hazard
Forest Management Plan	Details a 10-year forest management plan and provides information on each property, stewardship issues, stand descriptions, and possible management practices. Currently 8 active plans: Crystal Lake, Dead Hill & Gale Hill Reservoirs, Tattersall Farm, Meadow Brook, and Wheeler Woods	Multiple locations	Effective	2014	None needed	Multi-Hazard

Ways to improve and/or expand current policies, plans, and regulations: The Commonwealth currently has several regulatory revisions out for public review. These effect such environmental concerns as stormwater management and climate resiliency. Following the enactment of these regulations, the City will consider updating its wetlands protection ordinance, subdivision regulations, and possibly other sections of the City Code. With climate change increasing the potential for long periods of drought and resulting fires, the City will need to reassess its forest management program and determine a path forward for the next 10 years.

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Haverhill Programs and Activities -Groups, committees, initiatives, programs, etc.						
Fire safety alert program	City Fire Dept. notifies City residents (via newspapers, local cable t.v.) of elevated wildfire/brush fire risks during extended dry periods	City-wide	Effective	Ongoing	None needed	Wildfires
CSO Abatement Program	City completed Phase 1 in 2006 which reduced CSO volume by 57%, and Phase II in 2017, reducing its new CSO volume by another 30%. The City is currently in Phase III focused on the Locke Street area sewer separation, anticipated to take 9 years.	Various streets between Hale St and Main St	Effective	Latest CSO long-term Control Plan schedule updated in 2023	No proposed changes at this time	Heavy Precipitation/ Flooding/ Pollution
Greening the Gateway Cities Program	Program focused on increasing tree canopy cover in urban residential areas for public health and environmental benefits	City-wide	Somewhat effective (waiting for trees to mature)	2012	City received DCR grant in 2023 and 2024. Additional staff needed for program management	Multi-Hazard
Forest Management Committee	Focused on preservation, protection, and perpetuation of actively managed forests, with particular focus on water quality, wildlife habitat, recreational opportunities, and renewable resources of timber	City-wide	Effective	2009	Funding needed to advance effort	Multi-Hazard
Haverhill Agricultural Commission	Group established to provide support for local agriculture, especially in the face of climate change	City-wide	Not effective	2019	Plans have been discussed to reactivate this group later in 2024	Multi-Hazard
Green Community Designation	Haverhill has been designated as a Green Community, making them eligible for annual grant opportunities.	City-wide	Effective	2017	The City continues to work towards 20% municipal energy reduction	Multi-Hazard

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
***Continued* Haverhill Programs and Activities** -Groups, committees, initiatives, programs, etc.						
Emergency Notification System	Reaches roughly 50% of residents and businesses. Residents can opt-in to this EM system to receive information for both short and long-term hazards	City-wide	Effective	Ongoing	Improvements have come in the form of social media platforms to push emergency notifications as well	Multi-Hazard
Community Rating System (CRS)	Voluntary incentive program that recognizes and encourages community floodplain management practices.	City-wide	Effective	1992	Haverhill currently participates and is designated as a class 9	Flooding
Ways to improve and/or expand current programs and activities: Haverhill has identified a need to reestablish active presence of Forest Management and Agricultural Committees.						
Haverhill Maintenance- Regular maintenance/programs						
Municipal Drainage System Maintenance and Repair Program	City strives to keep municipal drainage facilities (storm drains swales, culverts, stream channels, etc.) open and in good working order	City-wide	Effective	Budgeted in wastewater since 2012	Need to develop and fund City maintenance, repair, and replacement program	Flooding
Street Sweeping and Catch Basin Cleaning Program	The DPW sweeps City streets and cleans catch basins on a regular basis. Program expanded in recent years to comply with MS4 permit	City-wide	Somewhat effective for localized flooding	Ongoing	City is meeting current MS4 permit, but anticipates needing to improve inventory and inspection in future years	Flooding
Tree Limb Removal Program	City crews work closely with National Grid to remove dead and diseased tree limbs that pose a public safety hazard and threaten utility lines	City-wide	Somewhat effective.	Ongoing	City involvement limited to summer months only. More staff needed to expand program	Multi-Hazard
Mosquito Control District	Haverhill is part of the Mosquito Control District to manage mosquitos in the City	City-wide	Very effective	Ongoing	None needed	Multi-Hazard
Ways to improve and/or expand current maintenance programs: Haverhill has identified that more staff capacity and funding is needed to continue maintenance programs in the City.						

Continue to page 263 of the Plan to review Haverhill's next section: City of Haverhill Mitigation Action Plan

7.2.5 City of Lawrence Existing Resource Matrix

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Lawrence Policies, Plans, and Regulations- Building codes, land use, development ordinances, community plans/policies						
National Flood Insurance Program (NFIP)	Regulates development activity and provides flood insurance for structures located in flood-prone areas	FEMA Flood Zones	Effective	1982/2012	Planned update to adopt new FIRM maps in 2025	Flooding
Local Wetlands Ordinance	Established Local Wetlands Ordinance Stricter than State WPA	City-wide	Effective	2005/ 2010	None needed. Board members attend conferences and trainings each year	Flooding
Community Development Plan	Provides guidance for community growth and preservation of open space and natural resources	City-wide	Effective	2019	None needed	All Hazards
Comprehensive Emergency Management Plan	Details Procedures to be followed in an event of an emergency of any type	City-wide	Effective	2019	Will need update in 2024	All Hazards
City of Lawrence Food, Oil and Grease Waste Ordinance	Protect stormwater infrastructure system by preventing dumping of grease oils and other products which pollute and obstruct performance of stormwater system. Overseen by DPW, Board of Health, Inspectional Services	City-wide	Effective	2017	None needed	Flooding
City of Lawrence Sewer & Stormwater Ordinance	Guidelines establish review standard for stormwater management best practice.	City-wide	Effective	created 2017/ updated 2020	None needed	Flooding
Municipal Vulnerability Plan	Community-based plan to assess vulnerability to climate change and extreme weather events and to identify adaptation options for infrastructure and assets.	City-wide	Effective	2018	Need to complete MVP 2.0 process to update plan in 2024	Multi-Hazard

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
***Continued* Lawrence Policies, Plans, and Regulations-** Building codes, land use, development ordinances, community plans/policies						
Local Open Space & Recreation Plan in Place	Strategy in place for protecting open space and recreation districts from development.	City-wide	Very effective	2017-2024	Needs to be updated	All Hazards (focus on flood/drought)
Ways to improve and/or expand current policies, plans, and regulations: Lawrence has identified updates needed to their Comprehensive Emergency Management Plan and their Municipal Vulnerability Plan. Additionally, the City does not have a current or active Master Plan. To better guide development, growth, and goals of the City, a master plan is needed.						
Lawrence Programs and Activities -Groups, committees, initiatives, programs, etc.						
Urban River Visions Program	As a program participant, the City has acquired and redeveloped existing properties to create an urban river park system along the Spicket River	Along the Spicket River	Effective	2005	City has proactively been acquiring riverfront parcels using this program for the last 20 years	Flooding
Geographic Response Initiative with EPA	Detailed plan to protect municipal water, sensitive ecological sites and other municipal interests	City-wide	Effective	2016	Equipment is not currently kept in Lawrence, as shared regionally for multiple rivers	Multi-Hazard
Federal Brownfields Program- Storm Water mitigation conditions	The City has leveraged storm water management projects within the 100-year flood and adjacent to wetlands and rivers through the Brownfields Program	Region-wide	Effective	1980s	Continue to enforce conditions for new development by including stormwater management best practices	Multi-Hazard
Green Community Designation	Lawrence has been designated as a Green Community, making them eligible for annual grant opportunities.	City-wide	Effective	2019	The City continues to work towards 20% municipal energy reduction	Multi-Hazard
Ways to improve and/or expand current programs and activities: Lawrence relies on the formation of ad-hoc working groups to advance work across the City (e.g. Trails Development Group, Parks and Recreation Development Group). More formally establishing these groups will allow for more continuous and supported efforts to achieve long-term goals.						
Lawrence Maintenance- Regular maintenance/programs						
Annual Spicket River Clean-up	The City in partnership with local non-profit annually cleans the Spicket River of debris.	Spicket River	Effective	Started in early 2000s	Annual Clean-up each September. Green team providing education around river pollution	Flooding

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
***Continued* Lawrence Maintenance**- Regular maintenance/programs						
Street Sweeping and Catch Basin Cleaning Program	DPW sweeps City streets and cleans catch basins on a regular basis	City-wide	Effective	Ongoing	Increased funding and staff capacity needed	Flooding
Tree Planting and trimming	Done in conjunction with DPW and Groundwork Lawrence	City-wide	Effective	Early 2000s	None needed	Multi-hazard
Fire Education Programs	Senior Safe Program, School Programs, Programs for faith groups and public organizations,	City-wide	Effective	Ongoing	None needed	Fire
Invasive species management	Received half a million-dollar earmark in FY2022 to manage invasives along rail trail and in Arlington Neighborhood	Rail trail and Arlington Neighborhood	Effective	2021	Institute a continued maintenance plan for LMRC corridor	Invasive Species
Ways to improve and/or expand current maintenance programs: Lawrence has identified that increased staff capacity and funding is needed to maintain maintenance programs across the City. This is especially true for more seasonal and intensive efforts such as invasive species management.						

Continue to page 267 of the Plan to review Lawrence's next section: City of Lawrence Mitigation Action Plan

7.2.6 City of Methuen Existing Resource Matrix

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Methuen Policies, Plans, and Regulations- Building codes, land use, development ordinances, community plans/policies						
National Flood Insurance Program (NFIP)	Provides flood insurance for structures located in flood-prone areas.	FEMA flood zones	Effective	1974/2012	None needed	Flooding
Floodplain Zoning District Ordinance	Floodplain ordinance requires all development, including structural and nonstructural activities, be in compliance with state building code requirements for construction in floodplains	Covers FIRM zones A, AO, AH, A1-30, AE, A99, VO, V1-30, VE and V (100-year floodplain)	Generally effective for new construction	Update to Floodplain Overlay District Ordinance currently before City Council (5/2024)	City plans to adopt new FIRM maps in 2025	Flooding
Stormwater Management Policy and Regulations	Planning Board and Conservation Commission review projects for consistency with MA DEP stormwater standards.	City-wide	Effective	Stormwater ordinance adopted in 2021, and regulations adopted in 2022	Establish more stringent monitoring and enforcement measures	Flooding
Local Wetlands Protection Ordinance	Local ordinance stricter than State WPA and Regulations	City-wide	Very effective	2012	Periodic training of Board members would improve understanding and enforcement of ordinance. Adoption of new FIRM maps required in 2025	Flooding
Local Open Space & Recreation Plan	Seeks to preserve and protect City's natural resources, but does not focus on flood hazard areas specifically	City-wide	Effective	2021	Approved through 2027	All Hazards (focus on flood/drought)
Municipal Vulnerability Plan	Community-based plan to assess vulnerability to climate change and extreme weather events and identify adaptation options for infrastructure and assets	City-wide	Effective	2019	MVP 2.0 program expected for 2019 communities in next few years	Multi-Hazard

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Continued **Methuen Policies, Plans, and Regulations-** Building codes, land use, development ordinances, community plans/policies						
Master Plan	Provides guidance for community growth and preservation of open space and natural resources	City-wide	Somewhat effective	2007	Currently undergoing update, expected in 2024	All Hazards
Comprehensive Emergency Management Plan	Details procedures to be followed in the event of an emergency of any type	City-wide	Not effective	Draft update completed end FY 2023 for comment/review	Currently undergoing update, expected in 2024. No funding to support implementation of plan once finalized	All Hazard
Searles Pond-Bloody Brook Resilience Plan (MVP)	A community-based plan focused on environmental management and nature-based solutions to reduce flooding impacts to homes, businesses, and infrastructure	Jackson St. corridor from Searles Pond to the brook outlet at the Spicket River	Effective	2022	Plan provides a comprehensive foundation in which projects can be selected and implemented	Multi-Hazard (focus on flooding)
Spicket River Watershed Plan	Plan that outlines water quality issues within the Picket River and identifies solutions to improve those issues	Spicket River watershed	Effective	2023	In process, expected completion in 2024	Multi-Hazard (focus on flooding)
Brownfields Assessment Grant	Funds to conduct re-use planning and assessment of Brownfields sites	City-wide	Effective	2023	None needed	Multi-Hazard (focus on flooding)
Water Infrastructure Risk & Resilience Assessment	Risk and Resilience Assessment (RRA) conducted in accordance with the American Water Infrastructure Act of 2018.	City-wide - Water System infrastructure	Effective	2020	None needed	Severe winter storms, and associated hazards
Ways to improve and/or expand current policies, plans, and regulations: Methuen is currently completing their Spicket River Watershed Based Plan, completing updates on their Master Plan and Comprehensive Emergency Management Plan, and anticipate updates to their MVP plan and Floodplain Zoning District Ordinance. The City also identified a need to bolster education for municipal boards charged with interpreting ordinances and to improve enforcement for regulations across the City (e.g. stormwater management ordinance)						

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Methuen Programs and Activities -Groups, committees, initiatives, programs, etc.						
Fire Safety Alert Program	City Fire Dept. notifies City residents (via newspapers, cable t.v.) of elevated wildfire/brush fire risks during extended dry periods	City-wide	Effective	Ongoing	None needed	Wildfires
Emergency Alert System	Reverse 911	City-wide	Effective	2021	None needed	All-Hazards
Municipal Vulnerability Committee	Committee that actively worked to establish and implement the Municipal Vulnerability Plan for Methuen	City-wide	Somewhat effective	2019	Group has not been active recently, but expected to reform for the MVP 2.0 process	Multi-Hazard
Greening the Gateway	Program aimed at increasing trees and tree canopy in urban residential areas	City-wide	Very effective	2023	Additional funding needed to sustain program	Multi-Hazard
Spicket River Planning Committee	Group actively involved in developing Spicket River Watershed Based Plan	Region-wide	Effective	2022	Actively working on Watershed Based Plan	Multi-Hazard (focus on flooding)
Green Community	Community is a Green Community and committed to energy reduction planning and carbon reduction.	City-wide	Effective	2018	Ongoing maintenance and monitoring	Multi-Hazard
Ways to improve and/or expand current programs and activities: Methuen has identified a need for more funding to sustain their Greening the Gateways Program. Additionally, the City is working to bolster neighborhood-based representation across groups/committees and efforts (e.g. Spicket River Plan and EV transition planning)						
Methuen Maintenance- Regular maintenance/programs						
Municipal Drainage System Maintenance & Repair Program	City strives to keep municipal drainage facilities (storm drains swales, culverts, stream channels, etc.) in good operating condition	City-wide	Somewhat effective	Ongoing	Additional resources and equipment needed for increased effectiveness. Additionally, collaboration with other depts needed to expand management.	Flooding
Street Sweeping & Catch Basin Cleaning Program	DPW sweeps City streets and cleans catch basins on a regular basis	City-wide	Effective	Ongoing	None needed	Flooding

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
***Continued* Methuen Maintenance**- Regular maintenance/programs						
Tree Limb Removal Program	City tree crew works closely with National Grid to remove dead and diseased tree limbs that pose a threat to public safety and utility lines	City-wide	Effective	Ongoing	Equipment upgrades and increased personnel needed	Multi-Hazard
Invasive species management	Municipal staff works with MassDOT and Mosquito Control to manage invasive species within the City	City-wide	Somewhat effective	Ongoing	Additional resources needed, as well as further collaboration and expanded communication to address growing challenge of managing invasives	Invasive species
Aquatic Invasive Species Management	Principal point of contact for City is Conservation Officer. Management Plan is in place for aquatic vegetation management at Forest Lake, with assistance from City's consultant.	Forest Lake	Effective	Ongoing	None needed	Aquatic Vegetation and invasive species
Stormwater Asset Management Plan	DPW Stormwater Asset Management Planning Team completed asset inventory and prioritized capital improvements	City-wide	Effective	2023	Stormwater management needs identified, sustainable funding source within municipal budget.	Flooding
Sewer System Asset Management Plan	Inventory and condition assessment of Methuen's sewer system infrastructure, including analysis of system inflows & infiltration	City-wide	NA	Underway	Currently being developed	Multi-Hazard
Water Asset Management Plan	Inventory and condition assessment of Methuen's drinking water distribution system infrastructure	City-wide	NA	Underway	Currently being developed	Multi-Hazard
Ways to improve and/or expand current maintenance programs: Methuen has identified that additional funding, staff capacity, and equipment is needed to continue and expand maintenance programs within the City.						

Continue to page 273 of the Plan to review Methuen's next section: City of Methuen Mitigation Action Plan

7.2.7 Town of Newbury Existing Resource Matrix

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Newbury Policy, Plans, and Regulations- Building codes, land use, development ordinances, community plans/policies						
National Flood Insurance Program (NFIP)	Regulates development activity and provides flood insurance for structures located in flood-prone areas	FEMA flood zones	Very effective	1977/2014	Update floodplain bylaw with 2024 map updates	Flooding
Local Wetlands Protection Bylaw (Chapter 95)	Regulates development activity on Plum Island from barrier beach to PI Turnpike bridge	Plum Island	Effective	Adopted STM 2001; Amended in its entirety ATM 2005	Expanding local wetlands bylaw to the rest of the Town	Flooding
Plum Island Overlay District (Zoning Bylaw 97-4D)	Regulates uses and dimensional requirements for development and redevelopment on Plum Island	Plum Island	Effective	Adopted 2001/last updated 2010	Should be reviewed; coordinate with Newburyport	Flooding
Building Code	Enforces the Massachusetts 9th Edition concerning Building Code regulations, including Section R.322 covering Flood Zone Requirements	All areas located in FEMA Flood Zones	Effective	9th Edition updated in 2015; 10th Edition scheduled for adoption in 2024	Could improve on explaining the overlap and differences between the State Building Code and the Plum Island Overlay District (PIOD)	flooding
Stormwater Management ByLaw and Regulations	Regulates development activity encompassing one acre or more town-wide, consistent with NPDES permit program	Town-wide	Somewhat effective	2009/ 2018	Need to address jurisdictional authority and process; clarify triggers	Flooding
Subdivision Rules & Regulations	Determines manner in which land parcels may be divided, and the specific stormwater/ flooding mitigation that is required	Town-wide	Effective	2016	Need clarifications to OSRD (see below) and also to lot shape definitions	Multi-Hazard
Master Plan	Provides guidance for community growth and preservation of open space and natural resources	Town-wide	Plan Effective: implementation needs to begin	1980/First update 2006 & current update 2023	Adopted in November 2023; Plan active from 2023-2035	Multi-Hazard

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
***Continued* Newbury Policy, Plans, and Regulations-** Building codes, land use, development ordinances, community plans/policies						
Local Open Space & Recreation Plan	Proactive plan to preserve and protect Town's open space and natural resources, but does not focus on flood hazard areas specifically	Town-wide	Somewhat effective	2000/ 2009	Plan update needed, especially around climate changes. Update to begin in 2024; policy review needed (e.g. Chapter 61 ROFR policy)	All Hazards (focus on flood/drought)
Open Space Residential Development Bylaw	Promotes cluster style residential development where appropriate to limit impervious surfaces and preserve open space and natural resources	Town-wide	Effective as a development option; Enforcement N/A	2001/ 2010	Update needed to clarify ambiguities/ inconsistencies in the requirements and provide increased focus on climate resilience	All Hazards (focus on flood/drought)
Estuary Management Plan (never adopted)	Provides guidance for prudent use and conservation of natural resources in Newbury portion of Great Marsh ACEC	Area of Critical Environmental Concern	Somewhat effective: Never adopted, but provides guidance	2005	Management Plan has not been adopted. Review and consider updates; consider adoption of revised plan.	Multi-Hazard
Beach Management Plan	Provides guidance on local policies, regulations, and procedures related to beach management	Newbury section of Plum Island	Somewhat effective	2009	Town is interested in updating plan and will be seeking funding in FY26.	Multi-Hazard
Water Supply Protection Overlay District	Zoning bylaw regulates development and other activities in municipal water supply areas and potential water supply areas. (Note: Supply has never been developed in northern overlay district area)	Aquifer recharge areas	Effective	1999/ 2011	Edits to bylaw needed to better address residential application including multi-family development	Multi-Hazard (focus on Flood/drought)
Comprehensive Emergency Management Plan (CEMP)	Details procedures to be followed in the event of any emergency	Town-wide	Very effective	2016	Current plan expired circa 2021/update in process	All -Hazards
Municipal Vulnerability Plan	Community-based plan to assess vulnerability to climate change and extreme weather events and to identify adaptation options for infrastructure and assets	Town-wide	Effective: Update needed	2018	MVP 2.0 is required. Update will focus on engaging vulnerable populations, and make the Town eligible for future Action Grant funding.	Multi-Hazard

Ways to improve and/or expand current policies, plans, and regulations: Newbury has a comprehensive range of plans and policies to address vulnerabilities across the Town. While development of new policies is not needed, improvements to existing ones are completed through regularly scheduled plan and policy updates as described above.

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Newbury Programs and Activities -Groups, committees, initiatives, programs, etc.						
Eight Towns and the Great Marsh Committee	Town participates in the Eight Towns and the Great Marsh Committee, a group focused on bolstering and protecting the health of the Great Marsh for ecosystem and community benefits	Town-wide	Effective	Group meets regularly	Identifying regional projects to advance coastal management goals	Multi-Hazard
Code Red Emergency Alert System	Town has ability to contact residents en mass or individually to provide alerts regarding emergency situations	Town-wide	Effective	Implemented 2018/updated regularly by vendor	Ideally would like to contract for next level of service, to allow the Town to send as many messages per year as needed, but current level of service is manageable.	Multi-Hazard
Green Community Designation	Newbury has been designated as a Green Community, making them eligible for annual grant opportunities.	Town-wide	Effective	2023	The Town continues to work towards 20% municipal energy reduction	Multi-Hazard
Climate Resiliency	Newbury has a representative to the Newburyport Resiliency Committee so as to enhance the towns' partnership and opportunities for working together on resiliency projects, especially for Plum Island	Town-wide	Somewhat effective	Group formed in 2015. Newbury Rep began attending ~2000	More collaboration on joint flooding, stormwater, and other shared watershed issues. In addition to the support provided by municipal staff, Newbury should consider convening its own citizen Climate Resiliency Committee	all climate hazards

Ways to improve and/or expand current programs and activities: Newbury could consider establishing its own Resiliency Committee to work proactively within the Town, neighboring municipalities (esp. Newburyport), and with partner organizations on all resiliency and adaptation issues.; concerns include but are not limited to future water supply, effective septic and sewer systems, combined sewer overflows impacting water quality of the Merrimack River and associated salt marsh and wetlands; etc.

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Newbury Maintenance- Regular maintenance/programs						
Municipal Drainage System Maintenance and Repair Program	Town strives to keep municipal drainage facilities (storm drains swales, culverts, stream channels, etc.) open and in good working condition. Program has evolved to ensure compliance with MS4 requirements	Town-wide	Effective	Ongoing	No improvements or changes needed at this time	Flooding
Hazardous Tree and Limb Removal	Inspection and removal of hazardous trees and limbs within the Town-owned Rights-of-Way. Town purchased bucket truck in 2019, which allows 90% of hazardous trees and limbs to be removed by the Town's DPW crew; a tree company is hired for removal of trees and limbs near electric lines. In addition, over several years, starting in 2016, National Grid has done Town-wide Hazardous Tree mitigation.	Town-wide	Very effective	Ongoing with recent upgrades	No improvements or changes needed at this time; the number of power outages has dropped dramatically since the Town started doing preventive tree and limb removal.	Multi-Hazard
Ways to improve and/or expand current maintenance programs: Newbury has identified the possibility of expanding municipal capabilities including invasive species control and management, coastal erosion (i.e. dune planting).						

Continue to page 278 of the Plan to review Newbury's next section: Town of Newbury Mitigation Action Plan

7.2.8 Town of Rowley Existing Resource Matrix

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Rowley Policies, Plans, and Regulations- Building codes, land use, development ordinances, community plans/policies						
National Flood Insurance Program (NFIP)	Regulates development activity and provides flood insurance for structures located in flood-prone areas	FEMA flood zones	Effective	1974/2014	None needed	Flooding
Floodplain District – Protective Zoning Bylaw	Regulates development and construction activities in designated flood areas (A1-30 and V1-30; and areas below elevation 15 ft. and below the elevation 10 ft. above thalweg of named river or stream)	FEMA flood zones	Effective	2022	Rowley updated to model bylaw language (as recommended by the state) in 2022. No additional updates are needed	Flooding
Stormwater Mgmt. and Erosion Control Bylaw & Regulations – General Bylaw	Regulates stormwater management and soil disturbance. Covers land disturbance >20,000 s.f., or 10,000 s.f. or more on slopes > 15%	Town-wide	Effective	2021/2022	Worked with MVPC to update and adopt changes to Stormwater Bylaw and Regulations in 2021 and 2022.	Flooding
Local Wetland Protection Bylaw – General Bylaw	Regulates activities near wetland resource areas (Protective of wetlands, buffer zones, vernal pools, and drinking water Approved Zone II)	Town-Wide	Effective	2019	Removed static fee schedule and updated language around small project administrative approval. No additional changes needed	Flooding
Municipal Water Supply Protection District – Zoning Bylaw	Regulates development and other activities	Designated public water supply wells and recharge areas	Effective	1960/ amended 2019	None	Flooding/ Drought
Subdivision Rules & Regulations	Determines manner in which land parcels may be divided, and the specific stormwater/ flooding mitigation that is required	Town-wide	Effective	1960/ updated 2005	General update needed to procedural and design standards	Flooding

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
***Continued* Rowley Policies, Plans, and Regulations-** Building codes, land use, development ordinances, community plans/policies						
Open Space & Recreation Plan	Provide guidance for community growth and development as well as preservation of open space and natural resources	Town-wide	Effective	2021	None needed	All Hazards
Master Plan	Provides guidance for community growth and preservation of open space and natural resources	Town-wide	Somewhat effective	2003	Grant received to begin plan update by conducting studies on traffic flow, development impact, and water supply.	All Hazards
Comprehensive Emergency Management Plan (CEMP)	Details procedures to be followed in the event of an emergency of any type	Town-wide	Effective	2017	Planned update in 2024 to ensure plan stays relevant.	All Hazards
Municipal Vulnerability Plan	Community-based plan to assess vulnerability to climate change and extreme weather events and to identify adaptation options for infrastructure and assets	Town-wide	Effective	2020	Rowley will need to complete MVP 2.0 process in the next 2-3 years.	Multi-Hazard
Earth Removal Bylaw – General Bylaw	Regulates earth (soils) removal and transport w/ operation and restoration plans required	Town-wide	Effective	Created 1979/ amended 2005	None needed	Flooding
Green Community Designation	Rowley has been designated as a Green Community, making them eligible for annual grant opportunities.	Town-wide	Effective	2018	The Town continues to work towards 20% municipal energy reduction	Multi-Hazard
Personal Service Wireless Facilities Protective Zoning Bylaw	Regulates development and other activities associated with wireless communication facilities	Town-wide	Effective	Updated 2000	None needed	Multi-Hazard
Ways to improve and/or expand current policies, plans, and regulations: Rowley has identified updates to the Town's Subdivision Rules & Regulations, Master Plan, Comprehensive Emergency Management Plan, and Municipal Vulnerability Plan.						

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Rowley Programs and Activities -Groups, committees, initiatives, programs, etc.						
Eight Towns and the Great Marsh (8TGM) Committee	Town participates in 8TGM, a group focused on bolstering and protecting the health of the Great Marsh	Town-wide	Effective	1993/ ongoing	New Rowley member recently appointed to group	Multi-Hazard
Emergency Alert System- Blackboard Connect	Provides emergency notifications to town residents	Town-wide	Effective	~2010	None needed	Multi-Hazard
Ways to improve and/or expand current programs and activities: Rowley has identified two ways to expand current programs and activities. These include a roadway drainage study to help understand flooding locations across the Town, and exploring options for increased emergency shelters during emergency events.						
Rowley Maintenance- Regular maintenance/programs						
Municipal Drainage System Maintenance & Repair Program	The Town strives to keep municipal drainage facilities (storm drains swales, culverts, stream channels, etc.) open and in good condition	Town-wide	Somewhat effective	Ongoing	More public works personnel and funds would increase overall effectiveness of program	Flooding
Hazardous Tree and Limb Removal	Inspection and removal of hazardous trees and limbs within the Town-owned Rights-of-Way	Town-wide	Somewhat effective	2016	Additional funding would allow for greater effectiveness	Multi-Hazard
Invasive Species Mgmt	Town conducts invasive species education and management through volunteer stewardship days	Town-wide	Effective	Ongoing	Town could bolster program to widen impact	Invasive Species
Beaver mitigation measures	Rowley's beaver population has a significant impact on flooding. The Town, through coordinated efforts of BOH, ConCom, Water Dept., and Highway Dept., implements several measures to mitigate related flooding	Town-wide	Somewhat effective	Ongoing	Additional funding needed to support more rigorous beaver mitigation program	Flooding
Ways to improve and/or expand current maintenance programs: Staffing and funding has increased since 2016, however the Town's infrastructure and population is continuing to grow. Therefore, staffing and funding needs to continue to grow as well.						

Continue to page 285 of the Plan to review Rowley's next section: Town of Rowley Mitigation Action Plan

7.2.9 Town of Salisbury Existing Resource Matrix

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Salisbury Policy, Plans, and Regulations- Building codes, land use, development ordinances, community plans/policies						
National Flood Insurance Program (NFIP)	Regulates development activity and provides flood insurance for structures located in flood-prone areas	FEMA flood zones Town-wide	Very effective	Updated 2012	Need to update Floodplain Bylaw	Flooding
Floodplain Overlay District Zoning	Zoning bylaw regulates development in flood hazard areas	Zones A, A1-30 and V on the FIRM Maps	Very effective	updated 5/2012	Need to update Floodplain Bylaw	Flooding
Storm Water Management	Implementation of EPA Phase II storm water requirements for large construction sites before Planning Board & Conservation Commission	Town-wide	Effective	Updated 2023 updated R/R 2022, 2021	Created a Stormwater Bylaw, Updated Planning board Rules and Regulations and Subdivision Control Regulations in 2022, 2021	Flooding
Watershed Protection Overlay District	Zoning bylaw regulates development and other activities in municipal water supply areas	Aquifer recharge areas	Effective	1987/ 2012	None needed	Flooding/ Drought
Local Open Space Plan	Plan targets purchase of available floodplain and wetlands buffers for protection	Town-wide	Effective	expired 11/2023	Working on updates expected 2024	All Hazards (focus on flood/drought)
Regulation of Communication and Wireless Communication Towers	Zoning bylaw addresses height and construction issues	Town-wide	Effective	1999	None needed	Multi-Hazard
Earth Filling and Earth Removal Bylaws	Zoning bylaws regulate earth movement, both as an import and export product, as well as earth stabilization	Town-wide	Effective	Earth filling 2003/ Earth Removal 1970	None needed	Multi-Hazard

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
***Continued* Salisbury Policy, Plans, and Regulations-** Building codes, land use, development ordinances, community plans/policies						
Sewer Commission Bylaw	Bylaws and regulations in place to protect the waste stream coming into treatment plant.	Town-wide	Effective	2004/ 2010	Currently reviewing and updating	Flooding
Municipal Vulnerability Plan	Community-based plan to assess vulnerability to climate change and extreme weather events and to identify adaptation options for infrastructure and assets	Town-wide	Effective	2019	MVP 2.0 program expected for 2019 communities in next few years	Multi-Hazard
No Net Increase in Runoff	Subdivision and Site Plan Special Permits require no net increase in site runoff from pre-construction runoff conditions	Town-wide	Effective	2020, 2021, 2022, 2023	Updated amendments to subdivision, site plan review and stormwater bylaw	Multi-Hazard (Flooding/ Erosion)
Subdivision Rules & Regulations	Determines manner in which land parcels may be divided, and the specific stormwater/flooding mitigation that is required	Town-wide	Effective	Updated 2022	None needed	Flooding
Town Zoning Bylaw	Promotes the health, safety, and welfare of Town residents. Sections detail the requirements relating to lot size, setbacks, contiguous buildable area, site plan review, and lot/slope requirements	Town-wide	Effective	Updated 2023	Have increased enforcements and clarification of bylaws	All Hazards
Salisbury Beach Management Plan	Provides guidance on local policies, regulations, and procedures related to beach management	Salisbury Beach and Merrimack River	Not effective	Expired, Draft plan not released yet for review	Town is working with MRBA to review DCR's draft plan. Town plans to adopt Plan for town-owned and privately owned properties once final	Coastal Erosion
State Wetlands Protection Bylaw and Regulations	Regulates development and other land alteration activities with 100-ft buffer zone	Town-wide	Effective	1972	Needs additional enforcement, Need a local bylaw to assist with local enforcement	Flooding

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
***Continued* Salisbury Policy, Plans, and Regulations-** Building codes, land use, development ordinances, community plans/policies						
Master Plan	Provides guidance for community growth and preservation of open space and natural resources	Town-wide	Effective	2008/ 2022	Amended several sections in 2022 need to complete updates	All Hazards
Comprehensive Emergency Management Plan	Details procedures to be followed in the event of an emergency of any type	Town-wide	Effective	2022	None needed	All Hazard
Ways to improve and/or expand current policies, plans, and regulations: Salisbury is actively working to update a number of existing plans to ensure their continued effectiveness. This includes the Town's Floodplain Bylaw, Open Space Plan, Sewer Commission Regulations, and Master Plan. Additionally, increased enforcement is needed for the Zoning Bylaw and State Wetland Protection Regulations (through the creation of a Local Wetland Bylaw) to ensure compliance.						
Salisbury Programs and Activities -Groups, committees, initiatives, programs, etc.						
Disaster and Emergency Notification Program (On Solve)	Adoption of program to provide notification to town in event of emergency or disaster. Notifications include all hazards including flooding for coastal residents.	Town-wide	Effective	2013	Need to increase use by all residents and property owners to make more effective, possibly add a blue light system for additional notification	All Hazards
Eight Towns and the Great Marsh Committee	Town participates on the Eight Towns and the Great Marsh Committee, a group focused on bolstering and protecting the health of the Great Marsh for ecosystem and community benefits	Town-wide	Effective	1993	Group meets regularly. Additional action is needed to identify and advance regional coastal projects	Multi-Hazard
Capital Improvement Programs	Identification and budgeting of projects that mitigate natural hazards as appropriate	Town-wide	Effective	Ongoing	Seek increased funding via outside sources	Multi-Hazard
Community Rating System (CRS)	Voluntary incentive program that recognizes and encourages community floodplain management practices.	Town-wide	Effective	2016	Salisbury currently participates and is designated as a class 8.	Flooding

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Salisbury Maintenance- Regular maintenance/programs						
Green Community Designation	Salisbury has been designated as a Green Community, making them eligible for annual grant opportunities.	Town-wide	Effective	2017	The Town continues to work towards 20% municipal energy reduction	Multi-Hazard
Education & Outreach on Natural Hazards Preparedness, Mitigation, and Response	Town provides outreach via information and links on website, notices on community access TV channel, and display of educational materials at Town Hall	Town-wide	Somewhat effective	Ongoing	Looking for more options, possible blue light system, CRS community and continue to work on ways to educate	Multi-Hazard
Ways to improve and/or expand current programs and activities: Salisbury can further bolster their systems through making improvements to their Emergency Notification systems and education and outreach initiatives. Efforts will ensure a greater portion of the community is reached through expanded services and notification tools/information.						
Municipal Drainage System Maintenance	Town DPW routinely inspects and cleans drainage systems to ensure proper operation	Town-wide	Somewhat effective	Ongoing	Increased funding to cover costs of proper cleaning	Flooding
Private Drainage System Maintenance	Private Stormwater Management Plans (SWMPs) filed with Planning Board and Conservation Commission require procedures to maintain private drainage systems	New development projects town-wide	Not effective	Ongoing	Need to increase follow up with the private development	Flooding
Street Sweeping Program	Routine street sweeping to remove sand & debris before they enter storm drains	Town-wide	Somewhat effective	Ongoing	Funding needed for replacing existing 1984 street sweeper	Flooding
Hazardous Tree and Limb Removal	Inspection and removal of hazardous trees and limbs in collaboration with power company and upon notification by property owners	Town-wide	Somewhat effective	Ongoing	Needs to be routine; additional funding required	Multi-Hazard
Ways to improve and/or expand current maintenance programs: Salisbury has identified that additional funding and capacity is needed to ensure maintenance is conducted regularly, updated equipment is available, and outreach can be conducted to different stakeholders.						

Continue to page 288 of the Plan to review Newbury's next section: Town of Newbury Mitigation Action Plan

7.2.10 Town of West Newbury Existing Resource Matrix

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
West Newbury Policies, Plans, and Regulations- Building codes, land use, development ordinances, community plans/policies						
National Flood Insurance Program (NFIP)	Federal program provides flood insurance for structures in mapped flood-prone areas	FEMA flood zones Town-wide	Effective	Section rewritten and adopted 2021	New map adoption expected in 2025	Flooding
Floodplain District Bylaw	Regulates properties which are subject to seasonal or periodic flooding in mapped flood hazard areas	Town-wide (see bylaw for specific areas)	Effective	Section rewritten and adopted 2021	New map adoption expected in 2025	Flooding
Stormwater Bylaw	Regulates all construction and land clearing activities for stormwater through a permitting process for sites in which 1 acre or more is disturbed.	Town-wide	Effective	Effective 2022	Further revisions are needed to clarify certain provisions such as common ownership. Implementing authority of the bylaw may change from planning board to the board of health	Flooding
Earth Removal Bylaw	Limits and regulates removal of soil from Town	Town-wide	Effective	1964/ 1995	None needed	Multi-Hazard (flooding/erosion)
Comprehensive Emergency Management Plan (E-CEMP)	Details procedures to be followed in the event of an emergency of any type	Town-wide	Effective	2023	Will be updated again in the near future with the Town's new Emergency Management Director	All Hazards
Septic Regulations	Regulations to protect the residents from on-site subsurface sanitary sewage disposal systems	Town-wide	Very Effective	2011	None needed	Flooding
No Net Increase In Runoff	The Town's stormwater management review, including Zoning, Subdivision and Site Plan review, require no net increase in site runoff from pre- to post-development	Town-wide	Effective	2023	Further revisions are needed to clarify certain provisions such as common ownership. Implementing authority may change from planning board to the board of health	Flooding

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
***Continued* West Newbury Policies, Plans, and Regulations-** Building codes, land use, development ordinances, community plans/policies						
Regulation of Communication and Wireless Communication Towers	Zoning bylaw addresses height and construction issues	Town-wide	Effective	2011	Updates needed to fully reflect recent changes in FCC Regulations ("shot clock", etc.)	Multi-Hazard
Groundwater Protection Overlay District Bylaw	Preserves and protects the Town's drinking water sources and recharge areas, as well as natural resources	Town-wide (see bylaw for specific areas)	Effective	2013	None needed	Flooding/Drought
Open Space Recreation Plan	Plan to preserve the ecological integrity of the Town's open spaces and natural resources, as well as community character and quality of life	Town-wide	Effective	2018	Will need to update OSRP by December 2025	All Hazards (focus on flood/drought)
Municipal Drainage System Maintenance	Town DPW routinely inspects and cleans drainage systems to ensure proper operation	Town-wide	Effective	Ongoing	Town continues to evaluate budgeting for drainage infrastructure maintenance and improvements. Anticipates need for greater budgeting in part due to permitting requirements.	Flooding
Subdivision Rules and Regulations	To assure orderly development while maintaining the rural character and natural resources of the Town	Town-wide	Effective	2019	Updates to assure consistency with Stormwater Management Permit Regs	Flooding
Municipal Vulnerability Plan	Community-based plan to assess vulnerability to climate change and extreme weather events and to identify adaptation options for infrastructure and assets	Town-wide	Effective	Created in 2019	Currently implementing FY24 MVP Action Grant (River Road resiliency planning). Anticipate seeking additional MVP grant funding.	Multi-Hazard
Master Plan	Provides guidance for community growth and preservation of open space and natural resources	Town-wide	Not Effective	1999	Will require a major town-wide effort to develop and adopt a new Master Plan	All Hazards

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
***Continued* West Newbury Policies, Plans, and Regulations-** Building codes, land use, development ordinances, community plans/policies						
Town Zoning Bylaw	Promotes the health, safety, and well-being of Town residents	Town-wide	Very Effective	2023	None needed	All Hazards
Ways to improve and/or expand current policies, plans, and regulations: West Newbury has identified updates needed to their Stormwater Bylaw, Comprehensive Emergency Management Plan, Regulations of Communication and Wireless Communication Towers, Open Space and Recreation Plan, Subdivision Rules and Regulations, and Master Plan. Additionally, they identify the need to create and adopt a Local Wetland Protection Bylaw that would expand protections for resource areas and resource area values beyond what is protected in the state Wetland Protection Act to support goals around flooding, water quality, and erosion hazards in West Newbury. The Conservation Commission is working on a draft bylaw targeting the spring 2024 Annual Town Meeting Warrant for potential adoption by voters. West Newbury also identified the need to create a policy to regulate runoff and sedimentation from construction sites that do not fall under the scope of any existing policy, or regulations would reduce flooding, erosion, and water quality hazards.						
West Newbury Programs and Activities -Groups, committees, initiatives, programs, etc.						
Climate Change Resiliency Committee	Citizen committee established to help lead Town's efforts at mitigating and managing impacts of climate change	Town-wide	Effective	Ongoing	Continued focus on climate change resiliency planning and infrastructure investments	Multi-Hazard
Code Red (Reserve 911)	Emergency alert system for residents	Town-wide	Effective	Ongoing	None needed	Multi-Hazard
West Newbury Wild and Native (WN2)	Group dedicated to sharing information and resources to promote native plants	Town-wide	Effective	Ongoing	None needed	Multi-Hazard
Green Community Designation	West Newbury has been designated as a Green Community, making them eligible for annual grant opportunities.	Town-wide	Effective	2013	The Town continues to work towards 20% municipal energy reduction	Multi-Hazard
Ways to improve and/or expand current programs and activities: West Newbury identified their interest in exploring opportunities to conduct geographically targeted alerts through the Code Red program to target specific communities within the Town.						

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
West Newbury Maintenance- Regular maintenance/programs						
Street Sweeping Program	Routine street sweeping to remove sediment & debris	Town-owned paved parking lots	Very Effective	Ongoing (annual)	None needed	Flooding
Hazardous Tree and Limb Removal	Inspection and removal of hazardous trees and limbs within the Town-owned Rights-of-Way	Town-wide	Effective	2023	Anticipate additional funding increases to keep up with need.	Multi-Hazard
Invasive Species Management	Surveying for and managing invasive species	Town wide on Town owned land and Town right-of-ways	Somewhat Effective	2022 first summer intern year	Additional funding and staff availability would allow for expansion of program to include better GIS mapping and data management of surveyed areas, more outreach, and more management of invasive plants by staff, contractors, and volunteers	Invasive species / wildfire
Ways to improve and/or expand current maintenance programs: West Newbury has identified that additional funding and capacity would enable maintenance and expansion of these programs across the Town. They also highlighted the need to explore opportunities to streamline invasive species work on regional scale and engage other stakeholders (e.g. National Grid) into the management effort.						

Continue to page 294 of the Plan to review West Newbury's next section: Town of West Newbury Mitigation Action Plan

7.3 Merrimack Valley Region Existing Resource Matrix

The community-specific measures outlined above benefit from a number of regional resources. These resources can be found in the form of policies, plans, regulations, programs and maintenance opportunities. A list of these measures our outlined in greater detail below.

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Regional Policies, Plans, and Regulations- Building codes, land use, development ordinances, community plans/policies						
Housing Production Plan	Outlines a strategy to meet housing needs across the region using equitable, sustainable, and smart growth strategies	Merrimack Valley region	Effective	Created 2018	Plan update is currently underway anticipated 2024	Multi-Hazard
Vision Zero Plan	Safety action plan for the region to eliminate fatal and injury crashes	Merrimack Valley region	NA	Expected 2024	MVPC is currently working to develop this plan, anticipated release in 2024.	Multi-Hazard
Active Transportation Plan	Expand active transportation network to enable mode shift in Merrimack Valley region	Merrimack Valley region	Very Effective	2014/undergoing update	MVPC is actively working to update plan, anticipated completion 2024.	Multi-Hazard
Transportation Improvement Program	Serves as the region's transportation capital plan	Merrimack Valley region	Very Effective	Updated 2024	MVPC recently upgrading scoring process for project selection to integrate climate related hazards (e.g. flooding)	Multi-Hazard
Comprehensive Economic Development Strategy (CEDS)	Five-year strategic plan for regional economic growth	Merrimack Valley region	Effective	Updated 2023	None needed	Multi-Hazard
Regional Priority Growth Strategy	Comprehensive regional land use plan for Merrimack Valley region	Merrimack Valley region	Somewhat Effective	Updated 2015/undergoing update	Plan is currently undergoing updated anticipated 2024	Multi-Hazard
Great Marsh Barriers Assessment	Extensive inventory and prioritization of all barriers in the Parker, Ipswich, and Essex reiver watersheds.	Communities within the PIE region	Very Effective	2018	Plan is actively being implemented as funding is available	Flooding, SLR
Ways to improve and/or expand current policies, plans, and regulations: The Merrimack Valley region has a number of plans that are actively being updated. These include the Housing Production Plan, Regional Priority Growth Strategy, and Active Transportation Plan. One additional plan is being developed and will help to coordinate regional efforts for the valley, the Vision Zero Plan.						

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Regional Programs and Activities -Groups, committees, initiatives, programs, etc.						
Merrimack Valley Stormwater Collaborative	Coalition of 15 Merrimack Valley communities working together on regional approaches to cost-effective stormwater management.	Merrimack Valley region	Effective	2008	None needed	Flooding
Merrimack River Collaborative	Coalition of RPAs, community groups, nonprofits, and municipal and elected officials advancing water quality in the Merrimack Valley.	Merrimack River Watershed	Effective	2023	Continued engagement with New Hampshire to ensure a multi-state approach	Multi-Hazard
Eight Towns and the Great Marsh	Group of municipally-connected representatives focused on bolstering and protecting the health of the Great Marsh for ecosystem and community benefits	Coastal Communities	Effective	1992	Group is actively working to identify regional projects to advance in coastal communities	Multi-Hazard
Municipal Information Mapping Access Program (MIMAP)	Internet-based GIS service maintained by MVPC that hosts critical community information and infrastructure data.	Merrimack Valley region	Very Effective	2006/2017 (data updated regularly)	General software update planned in next 2 years	Multi-Hazard
Regional Planners Coalition	Monthly convening of town/city planners to discuss best practices and current planning initiatives	Merrimack Valley region	Very Effective	2020	None needed	Multi-Hazard
Mayors and Managers Coalition	Biannual convening of Merrimack Valley Municipal CEOs to discuss high-level challenges and opportunities for regional initiatives	Merrimack Valley region	Very Effective	2007	None needed	Multi-Hazard

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Regional Programs and Activities -Groups, committees, initiatives, programs, etc.						
Northern Essex Regional Emergency Planning Committee	Comprised of the communities of Amesbury, Boxford, Georgetown, Ipswich, Merrimac, Newbury, Rowley, Salisbury, and West Newbury, groups focused on protection against hazardous materials.	Merrimack Valley region	Effective		None needed	Multi-Hazard
PIE Rivers Partnership	Partnership under the Ipswich River Watershed Association that convenes and advances priority projects for the Parker, Ipswich, and Essex Rivers	Communities within the PIE region	Effective	2011	Group convenes regularly and is actively working to update the PIE-Rivers Partnership Action Plan	Multi-Hazard
Ways to improve and/or expand current programs and activities: Regionally, communities participate on a number of coalitions that bring collaboration and strength to the region. Improvements to expand and strengthen these groups has been identified above.						

Existing Resource	Description of Resource	Area Covered	Effectiveness	Year Created/ Updated	Improvements or Changes Needed	Hazard Addressed
Regional Maintenance- Regular maintenance/programs or systems						
Eagleview Aerial Imagery Data	MVPC contracts with Eagleview to conduct regional aerial flights every 2-5 years. Aerial data is made available to municipal staff for planning (through MIMAP)	Merrimack Valley region	Very Effective	2001/ last flown 2023	Constantly working to improve aerial imagery data with technology upgrades	All hazards
MVPC Experience Builder (ArcGIS)	MVPC creates and maintains online applications through Experience Builder for use throughout the region by municipal staff. Examples include: Open Space Inventories, REPA Viewer, LID Viewer.	Merrimack Valley region	Very Effective	Ongoing	Transitioning Web Apps (older technology) to Experience Builder in response to Esri updates	Multi-Hazards
Ways to improve and/or expand current maintenance programs: Both of the regional maintenance systems described above are constantly being improved as new technology is made available.						

SECTION 8. MITIGATION STRATEGIES

This section of the Hazard Mitigation Plan presents community specific as well as regional mitigation actions that, effectively implemented, will serve to minimize risks and reduce losses from natural hazards in the Merrimack Valley region. Mitigation Action Plans were developed by each Local Hazard Mitigation Planning Team by reviewing their 2016 mitigation goals, identifying progress since 2016, reprioritizing existing actions, and identifying new mitigation actions based on current and projected risk and vulnerability.

8.1 Overarching Mitigation Goals

A set of overarching mitigation goals helped to guide Local Hazard Mitigation Planning Team's. The Plan's mitigation goals represent broad statements that are achieved through the implementation of more specific, action-oriented initiatives by the participating communities, acting individually and in concert. In updating the Hazard Mitigation Plan, the goals of the 2016 Plan were reviewed, amended, and affirmed. The regional goals are outlined below:

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

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

Goal 3: Increase the financial capability of communities in the Merrimack Valley region to implement hazard mitigation measures through maximizing available outside grant funding opportunities as well as locally available fiscal resources.

Goal 4: Improve existing local policies, plans, regulations, and practices to reduce or eliminate the impacts of known natural hazards.

Goal 5: Investigate, design, and implement a range of structural projects that will reduce the effects of natural hazards – especially flooding – on public and private property throughout the region.

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

Goal 7: Develop and implement adaptation strategies and modify local emergency plans to protect the public, critical infrastructure, property, and natural resources from the impacts of climate change.

8.2 Developing Community-specific Mitigation Actions

Using 2016 Mitigation Action plans, each LHMPT reviewed the full list of actions for their community and provided written updates. Each action was assigned a status of "complete," "in progress," and "not completed." Team members then reviewed the "in progress" and "not completed" actions to determine which should be carried forward into the Hazard Mitigation Plan update.

Once existing actions had been fully reviewed, each LHMPT used their Challenge Statements, other community plans (e.g. Municipal Vulnerability Plan), and comprehensive list of Community Lifelines to identify new mitigation actions to include in 2024. Each new action identified was integrated into the Mitigation Action Matrix, by categorizing the action as follows:

- Category of action: Planning, Structural, Nature Based Solution, Education
- Description of the action: Brief description of mitigation action
- Hazard Addressed: One or more of 15 State identified natural hazards
- Responsible Group: Department or group responsible for advancing action
- Timeframe: Short <2 years, Medium 3-4 years, Long > 5 years
- Cost: Low < $50k, Moderate $50-250k, High > $250k
- Resources/Funding: Funding agency or group to support action
- Action Status: Brief summary of where current action stands

Once the Mitigation Action Matrix was completed, LHMPTs reviewed each of their current actions and prioritized them using a set of ten (10) criteria. These criteria provided LHMPTs an opportunity to fully consider the feasibility of each mitigation action. For each action, LHMPTs considered the 10 criteria and assigned each one a score of 1= Effective or feasible, 0= Neutral, -1= Ineffective or not feasible. Scores for each action were then totaled. The lowest possible score an action could receive was -10 and the highest possible score was 10. LHMPTs used final aggregate scores to review and eliminate projects that were not feasible (often indicated by a negative score) and prioritize their list of final mitigation actions. The final prioritization is reflected in the order of projects listed in each matrix, and by the score in the "Priority" column.

1. *Funding Feasibility:* Is it feasible to cover the associated costs of this action?
2. *Safety:* How effective will the action be a protecting lives and preventing injuries?
3. *Property:* How significant will the action be at eliminating/reducing property damage?
4. *Authority:* Does the community have authority to implement the action?
5. *Social:* Is there public support for the action?
6. *Community Resilience:* Will the action benefit a vulnerable group in the community?
7. *Environment:* Are there potential environmental impacts of the action (+/-)?
8. *Capacity:* Are there personal/administrative resources to implement and maintain the action?
9. *Champion:* Is there a strong advocate for the action (department, agency, group)?
10. *Symbiosis:* Does the action advance other identified community objections?

Outcomes from each LHMPTs' effort are detailed below in each communities' Mitigation Action Plan Matrix, providing a comprehensive guide for community action to reduce risk and vulnerability from natural hazards over the next five years.

8.3 Mitigation Action Plan Matrices by Community

8.3.1 City of Amesbury Mitigation Action Plan

AMESBURY COMPLETED PROJECTS SINCE 2016								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources / Funding**	**Year Added**	**2024 Project Update**
Planning	Update building footprints and data sets. The City will use this data to correlate building improvements and values towards assessing costs benefit risks of manmade and natural hazards.	Flooding	Assessor's Office, Building Commission	Long-term	Low	City Planning Dept Budget	2016	Data was updated by the Amesbury Assessor's office in 2022. Correct and comprehensive data is now located within the BGIS system as well as MIMAP
Planning	Develop a regulation that limits earth removal and placement and develop an appropriate building height definition.	Flooding	Lakes & Waterways Commission, DPW	Medium-term	Low	City Planning Dept. Budget	2016	Amesbury has regulations limiting earth removal in their Zoning Ordinance (Section X1.A and X1.B). The LHMPT decided to not establish building height definitions, as concerns are already addressed through existing codes and regulations.
Planning	Develop plans to address hazardous material contamination in the event of natural disaster/storms	Multiple Hazards	City-Wide	Long-term	Moderate	City Budget (multi dept: Planning, Emergency Mgmt, etc.)	2016	Since 2016, plans and protocols to address hazardous material have been developed individually within each department. As a follow-up all plans will be consolidated into one location for easy access.
Planning	Add common naming conventions to the existing assessor records for land use code. This will provide a data to generate datasets and buildout maps to run scenarios or population and property values to assess hazard impacts	All hazards	Assessor's Office, Building Commission	Long-term	Low cost	City Budget (Planning Dept.)	2016	Common naming conventions were added into existing assessor records by City Assessors in 2021.

AMESBURY COMPLETED PROJECTS SINCE 2016								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources / Funding**	**Year Added**	**2024 Project Update**
Planning	Explore updating the fire hydrant data set to include ID scheme where each hydrant has a unique ID that is present both in the GIS data and within the City's hydrant database to assess Fire response capabilities and risk.	Wildfires/ Brushfires	DPW, Water Dept., Fire Dept.	Long-term	Low cost	Community Compact Grant	2016	Amesbury completed this action in 2019 through a multi-community grant with Salisbury and Merrimac. With technical assistance from MVPC, all hydrant data has been updated.
Planning	Participate in the MVPC, and regional floodplain managers group to discuss issues and solutions to natural hazards and flooding problems. The proposed actions will be coordinated with other regional and community priorities, as well as with mitigation goals of state and federal agencies.	Flooding	DPW, Floodplain Manager	Short-term	Low cost	City DPW Budget	2016	Amesbury actively participates in MVPC Regional Stormwater Collaborative Group.
Planning	Develop and implement a residential water-metering program. By metering each user, the City would be able to promote conservation and limit water usage during drought.	Drought	DPW, Mayor, Conservation	Medium-term	Moderate cost	City Budget (Water Dept.)	2016	The City contracted with Pentucket Water who completed this action in 2021.
Planning	Explore updating the floodplain bylaws to incorporate the additional provisions in the MVPC Natural Hazard Mitigation Plan to better protect land subject to storm flow.	Flooding	Planning Board, City Council	Long-term	Low cost	MS4 Municipal Assistance Grant	2016	Amesbury's Stormwater Ordinance, adopted in 2020, sets regulations regarding stormwater runoff. Additionally, currently amendments to the Wetland Floodplain Protection District further address this goal.
Structural/ Education	Install warning sirens or alternative warning device for City	Multiple Hazards	Fire Dept., Emergency Mgmt., Police Dept.	Short-term	Moderate cost	City Budget (Emergency MGMT Dept.)	2016	In 2023, Amesbury established Smart911, an emergency notification system for the City.

AMESBURY DROPPED PROJECTS FROM 2016 Plan (not completed and not advancing to 2024 Plan)								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources / Funding**	**Year Added**	**2024 Project Update**
Planning	Adopt a sewer neutral regulation through a General Ordinance. Where new sewers are proposed, residential development/ redevelopment shall be permitted to have only the no. of bedrooms allowed under Title V and local regulations whether or not City sewer is available.	Flooding	Planning Board, City Council, Board of Health, DPW, Sewer Dept.	Long-term	Low cost	MS4 Municipal Assistance Grant	2016	Amesbury has identified this action as conflicting with their Smart Growth goals, and has decided to remove it from their plan.
Education	Prioritize public education about flood action and flood proofing. Make materials available describing simple and inexpensive means of flood proofing.	Flooding	Conservation, Emergency Mgmt., City Council	Medium-term	Low cost	MVP Action Grant	2016	In 2023, Amesbury decided to include this goal in the broader education goal addressing education of all natural hazards.
Planning/ Structural	R Street Bridge replacement.	Multiple Hazards	Conservation, DPW	Medium-term	High cost	MassDOT Municipal Small Bridge Program	2016	While this project remains a high priority, the City has identified a need for a larger and more comprehensive City-wide bridge assessment prior to action. A new action has been added to represent this pivot.

AMESBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	To increase preparedness for flood hazard events~ explore certifying a member of the City staff as a Floodplain Manager with the Association of Floodplain Managers. Certified managers are kept up-to date on flood mitigation requirements and strategies and work to reduce flood losses and protect/ enhance the natural resources and functions of floodplains.	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, Other Severe Weather, and Coastal Conditions	Conservation, DPW	7 (scored as 6, but adjusted by LHMPT)	Medium-term	Low cost	Conservation Department and Department of Public Works Budget	2016	Amesbury had a certified Floodplain Manager, until the position became vacant in 2016. Next steps include identifying who should serve in this role and enrolling and completing the certification program.
Planning	Develop a stormwater utility plan for the City of Amesbury	Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, Other Severer Weather, and Coastal Conditions	Planning Board, Conservation Department, DPW	7	Medium-term	Low Cost	Planning Department, Conservation Department and DPW Budget	2024	Next steps include assessing current stormwater infrastructure and working with City and outside groups/ consultants to develop plan.
Planning/ Education	Bolster Emergency Management Response Capacity: 1. Identifying and certifying an Emergency Management Director for the City; 2. Conduct ICS training; and 3. Coordinate Emergency response with all Department Heads	All Hazards	Fire Dept., Emergency Mgmt., Police Dept.	6	Long-term	Low cost	Emergency Management Performance Grants	2016	Due to staff transitions and reduced capacity, no action has occurred since 2016. This goal was further bolstered in 2023 to add clear next steps (1-3)

AMESBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Review Amesbury's drainage system through compiling and maintaining data	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, Other Severe Weather, and Coastal Conditions	Department of Public Works	6	Short-term	Low cost	Stormwater Utility and City Budget	2016	Initial steps taken to review/map drainage systems. More updates are needed to inventory infrastructure.
Structural	Update Amesbury's drainage system. Due to extensive erosion and age the pipelines and canals have filled in blocking water flow.	Inland Flooding, Coastal Flooding, Storm Events, Erosion	Department of Public Works	6	Long-term	High	Stormwater Utility, MVP Action Grants, FEMA HMP Grants	2016	Next steps include developing a stormwater utility in which funds can be obtained to address drainage infrastructure.
Planning	Conduct a comprehensive assessment of erosion along Merrimack River	Riverine Erosion	Conservation Department, Lakes and Waterways Commission	6	Short-term	Low cost	Supportive Coastal Infrastructure and Local Maritime Economic Development Planning Grant	2024	Next steps include scoping the project and identifying potential funding sources for the study.
Planning	Buildings and infrastructure in areas of projected sea level rise (Merrimac Street, Lower Main Street, Evans Place and Pleasant Valley Road) should be designed for protection from flooding as well as to minimize risk to human health and safety.	Coastal Flooding, Hurricanes/ Tropical Storms, Tsunamis	Building Commission, Planning Board, City Council	5	Long-term	Low cost	FEMA Hazard Mitigation Grant	2016	This topic is being addressed through amendments to the Wetlands and Floodplain Protection District. To ensure future SLR protections are considered, a CAP or SLR study for Amesbury should be explored.

AMESBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Education	Increase public awareness of hazard risk and vulnerability through a public education program. 1. Provide natural hazard education/outreach for contractors as well as the general public (e.g. re-engaging with the SAFE program in schools); 2. Provide natural hazard pre-mitigation materials to all residents of the City via the website, & local broadcasting. 3. Maintain, review and publicize the current action plan on an annual basis; 4. Coordinate with MVPC to maintain, review and publicize evacuation routes.	Emphasis on: Flooding, Hurricanes, Wildfires, Earthquakes, Tornadoes, Tsunamis	Mayor, City Council, Emergency Mgmt., Fire Department	5	Short-term	Low cost	Emergency Management Department Budget	2016	No major action completed since 2016 due to lack of capacity and funding. Actions 1-3 remain a priority, with action 1 bolstered to include the SAFE program.
Planning	Conduct a comprehensive City-wide bridge assessment to identify bridges in need of maintenance and repair. Using this plan, prioritize bridges for future repair/replacement.	Inland and Coastal flooding, Earthquakes, High Wind Events (Thunderstorms, Hurricanes, Tornadoes)	Conservation, DPW, Highway Department, Fire Dept, Police Department	5	Long-term	Moderate cost	MassDOT Municipal Small Bridge Program	2024	Next steps include applying for funding for the assessment and identifying a group to complete the study.
Planning	Conduct comprehensive flood assessment to understand areas in City most susceptible to flooding, including future flooding projections.	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, Other Severe Weather, and Coastal Conditions	Conservation Dept., Lakes and Waterways Commission, Emergency Management Department	5	Medium-term	Low-Moderate cost	MVP Action Grant or FEMA FMA Grant	2024	Next steps include scoping the project and identifying potential funding sources for the study.

AMESBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Develop an invasive species monitoring and management plan	Invasive Species, Drought, Extreme Temps, Wildfires/ Brushfires	Conservation Commission	5	Long-term	Low cost	MVP Action Grant, Fish and Wildlife Service Invasives Species Eradication Funding	2024	Next steps include understanding the scope of the plan through conducting an invasive species assessment and understanding locations of concern/need around the City.
Planning/ Structural	Address erosion and promote public accessibility at City Boat Ramp.	Flooding, Riverine Erosion	Harbor Master,	5	Long-term	High cots	Supportive Coastal Infrastructure and Local Maritime Economic Development Planning Grant	2024	Amesbury received $840,000 to improve recreational access and additional waterfront improvements to the Merrimack River. Next steps include developing designs for the project.
Planning	Explore ways to bolster the City shelter system- specifically identify reunification shelter options and fallout shelter options.	Extreme temps, Winter storms, Flooding, Hurricanes, Earthquakes, Tornadoes, Tsunamis	Emergency Management Department,	5	Long-term	Low cost	Emergency Management Performance Grants	2024	Next steps include inventorying the current shelter system to identify gaps in service and short and long-term needs.
Planning	Explore the adoption of regulations and incentives to restrict new development and redevelopment in A and AE zones where there is known to be danger of significant flood damage. Inventory and map vacant land in velocity zones.	Inland and Coastal Flooding, Riverine Erosion, Landslides	Planning Board, Conservation Commission, City Council	4	Long-term	Low cost	Planning Department Budget, FEMA FMA Grant	2016	Amesbury's Wetlands and Floodplain Protection District (Zoning Ordinance Section XII) prohibits development or expansion of structures within A and AE Zones outside of a special permit. Additional provisions are being considered and integrated into amended version which is being developed now.

AMESBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Develop necessary implementing regulations to adopt a ''No Adverse Impact" policy that ensures the actions of one property owner do not adversely impact flooding risk for other properties or imperil public safety.	Flooding, Erosion, Landslides, Brushfires/ Wildfires	Building Commissioner, Conservation	4	Short-term	Low cost	Planning Department, Conservation Department Budget	2016	While Amesbury often operates with this policy, it has not been officially adopted, as part of a bylaw/regulation. Next steps include identifying the appropriate regulations and formally adopting language.
Structural	Complete a dam inspection on all dams within the City. Implement the recommendations of the Dam Inspection and Evaluation Report.	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, Other Severe Weather, and Coastal Conditions	DPW, Lakes and Waterways	4	Medium-term	Moderate cost	Department of Public Works Budget, FEMA National Dam Safety Program	2016	Amesbury is in communication with ODS to determine dam status. Once inspections have been conducted, City can use report to identify needed action.
Planning/ Education	Develop and implement a Volunteer Disaster Assistance Program or Community Emergency Response Team (CERT).	Multi-hazard (Emphasis on major events: Winter Storms, Flooding, Hurricanes, Earthquakes, Wildfires, Tornadoes)	Fire Dept., Emergency Mgmt., Police Dept.	4	Short-term	Low cost	Emergency Management Performance Grants	2016	Due to staff transitions and reduced capacity, no action since 2016. Next steps include identifying department/ point person for effort & creating comprehensive engagement plan.
Planning	Coordinate with the Town of South Hampton, NH on the upkeep, monitoring and maintenance of the Stateline Dam. Explore the need for a Memorandum of Understanding to ensure the ongoing structural integrity of the dam.	Flooding/ Dam Failure	Mayor, Conservation, Lakes & Waterways Commission, DPW	3	Medium-term	Low-Moderate cost	FEMA National Dam Safety Program	2016	No action has been taken since last plan update. Next steps include contacting South Hampton, NH to assess information and current protocols for the Dam.

AMESBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning/ NBS	Maintain and secure land as open space in flood zones. This is one way to keep the number of people and homes vulnerable to severe storms and flooding from expanding. Attention will also be given to conserving land around Lake Gardner to reduce risk to the downstream Lake Gardner High Hazard Dam.	Flooding, Drought, Extreme Temps, Wildfire/ Brushfires, Dam Failure	Conservation, Lakes & Waterways Commission	3	Long-term	High cost	Community Preservation Funds	2016	Amesbury has been able to conserve a number of parcels since 2016, but this remains a top priority for multiple departments. Next steps include continuing to seek funding and available parcels to conserve.
Planning/ Structural	To reduce and/or prevent future property damage and the loss of life and injury, apply for funding for the acquisition and demolition of damaged property due to flooding.	Inland and Coastal Flooding	DPW, Emergency Management	3	Medium-term	High cost	FEMA HMGP	2016	To date, no major acquisitions have occurred due to limited funding. However, Amesbury is actively applying for funding to advance this goal.
Planning	Continue to implement the recommendations of the Wildland Fire Preparedness Plan for the City of Amesbury.	Drought, Wildfire	Fire Department, Conservation Department	2	Long-term	Low cost	EMPG, EMA Budget	2016	Amesbury has been actively working with neighboring communities to implement. However, plan has not been updated since 2016. Next steps include reviewing and updating plan to ensure it remains effective.
Planning	Develop a Forest Management Plan to ensure ecological health	High Winds, Invasive Species, Extreme Temps, Flooding, Drought	Conservation Department	2	Medium-term	Moderate cost	DCR Community Forest Grants	2024	Next steps include initiating project through assessing internal capacity and identifying the scope of the plan.

8.3.2 Town of Boxford Mitigation Action Plan

BOXFORD COMPLETED PROJECTS SINCE 2016								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Structural	Implement Drainage Management System improvements action plan. Projects include: 1) Topsfield Rd. pipe replacement for capacity & headwall (2016); 2) Adams Rd. pipe replacement & headwall repair (2016); 3) Main St./ Bennet Rd. Clean pipe & install headwalls (2016); 4) Kelsey Rd. Replace 15" pipe with 18" culvert (2016); 5) Woodcrest Rd. Replace pipe for capacity, road repair (2016); 6) Main St. by Bayns Hill. Repair headwalls and remove tree (2016); 7) Main St. replace 12" culvert pipe for capacity & repair headwalls (2016); 8) Highland Rd. Repair headwalls (2016); 9) Kimball Rd. /Repair headwalls (2016); 10) King George Rd./Pipe replacements for capacity & headwall repairs (2017); 11) Georgetown Rd. by Stagecoach Rd. Repair submerged pipe (2018); 12) Georgetown Rd. by Ipswich Rd. Replace pipe (2018); 13) Lawrence St. @ Main headwall repair (2019)	Flooding	DPW in-house	Long-term (phased over 5 years)	Moderate ($146k)	Town match/ state or federal grants if available (MassWorks Infrastructure /MassDOT); (FEMA HMGP/ PDM/Flood Hazard Mitigation)	2016 generated through Town's CIP budget planning process	Since the 2016 update, actions 1-9 have been completed. Actions 10-13 were not completed and have been removed from the Mitigation Plan list due to reprioritization and need.
Planning/ Education/ Structural	To mitigate against damage and disruption from high winds, promote to the maximum extent practicable, the use of underground utilities in all new development and redevelopment.	Storms	Planning, DPW, National Grid, private developers	Long-term	Low to High cost based on extent/ area of work	Town (for municipal facilities) and private developers	2008	Subdivision regs modified to require underground utilities in new developments. No progress made with Nation Grid to retrofit existing network due to limited feasibility. This portion of the action was dropped.

BOXFORD COMPLETED PROJECTS SINCE 2016								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Structural	Replace collapsed Middleton Rd. culvert at Crooked Pond stream to reduce flood risk. Project calls for replacing existing 23" diameter corrugated culvert with 6' x 12' concrete box culvert. Project designed to meet 2014 MA Stream Crossing standards and will accommodate 100-year storm	Flooding	DPW in-house	Short-term	High (estimated $382k)	Town match/ Potential FEMA grants—HMGP, PDM, Flood Mitigation	2016	Funding secured and Middleton Road culvert was replaced in 2019.
Planning	Update & implement Stormwater Management Plan for compliance with NPDES MS4 permit	Flooding/ Storms	Boxford DPW/ Conservation Commission	Medium-term	Low cost	Town Budget (Conservation and DPW)	2008	MS4 requirements complete, including: infrastructure inventory mapping, development of Stormwater Management Plan and IDDE, updated Stormwater Bylaw (in compliance with NPDES program) adopted. Town is continuing to conduct required monitoring and working to update Stormwater Bylaw to better reflect requirements.

BOXFORD DROPPED PROJECTS FROM 2016 Plan (not completed and not advancing to 2024 Plan)								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Acquire/protect dams at Four Mile Pond & Lowes Pond	Flooding	Conservation Commission/ Lakes, Ponds & Streams Committee	Long-term	Moderate to High cost	Community Preservation Act funds; DCS Self Help Program grants	2008	Action is not currently possible. The Four Mile Pond Dam was acquired by a group of pond abutters- no likelihood of Town acquiring dam. Lowe Pond Dam is owned by a private homeowner, not interested in Town ownership.

BOXFORD CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning/ Structural	Replace culverts across Town that are contributing to localized flooding, and preventing normal hydrological flow: Herrick Road, Georgetown Road, Pye Brook Lane, Glendale Road, Ipswich Road	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, Other Severe Weather, and Coastal Conditions	DPW and contractors	8	Long-term	High	MVP Action Grants and ARPA funding and local funds (Chapter 90 and borrowing)	2024	Culverts in Pye Brook watershed were studied and designs were created for new culverts. Designs have been approved and permitted through local Conservation Commission and DEP. Next steps: secure funding and prioritizing the replacement of the culverts.
Planning	Create inter-departmental GIS MIMAP database and mapping of municipal facilities and resources to enhance emergency operations and incident management.	All hazards (Including: Earthquakes, Tornadoes, Wildfires, Landslides and Storm Events)	Planning/ Conservation, DPW, Assessors, Emergency Management team, MVPC	7	Long-term	Moderate	MVPC Local Technical Assistance, MS4 Municipal Assistance Grant	2008	Continue to utilize and update the Town's online stormwater data viewer. In 2019 the Town partnered with the MVPC to create an online drainage data management editor and viewer in order to make updates to the system as they are realized. Additionally, all drainage repairs as well as annual catch basin cleaning is monitored and documented through the online app.
Planning/ Structural	Analyze existing flooding problem areas and design/implement appropriate corrective measures for dams and bridges. Priorities areas include: Depot Rd./ Bare Hill Rd. by Four Mile Pond (2008); Lowe Pond Dams (2016); Endicott Bridge (2023)	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, Earthquakes, and Coastal Conditions	Boxford Public Works	6	Long-term	High Cost	MassDOT Municipal Small Bridge Program, EEA Dam and Seawall Repair Program Grants	2008	Boxford collaborated with the Town of Topsfield to advance the design of Endicott Bridge reconstruction. This will be utilized for ch. 85 bridge review and local permitting of the work. Expected to be filed in 2024 and approved in 2025. Boxford will pursue funding through the state's "small bridge" program.
Planning	Develop a Tree Maintenance and Vegetation Plan for the Town	Drought, Flooding, Extreme Temps, Severe Weather, Wildfires, Invasive Species	DPW and Planning Department	5 (scored at 9, but adjusted by LHMPT)	Medium-term	Moderate cost	DPW and Planning Department Budget	2024	Town will use information gathered at the Massachusetts Certified Tree Warden's conference in 2023 to advance this initiative in 2024 to be adopted in 2025.

BOXFORD CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Amend local subdivision rules and regulations to require the maximum practicable use of low impact development techniques in all new development and redevelopment. Next steps include clarifying implementation of zoning bylaw driveway construction standards and applicability of stormwater runoff requirements.	Flooding, Drought, Wildfire, Landslides	Boxford Planning Board	5	Short-term	Low cost	MVPC District Local Technical Assistance, MS4 Municipal Assistance Grant	2008	Amendments were made to wetland protection bylaw to promote LID. Further, the Town will be working towards creating and adopting town wide standards for construction to promote proper design of stormwater BMPs including LID techniques.
Planning	Incorporate hazard mitigation in local policies, plans and programs (e.g. Capital Improvement Program, Master Plan, Open Space and Recreation Plan, Stormwater Management Plan)	All Hazards	Town Departments	4	Medium-term	Low cost	Planning Department and Conservation Commission Budgets, MVPC District Local Technical Assistance	2008	Town has integrated main themes and recommendations from HMP planning effort into relevant community plans. Efforts will continue to be made to further integrate content as applicable (e.g. MVP 2.0, and OSRP update).

Local Hazards: Boxford has identified that their community is not impacted by Coastal Flooding, Coastal Erosion, or Tsunamis.

8.3.3 Town of Groveland Mitigation Action Plan

GROVELAND COMPLETED PROJECTS SINCE 2016								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Upgrade emergency dispatch center as capacity modernization project.	All Hazards	Public Safety Departments	Short-term	Medium cost	Local & FEMA grants-HMGP	2016	Upgrades were made to the Emergency Dispatch Center in 2016. These include: Consol update, CAD system upgrade, and software updates.
Planning	Develop and implement stormwater management program and maintenance plan to ensure compliance with MS4 permit, including inspection, cleaning and maintenance of stormwater facilities	Flooding	Town Departments with Town Highway Dept. lead	Long-term	Medium cost	Town with resource assistance of MVPC, MS4 Municipal Assistance Grant	2008	Groveland has completed requirements associated with current MS4, including: infrastructure inventory mapping, development of a Stormwater Management Plan and IDDE. The Town's Stormwater Bylaw was adopted in compliance with NPDES program. The Town is continuing to conduct monitoring and maintenance as required by permit.
Planning	As opportunities arise, acquire & protect private undeveloped open space in flood hazard areas. Priority areas targeted are Johnson's Pond area, Center Street Greenway including Zone 2 Public Water Supply Protection Area Parcels.	Multi-Hazard	Conservation Commission, CPA Committee	Long-term	High cost	Town with grant assistance from state DCS, Mass. Land & Water Conservation Fund, Essex County Greenbelt Association	2008	Major conservation efforts lead to protection of 8 parcels since 2016, totaling 44 acres of land. Town will remain open to addition conservation/ preservation opportunities as they arise.
Planning	To reduce public risks from all natural hazards, update Town web page for hazard preparedness, mitigation and response Next steps/gaps include establishing alert system for distribution of info/resident notification	All Hazards	Emergency Management Director	Medium-term	Low cost	Town with advice from MEMA, DCR and MVPC	2008	Emergency Management section developed on Groveland Police department Website. Additional information can continue to be added specific to natural hazard preparedness

GROVELAND DROPPED PROJECTS FROM 2016 Plan (not completed and not advancing to 2024 Plan)								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Develop and implement DCR Fire Wise Program in heavily forested areas and neighborhoods	Brushfires	Fire Department	Long-term	Medium cost	Dept. of Conservation and Recreation	2008	Since the 2016 update, DCR has added staff to Essex County to respond to wildfire/brush fires. Due to bolstered capacity, Groveland does not need to upkeep Fire Wise Program.

GROVELAND CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning/ Structural	Complete design, permitting and construct improvements to the Johnson's Creek Dam. Next steps include design & cost estimate development	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	Town Highway Dept	9 (scored at 8, but adjusted by LHMPT)	Medium-term	High cost	EEA Dam and Seawall Repair Program Grant, EOED Massworks Grant	2016	Since 2016, a survey and design (50%) has been conducted. Groveland is actively working to get the project listed in the TIP and secure funding.
Structural	Prioritize drainage system improvements needs; seek outside funding for engineering studies, design, and construction	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	Town Highway Dept	8	Medium-term	Medium cost	MVPC Technical Assistance, MS4 Municipal Assistance Grant, DER Culvert Replacement Municipal Assistance Grant	2008	Mapping of drainage system infrastructure is ongoing, with the intent to initiate information into MIMAP. Next steps include prioritizing drainage projects and identifying funding to begin structural improvements.
Planning/ Structural	Construct storm system improvements including outfall capacity replacement at Main/School Street	Inland Flooding, Storm Events, Erosion	Town Highway Dept	8	Short-term	Moderate cost (cost for Main/ School St. project est. at $150k)	FEMA HMGP, FMA, PDM; DER Culvert Replacement Municipal Assistance Grant	2016	No action has occurred, and conditions of outfalls continue to worsen. Next steps include continuing to engage the Army Corps of Engineers.

GROVELAND CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timefra me**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Education	Address stormwater management challenges through expanded education and outreach	Flooding from precipitation events, winter storms, hurricane/ tropical storms, and other severe weather	Planning Board/ Conservation Commission	7	Short-term	Low cost	MS4 Municipal Assistance Grant	2024	Next steps include identifying key audiences within Town to conduct outreach to, and exploring groups/programs (such as Greenscapes) that can bolster Groveland's capacity.
Planning	Conduct invasive species assessment to identify locations of vulnerability and create a plan to manage ecosystem health	Invasive Species, Extreme Temps, Drought, Wildfires, Flooding	Conservation Commission	7	Medium-term	Low cost	Mass-Wildlife Habitat Mgmt. Grant Program	2024	Next steps: find funding and staff capacity to conduct assessment. Some aspect of invasive assessment (trees) will be done as part of Tree Assessment currently underway.
Structural	Install generator at Bagnall School shelter critical facility	Winter Storms, Hurricanes, Earthquake, Tornados, Extreme Temps,	Emergency Management Director	6	Short-term	Moderate cost (estimate d cost of $100k)	Local match & FEMA Hazard Mitigation (HMGP)	2016	Bagnall School currently has one generator. A second generator is needed. This project still remains a high priority. Next steps include finding funding to purchase and install second generator.
Planning	Perform town-wide tree assessment. Establish pruning cycle to remove hazardous trees and perform utility line clearance.	Winter Storms, High Winds, Hurricanes, Wildfires	Highway Department, Municipal Light Department	6 (scored at 9, but adjusted by LHMPT)	Medium-term	Moderate	DCR Urban and Community Forestry Challenge Grant	2024	Tree inventory and hazard assessment are underway. Line clearance currently happening.
Planning	Bolster Stormwater Management Systems	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	Planning Board/Highwa y Department	6	Short-term	Low cost	MVPC District Local Technical Funds, MS4 Municipal Assistance Grant	2024	Following completed mapping work, add stormwater information into MIMAP. Once within system, info can be easily accessed and used for more regular maintenance & monitoring.
Structural	Improve stormwater infrastructure	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	Highway Department	6	Long-term	High cost	DER Culvert Replacement Municipal Assistance Grant Program, MVP Act Grant	2024	Continue to upgrade outdated/undersized culverts across Groveland.

GROVELAND CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timefra me**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Identify non-compliant structures in the community; work with elected officials, MEMA and FEMA to correct non-compliance issues and prevent future noncompliance through ongoing communication, training & education.	Multi-Hazard (Emphasis on extreme events that require evacuation: Earthquake, Tornadoes, Wildfires)	Building Dept/ Emergency Mgmt.	5	Short-term	Low cost	Municipal Americans with Disabilities Act (ADA) Improvement Grant	2008	Non-compliant structures in Groveland have been identified. A number of ADH and Life Safety updates have been made. Groveland will continue to make updates as funding is available.
Planning	Incorporate hazard mitigation in local policies, plans and programs (e.g. Capital improvement Program, Master Plan, Open Space & Recreation Plan, Stormwater Management Plan)	All Hazards	Board of Selectmen/ Planning Board/ Conservation Commission/ Highway Department	5	Long-term (ongoing)	Low cost	Planning Department, Conservation Department and Highway Department Budgets	2008	HMP has been integrated into community plans which have been updated since 2016. These include: Stormwater Plan/MS4, OSRP, and Capital Improvement Plan. HMP will continue to be integrated as plan updates occur
Planning	Update local Subdivision Rules & Regulations to require the maximum practicable use of Low Impact Development techniques in all new development and redevelopment	Flooding, Erosion, Landslides, Drought, Wildfire	Planning Board	5	Medium-term	Low cost	MS4 Municipal Assistance Grant	2008	With assistance from MVPC, Town conducted a full review of the Subdivision Rules and Regulations. No changes have been made to date. Town is considering what elements to include as part of an update (e.g. LID alternatives analysis).
Planning	Upgrade/obtain emergency response equipment including an all-terrain vehicle for rail trail areas and a drone for monitoring	Multi-Hazard (Emphasis on Flooding, Wildfires, Landslides, Earthquakes)	Police Department/ Fire Department	4	Short-term	High cost	FEMA Preparedness Grant Program	2024	Application denied by DCR, Town is seeking funding to purchase equipment/ resources.

Local Hazards: Groveland has identified that their community is not impacted by Coastal Flooding, Coastal Erosion, or Tsunamis.

8.3.4 City of Haverhill Mitigation Action Plan

HAVERHILL COMPLETED PROJECTS SINCE 2016								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Enact Updates to Water Supply District Zoning for compliance with new requirements of 310 CMR 22. Updates include expanding list of prohibited land uses within Zone A.	All Hazards	City Council / Conservation/ DPW Water	Short-term	Low Cost	City/MVPC/ MassDEP technical assistance	2016	City Council approved the updated Water Supply District Zoning Ordinance.
Planning	Adopt Stormwater Management Ordinance	Flooding	City Council/ Conservation/DPW Wastewater	Short-term	Low Cost	City Budget (Conservation Dept. and DPW)	2016	City Council adopted Stormwater Management Ordinance in 2018.
Structural	Recertification of Downtown Flood Protection system installed in 1930s including: 1) Repairs and 2.5' addition to floodwall; 2) Repairs and cleaning of Little River conduit; and 3) Pump Station improvements including spare pumps purchase	Flooding	DPW, City Engineer	Short-term	High Cost ($5.4 million)	City Funded through State Revolving Loan Fund	2008	Project completed in 2016. Repairs were made to the floodwall, as well as repairs and cleaning of the Little River Conduit, and pump station improvements were made.
Planning	Amend local zoning to allow and promote the use of Open Space Residential Design as a tool to minimize impervious surfaces, maximize open space preservation and reduce stormwater runoff	All Hazards	City Council, in consultation with Planning Board and Conservation Commission	Short-term	Low Cost	Zoning Review Committee/ Haverhill Planning & Community Development Dept.	2008	Haverhill completed and adopted major revisions of their Zoning bylaw in 2020, addressing topics relating to OSRD, Smart Growth overlay districts, Floodplain overlay districts, water supply protection districts, and water front districts.

HAVERHILL CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning/ Structural	Separate combined sewer infrastructure in several locations across the City (Riverside area and Locke Street area) to address CSOs and explore ways to decrease stormwater run-off through increased stormwater retention or increased drain capacity.	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	DPW, City Engineer	8	Long-term	High Cost ($40 million)	FEMA BRIC grant, SRF Loans, Sewer Rates	2024	The City is just initiating the planning phase for the Riverside area, and currently in construction phase 1 and design of phase 2 for the Locke Street area.
Structural	Work cooperatively with MassDOT Highway to rehabilitate the Route 125 Basiliere Bridge (Note: 2 other formerly Structurally Deficient bridge—Rocks Village & Bates Bridge were rehabbed/ replaced in 2013 & 2011)	All Hazards (Including Earthquakes, Flooding, and Severe Storms)	MassDOT Highway, City, Merrimack Valley MPO	8 (scored at 3, but adjusted by LHMPT)	Long-term	High Cost	MassDOT Funding/ Metropolitan Planning Organization funds. Work slated for 2025	2008	Basiliere Bridge currently in design phase. Project programmed on MPO Transportation Improvement Program and funding secured. Construction anticipated to start in fall of 2025.
Planning	Work with DCR Office of Dam Safety and dam owners to ensure timely dam inspections and maintenance, with special attention to Millvale Reservoir Dam, Crystal Lake Dam, Lake Pentucket Dam, Frye Pond Dam, and Little River Dam	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	DCR Office of Dam Safety, City Engineer, dam owners	8	Short-term	Low-Medium Cost	Dam Owners, DCR Office of Dam Safety; FEMA National Dam Safety Program	2008	Many dams of concern (Crystal Lake Dam, Lake Pentucket Dam, and Frye Pond Dam) have been addressed. Design for removal and river restoration at Little River Dam (funding from EEA) is currently ongoing. Annual inspections of all dams are ongoing.
Structural	Upgrade the wastewater treatment plant to increase wet weather treatment capacity and address CSO's.	Flooding from Precipitation Events, Winter Storms, Hurricane / Tropical Storms, and Other Severe Weather	Wastewater Department	8	Long-term	High Cost	SRF low-interest loan (ARPA funding 60% of design) & Wastewater user rates	2023	The City is just starting preliminary design.
Structural	Small bridge repairs/replacement at Rosemont Street (replace), North Forest Street (repair), West Lowell Street (repair)	Multi-Hazard (Including Earthquakes, Flooding, and Severe Storms)	DPW, City Engineer	6	Medium-term	High Cost	Municipal Small Bridge Program), ARPA funding	2024	The City is working to advance projects as funding enables. Rosemont Street recently received ARPA funding and is beginning design.

HAVERHILL CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Update Local Subdivision Rules and Regulations regarding stormwater management and Low Impact Development (LID).	Flooding, Erosion, Landslides, Drought, Wildfires	City Planning Board	6	Medium-term	Low Cost	MS4 Municipal Assistance Grant, Planning Conservation Dept Budgets	2008	City's MS4 needs updating to maintain compliance with EPA's requirements. Local Subdivision Rules and Regs need to be updated to reference design requirements.
Planning	Complete assessment of the Millvale Reservoir Dam to explore options for dam replacement/repair. Consider options to increase resilience of the dam and reduce climate vulnerability.	Dam Failure, Flooding	DCR Office of Dam Safety, City Engineer, Conservation Dept.	6	Long-term	Moderate Cost	Massachusetts Dam and Seawall Grant	2024	The City has listed the Millvale Dam on their 5-year Capital Improvement Plan to replace/repair. Annual inspections of the dam is ongoing.
Planning/ Infrastructure	Install emergency generators across the City, including: The Citizen Center, Schools, and other key locations.	Multi-Hazard (Emphasis on: Winter Storms, Hurricanes, Earthquakes, Tornadoes)	Human Services/ Community Development	5	Short-term	Moderate Cost	Community Development Block Grants, FEMA HMGP or PDM grants	2024	City is using CDBG and other funds to install emergency generators at City Hall, shelters, food pantries and other social safety net facilities. Funding is still needed to build resiliency at other locations.
Education	Conduct outreach and education to residents about local invasive plant species to bolster awareness of presence and actions to mitigate and manage	Invasive Species, Extreme Heat, Wildfires	Conservation Department	5	Medium-term	Low Cost	Conservation Department Budget, MVP Action Grant	2024	This is a new action for the City. First steps include initial planning to identify target invasive species and outreach approach
Planning	Incorporate hazard mitigation in local plans and initiatives (e.g. Capital Improvement Program, Master Plan, Open Space & Recreation Plan)	All Hazards	City Departments	5 (scored at 9, but adjusted by LHMPT)	Long-term	Low-Medium Cost	Planning Department, Conservation Department Budget	2008	Conservation Office is currently coordinating updates to the Open Space & Recreation Plan that expired in 2023.
Structural	Bank repair/stabilization at Kenoza Lake. Silting from erosion exacerbated by rain events jeopardizes City's water supply	Flooding, Riverine Erosion	City DPW	4	Medium-term	High Prelim construction cost estimate $350k	Mass. Land & Water Conservation Fund, DCS Mass. Energy & Environmental Affairs Drinking Water Supply Program; FEMA HMGP	2016	This project has been included on the Capital Improvement Plan and expected to be initiated in the next two years.

HAVERHILL CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Structural	Expand stream flow/ drainage system capacity at North Avenue bridge/dam on Snow's Brook	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather, Earthquakes	City DPW/ Engineering/ MassDOT/ Merrimack Valley MPO	4	Medium-Long term	High Cost (prelim design phase est.$1.6 million)	Funding Authorized by City Council, MassDOT funding, Federal Highway Administration funding	2016	Project is still currently in design phase by City/MassDOT/70%. The plan is to remove the dam and restore full stream flow.
Planning	Explore additional water supply options, such as the Merrimack River	Drought	Water Department	4	Medium-Long term	High cost	State Revolving Funds	2024	Design and permitting are currently ongoing with construction set to begin in 2025.
Structural	Remove dilapidated Brandy Brow Road bridge over East Meadow River and restore natural streambank	Flooding, Drought, Riverine Erosion, Earthquakes	DPW, Conservation Department	4	Short to Medium-term	Moderate Cost	Culvert Replacement Municipal Assistance Grant Program	2024	Design completion anticipated June 2024
Structural	Assess and upgrade Route 108 culvert system to restore natural stream flow patterns and eliminate flooding on Route 110	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	Conservation Commission, DPW	4	Short to Medium-term	High Cost	Culvert Replacement Municipal Assistance Grant Program	2024	Municipal stakeholders discussed concerns and have pursued project funding in recent years.
Planning/ Human Services	Develop a comprehensive strategy for sheltering in the City.	All Hazards (emphasis on: Extreme Temps And Major Storm Events)	Planning Department, Emergency Management Departments	3	Short-term	Low cost	Planning Department and Emergency Management Department Budgets	2024	Group has met that includes various social agencies from the City as well as City councilors. Beginning planning stages.

Local Hazards: Haverhill has identified that their community is not impacted by Coastal Flooding or Tsunamis.

8.3.5 City of Lawrence Mitigation Action Plan

LAWRENCE COMPLETED PROJECTS SINCE 2016								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning/ Structural	Develop a proactive program to analyze existing sewer backup locations and causes, and to design and implement appropriate corrective measures, rather than reacting to each incident after it occurs	Flooding	Lawrence Public Works and Engineering Depts.	Short-term	Medium cost	DEP State Revolving Funds	2008	IDDE program has been fully implemented
Planning	Consistent with phase II Program requirements, develop and implement drainage system maintenance plan to ensure regular inspection, cleaning and maintenance of municipal stormwater facilities and waterways	Flooding	Lawrence Public Works Dept., Conservation Commission	Long-term	Medium cost	City budget (Conservation and DPW) /MV Stormwater Collaborative	2008	Maintained annual compliance with the new MS4 permit, including IDDE plan and SWMP plan. Ongoing maintenance will continue until new permit is issued
Planning/ Education	Develop and implement timely warning system (local access cable TV and/or radio) to alert public about pending floods and other hazard emergencies	All Hazards	City Departments	Short-term	Low	City Budget (Emergency Mgmt. Dept)	2008	CodeRed Emergency Alert System in Place. Link to signup is on City Website
Planning	Create interdepartmental GIS database and mapping of municipal facilities and resources to enhance emergency operations and incident management	All Hazards	City Departments	Long-term	Medium cost	City, with technical assistance from MVPC (Community Compact Grant)	2008	MIMAP provides comprehensive database in which to map and capture data for the City. Maintenance and use are ongoing, with new upgrades and additions rolled out periodically.
Structural	Construct and/or reposition existing pumps along the Shawsheen River basin to improve flow and prevent failure during flooding events.	Flooding	DPW, Private Contractor	Short-term	Medium-High cost	FEMA HMGP	2016	Project completed in 2018

LAWRENCE COMPLETED PROJECTS SINCE 2016								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Structural	Upgrade capacity & reliability of sewer lifts stations with generators and pumps. Highest priorities are lift stations at Pembroke Drive and Pilgrim Road.	Flooding	DPW, Private Contractor	Medium-term	High cost ($1 million per lift station)	DEP State Revolving Funds	2016	Generators have been installed at Pembroke Drive and Pilgrim Road Pump Stations
Education	To reduce public risks from all natural hazards, establish and maintain City web page describing safety "tips and techniques" for hazard preparedness, mitigation, and response, with direct links to the MEMA and FEMA hazard mitigation websites.	All Hazards	Emergency Management Director	Long-term	Low cost	City Budget Emergency Mgmt Dept.	2008	Since last update, City has begun using social media to share information with community and conducts targeted outreach at the Senior Center and other locations around emergency preparedness. Links are also included on City website.
Planning	Participate in EPA's "Geographic Response Program" to protect river resources by developing plan response protocols	Flooding/ Storms	City of Lawrence Planning, Emergency Management, EPA & DEP	Long-term	Low cost	City of Lawrence & EPA	2016	Lawrence is currently participating in regional program

LAWRENCE DROPPED PROJECTS FROM 2016 Plan (not completed and not advancing to 2024 Plan)								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Structural	Replace for operational capacity 20+ year old generator at Lawrence Police Station (critical facility)	All Hazards	Police Dept./Building Dept.	Medium-term	Moderate (Order of cost est. is $100k)	City of Lawrence, FEMA HMGP	2016	Not completed. City is planning to build a new Police Station which will have generators integrated into design of new site.

LAWRENCE CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Incorporate hazard mitigation in local policies, plans, and programs (e.g. Capital Improvement Program, Master Plan, Open Space &Recreation Plan, Phase II Stormwater Mgmt. Plan	All Hazards	Planning Dept., Community Dev. Dept., Cons. Comm.	9	Medium-term	Low-Medium cost	Planning Dept., Community Development Dept. and Conservation Dept. Budgets	2008	Open Space Plan was updated and approved in 2019. No action has been taken on updating the City's Master Plan
Planning	Strictly enforce and, as appropriate, upgrade City zoning bylaw, subdivision rules & regulations, and wetlands regulation to minimize incidence and impacts of flooding and other natural hazards	All Hazards (Emphasis on: Flooding, Landsides, Erosion, Drought)	Planning Department, ZBA, Planning Board	8	Medium-term	Medium cost	Planning Dept. and Conservation Dept. Budgets	2008	Land Use Regulations were passed in 2018. Stormwater Ordinance was revised and is still awaiting adoption
Planning	Explore green energy options for Lawrence, including electric car parking stations	Extreme Temps, Climate Impacts	Planning Department	8	Long-term	Medium Cost	DOER Green Communities Grant Program	2024	The City has recently completed 5 projects around Lawrence. Next steps include continue to advance projects as funding allows.
Planning/ NBS	Bolster municipal capacity through partnering with Groundwork Lawrence to integrate invasive species management into general maintenance such as landscaping across the City.	Invasive Species, Extreme Temps, Drought	Dept. of Public Works, Dept. of Recreation, Groundwork Lawrence, ConCom	8	Medium-term	Medium Cost	DPW and Dept of Recreation Budgets, DCR Grant	2024	The city has been working with GWL to identify management plans for invasive species (including non-native tree species that may bring benefits, and others that should be managed and removed). This work will continue to improve municipal capacity in Lawrence.
Planning	Establish and adopt the MBTA overlay district promoting smart and cluster development	Flooding, Drought, Wildfires	Planning Department	7	Short-term	Low cost	Housing Choice Grant	2024	The project has just recently been initiated. Work will begin to select a consultant and initiative planning and work over the next few months.
Structural	Replace and reconfigure Daisy Street Bridge to eliminate stream flow bottleneck and minimize area flooding hazard	Flooding, Riverine Erosion	City DPW/MVMPO/ Community Development	7	Long-term	High cost	MassDOT TIP program	2016	No action- project has not yet been funded on the TIP. Still waiting for funding for project.

LAWRENCE CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Structural	Analyze existing flooding problem areas and design/ implement appropriate corrective measures, such as re-directing floodwaters to uninhabited areas or wetlands	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	Lawrence Public Works and engineering Depts.	7	Long-term	Medium cost	MVP Action Grant, EPA Urban Waters Program	2008	Stormwater Asset Management Plan established in 2023. Flooding has been improved by upstream impervious surface removal and dam removal. Flooding along the Merrimack and its tributaries remains a concern. Next steps include integrated green infrastructure along Spicket and Shawsheen Rivers.
Planning	Explore feasibility of developing and implementing DCR Fire Wise Program in Den Rock Park	Wildfires/ Brushfire, Landslide	Lawrence Fire Dept.	7	Long-term	Low-Medium cost	DCR Forest Fire Control Program	2008	No activity to date. Next step set up coordination/ consultation meeting with DCR
Planning/ Structural	Relocate DPW to new site outside of floodplain	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	Planning Department, DPW	7	Long-term	Moderate	Mass Development Funding	2024	Location scouting currently underway. Potential site has been identified: existing brownfields site. Remediation is currently underway.
Planning	Continue to address CSO events through small (e.g. green infrastructure) and larger (e.g. infrastructure) projects	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	DPW, Water Commission, Conservation Department	7	Long-term	High	MVP Action Grants, 319 grants, Federal Infrastructure Funding	2024	The City has worked to update policy (e.g. stormwater management bylaw) and development guidelines. Next steps include working to advance on the ground projects.
Planning	Development of a Master Plan	All Hazards	Planning Department, Conservation Department	6	Medium-term	Moderate	Housing and Livable Communities Funding	2024	Lawrence does not currently have an updated Master Plan. Next steps include finding funding to support the planning effort and engaging a consultant to help write the plan.

LAWRENCE CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Amend local subdivision rules & regulations to require the maximum practicable use of low impact development (LID) techniques in all new development and redevelopment	Drought, Flooding, Extreme Temps, Wildfires/ Brushfires, Severe Weather	Lawrence Planning Board	6	Short-term	Low cost	MS4 Municipal Assistance Grant	2008	Local subdivision rules and regulations were not amended. Other relevant actions City has completed involve new DEP approved standards for total suspended solids and total phosphorous during new/redevelopment activities to monitor erosion/stormwater runoff.
Structural	To mitigate against damage and disruption by high winds, promote to the maximum extent practicable the use of underground utilities in all new development and redevelopment	High Winds/Thunder storms, Hurricanes, Earthquakes, Tornadoes	Town Departments and Private Developers	6	Long-term	Moderate-High cost	Private Developers, DOER Massworks Grant	2008	Corridor improvements are ongoing. Since last update, all telephone and electric lines have been moved underground along Merrimac Street. Work will continue along additional corridors and new/re-development projects (e.g. Arlington Street)
Structural	Install new generators at Police Station and New Schools (Leahy and Oliver)	Flooding, Extreme Temps, Winter Storms, Hurricanes/ Tropical storms, Earthquakes, Tornadoes	School Department, Planning Department	6	Long-term	Moderate cost	FEMA Hazard Mitigation Grants	2024	Schools are currently being constructed. Next steps include finding funding, purchasing and installing generators.
Planning	Explore conducting an assessment of the Stevens Pond Dam to consider options for dam removal/ rehabilitation. As part of the process, consider options that would increase resilience of the dam and reduce vulnerability to future climate impacts.	Dam Failure, Flooding	Water Commissioner, Conservation Dept/ConCom	6	Medium-term	Moderate Cost	Mass DER Preliminary Design Grant	2024	The city is looking to meet with Merrimack River Watershed Council and the Merrimack Valley Planning Commission to explore grants to support assessment of the dam.

LAWRENCE CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning/ Structural	Expand water treatment facility to provide more potable water during low water conditions.	Drought	DPW	4	Short-term	High Cost (estimated at $5.5 million)	Hazard Mitigation Grant, ARPA Funding	2024	The City plans to remodel their raw water intake. This will include moving the intake to the middle of the river to address lower water levels due to draught or repairs on the canals. It will also include new pumps and upgrades to the building structure.
Planning	Assess feasibility of restoring old reservoirs for increased potable water supply	Drought	Water Department and DPW	4	Long-term	Moderate	ARPA Funding	2024	Engineering study needed to test the durability of the City reservoir (Tower Hill)
Planning	Reduce repetitive flood losses by acquiring property in high risk, recurrent flood districts through incentive programs and tax taking. Multi-benefit through increasing open space.	Flooding, Extreme Heat, Drought, Wildfire/ Brushfire	City of Lawrence	4	Long-term	High cost	FEMA FMA, PDM, HMGP; Mass. Land & Water Conservation Fund	2008	Actively working on the Spicket River Watershed Based Plan. Next step is to finalize plan, and implement actions outlined.
Structural	Reconstruct/replace structurally deficient Amesbury Street Bridge over South Canal	Flooding, Erosion, Earthquakes	MassDOT Highway/City/ Merrimack Valley MPO	4	Long-term	High cost	Mass-Highway Bridge Program /MVMPO	2016	No action- project has not yet been funded on the TIP. Still waiting for funding for project.

Local Hazards: Lawrence has identified that their community is not impacted by Coastal Flooding or Tsunamis.

8.3.6 City of Methuen Mitigation Action Plan

METHUEN COMPLETED PROJECTS SINCE 2016								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Adopt "Steep Slope" regulation to prohibit or strictly regulate development on steep slopes in order to reduce stormwater runoff and erosion	All Hazards	City Council, in consultation and cooperation with Planning Board and Conservation Commission	Short-term	Low cost	City Budget (Conservation and Planning Dept.)	2008	Steep Slope regulation integrated as part of update to Stormwater Regulations in 2020
Structural	Upgrade Central Fire Station for space and communications capacity	All Hazards	Fire Department	Medium-term	High cost	City/State Public Safety grants	2016	Central Fire Station upgrades completed in 2023
Planning	Develop plan program of upgrading/ replacing City emergency vehicle fleeting including fire pumper, ladder truck, ambulances.	All Hazards	Fire Department	Medium-term	High cost ($6.5+ million over 6 years)	City/State Public Safety grants	2016	City's emergency vehicle fleet has been fully replaced as of 2022
Education	Develop & implementation citywide emergency notification system (Code Red or Reverse 911)	All Hazards	Police/Fire Emergency Management	Short-term	Low cost	City/ State Public Safety	2016	Citywide public notification system established and implemented in 2021

METHUEN CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning/ Structural	Design and construct new DPW Maintenance Facility, which is currently located within the 100-year floodplain	Flooding from Precipitation Events, Winter Storms, and Hurricane/ Tropical Storms	DPW, DECD, Finance	10	Long-term	High cost ($6.5+ million over 6 years)	ARPA, Brownfields Revolving Loan Program, Capital Bond	2024	Project is in site assessment, planning phase.

METHUEN CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning/ Structural	Design and construct public safety building to replace outdated Central Fire Station (1899) & Quinn Building Police Station (1959)	All Hazards (Emphasis on Wildfires and Major Emergency Response Events)	Police, Fire, Finance	10	Long-term	High cost $(6.5+ million over 6 years)	Capital Bond, Public Safety Grants	2024	Next steps include final siting decision, financing plan and design/ permitting
Structural	Update HVAC systems at municipal facilities including Methuen Housing Authority buildings that serves vulnerable populations	Extreme Temps	MHA, DECD	10	Medium-term	High Cost	Capital Bond, EOHLC Community Development Block Grant	2024	Define Scope and Prioritize Facilities for upgrades
Structural	Separate combined system sewer/drain line in Arlington District	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	DPW	10	Medium-term	High cost ($6.5+ million over 6 years)	ARPA, Sewer Overflow and Stormwater Reuse Municipal Grants	2024	Project in preliminary design/engineering. Project coordination on implementation with City of Lawrence. First phase construction to be complete by 2027.
Planning/ Structural	Prepare Methuen Water System Master Plan to prioritize distribution system upgrades and improvements at the Water Treatment Plant which began operation in 1984.	Extreme Heat, Drought, Flooding	DPW	10	Short-term	Low cost	Capital Plan, BIL funding for WQ improvement	2024	Procure technical engineering consultant
Planning/ Structural	Increase power redundancy for municipal facilities through installing back-up generators, including at the Raw Water Intake Station, water and sewer pump stations, Central Administration Building @ 10 Ditson Place, and Methuen School Dept. Admin Offices & Preschool @ 9 Branch St.	Multi-hazard (Emphasis on: High winds, Winter storms, Tornadoes, Hurricanes, Earthquakes	DPW	10	Medium-term	High Cost	ARPA, Capital Bond, FEMA Preparedness Grants	2024	Design completion and construction procurement in 2024 for Burnham Road sewer station upgrade including backup power generation for pump station and Raw Water Intake pump.
Structural	Route 213/North Broadway Area Water Main Project - Providing looped water distribution system for resilience in event of water main breaks in neighborhoods off Broadway north of Route 213.	Extreme Temps, Earthquakes, Flooding, Drought	DPW	10	Short-term	Medium Cost ($3.75 million)	ARPA Funds	2024	Project is in design engineering. Next steps after completion of final design are preparation of construction bid package.

METHUEN CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Formalize Emergency Management Plan	All Hazards	Emergency Management	10	Short-term	Low cost	Emergency Management Department Budget	2024	In process of updated Comprehensive Emergency Management Plan- expected completion in 2024. As part of this update, a formalized energy management plan will be addressed
Structural	Rehabilitate Granite St. Water Pumping Station to provide interconnection between Methuen and Lawrence water systems	Extreme Temps, Earthquakes, Flooding, Drought	DPW	10	Short-term	High ($6.2 million)	ARPA Funds	2024	Project is in design engineering. Project is a resilience measure providing water source emergency backup thru interconnection between Methuen and Lawrence water distribution systems. Currently in design. Next steps: complete design and prepare construction package for construction by end of 2026.
Planning/ Structural	Replace failing/undersized culverts at locations including Brook St.; Pelham St. at Harris; Woodburn Dr.; and Drew St. (off Old Ferry Rd)	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	DPW/ Conservation	10	Medium-term	Medium Cost	Capital Bond, DER Culvert Replacement Municipal Assistance Grant	2024	Locations identified as priorities. Next step is design/permitting
Planning	Develop Municipal Decarbonization/ Energy Transition Plan	Extreme Heat, Climate Resiliency	DECD	9	Medium-term	Low cost	Green Community Grant Program	2024	Greenhouse gas inventory completed 2022. Next step: procure technical consultant and secure financing for plan.
Land Acquisition /Planning-Design	Advance design plans and undertake land acquisitions for implementing Merrimack Riverfront Corridor Master Plan Concept (2019)	Flooding, Riverine Erosion	DECD	9	Long-term	High Cost	Capital Bond; Land & Water Conservation Fund	2024	Master Plan concept design completed 2019
Planning	Amend local Subdivision Rules and Regulations to require the maximum practicable use of Low Impact Development (LID) techniques in all new development and redevelopment projects	Extreme Temps, Flooding, Drought	City Community Development Board/staff	8	Short-term	Low cost	MS4 Municipal Assistance Grants	2008	Received EEA Planning Grant to update Regulations in 2023-2024. Project scheduled to be complete June 2024.

METHUEN CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Work collaboratively with MA and NH state and municipal officials and upstream Spicket River dam operators to establish and implement an effective protocol for regulating river flow to prevent flooding.	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	City Emergency Management, MA DCR and NH Dam Safety, dam owners/ operators	8	Long-term	Low cost	604(b)/ 319 Grants, MS4 Municipal Assistance Grant	2008	Work towards this goal has continued since last update. Next step is that Lawrence needs to install flood gate at Mill Pond.
Planning/Structural	Plan and Construct Resilience Upgrades to the following identified problem bridge structures: Stone Arch Bridge at Broadway by Organ Hall (MassDOT); Oakland Avenue Bridge over Rail Trail (Methuen local); privately owned steel bridge structures at end of Chase St. spanning Spicket River.	Flooding, Earthquakes, Riverine Erosion	DPW	8	Medium-term	High cost	MassDOT Municipal Small Bridge Program, Property Owner @ Chase St.,	2024	Work with state and property owner to Conduct bridge assessments and develop cost estimates, finance plan for bridge upgrades.
Structural	Design and construct drainage improvements to remedy recurring flooding along Bloody Brook in the vicinity of Swan and Jackson Streets	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	City, MEMA, FEMA	7	Short-term	High Cost	FEMA HMGP, PDM, FMA; MVP Action Grant	2008	Comprehensive Bloody Brook and Searles Pond Resilience Plan developed through MVP action grant 2020-2021. Working to implement measures plan identified.
Structural	Drainage system capacity improvements including resized pipes at area of Tobey Ave/Grandview Road	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	DPW	7	Medium-term	High cost	FEMA HMGP, PDM, FMA; MVP Action Grant	2016	No action since 2016. Next steps include design and funding
Structural	Replace 97-year-old East Fire Station building at Salem/East Street with new, expanded capacity facility	Multi-Hazard (Emphasis on Wildfires)	Fire Dept/ Community Development /Bldg. Dept.	6	Long-term	High cost ($6.5 million)	Public Safety Agency Grants	2016	No activity. Flooding damage reported in August 2023. Next steps to include finance plan, site selection & design.

METHUEN CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning/ Structural	Implement phasing plan for vehicle electrification and charging infrastructure at municipal facilities	Extreme Heat, Climate Resiliency	DPW, DECD, School Dept.	6	Long-term	High Cost	Green Community Grant Program	2024	Fleet Electrification Assessment Completed 2021. Next steps - install charging stations and begin EV procurement.
Planning	Complete inventory of invasive plant species impacts on Methuen	Invasive Species, High Heat, Drought, Landslides	Department of Economic and Community Development	6	Short-term	Low Cost	DECD budget, MVP Action Grant	2024	Planning for this project has already been initiated.
Structural	Design and construct drainage improvements to reduce Spicket River flooding at the Rail Trail Bridge over Spicket "choke" point. Next steps are for design and funding to incorporate bridge replacement into Rail Trail improvement project.	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	City DPW/ Community Development; MassDOT	5	Short-term	High cost	FEMA FMA, MVP Action Grant, MassDOT Surface Transportation	2008	Work towards this goal has continued since last update. Improvements to the rail trail were made in 2018. Rail trail Bridge over the Spicket (at end of Pine Street) has not yet been replaced. Next step includes trying to identify opportunities for design.
Planning	Reduce repetitive flood losses along the Spicket River through flood-proofing and/or property acquisition.	Flooding, Extreme Temps, Drought	Property owners, City	5	Long-term		Property owners, FEMA FMA, Mass. Land & Conservation Fund	2008	No activity. Next steps are to organize planning process to identify and prioritize properties for protection.
Structural	Rehabilitate the Hampshire Road Bridge spanning the Spicket River near the Methuen - Salem NH town line.	Flooding, Earthquakes, Riverine Erosion	MassDOT, City, MVPC/ Merrimack Valley MPO	3	Long-term	High cost	MassDOT Highway	2008	No action as project not funded in Regional Bridge Program. Elevating the bridge and roadway will impact clearance under I-93 and may require expanded scope with changes to I-93 overhead.

Local Hazards: Methuen has identified that their community is not impacted by Coastal Flooding or Tsunamis.

8.3.7 Town of Newbury Mitigation Action Plan

NEWBURY COMPLETED PROJECTS SINCE 2016								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Amend local Subdivision Rules and Regulations to incorporate Town's Stormwater Regulations and require the maximum practicable use of Low Impact Development (LID) techniques in all new development and redevelopment	Flooding	Planning Board; Planning Department	Short-term	Low cost	Town, MS4 Municipal Assistance Grant	2016	Local subdivision Rules and Regulations amended. Updates include: changes in ROW requirements, updates administration process, and applies stormwater requirements consistent with local bylaw.
Planning/ Education	To reduce public risks from all natural hazards, establish and maintain Town web page and Police Department web page and Facebook page offering safety "tips and techniques" for hazard preparedness, mitigation, and response, with direct links to the MEMA and FEMA hazard mitigation websites.	All Hazards	ConCom; Building Commissioner/ Floodplain Manager; Town Clerk; Police; Emergency Management Director	Short-term	Low cost	Town Budget (Emergency Mgmt. Dept)	2008	Led by the Police Department and the Emergency Management Team, the Town is maintaining webpages and information sharing, as well as finding new ways to engage and reach residents. Completed, maintenance is ongoing.
Structural Project	Design & construct new Police Station to replace existing outdated and under capacity structure.	All Hazards	Select Board; Assistant Town Administrator; Municipal Building Committee; Finance Committee; Capital Planning Committee	Long-term	High cost	Tax Override – Debt Exclusion	2016	A new Police Station was constructed in 2020 at 7 Morgan Ave.
Education	Make residents aware of emergency procedures and resources, through publications such as "Public Health Emergency Preparedness Handbook	All Hazards,	Board of Health; Emergency Management	Short-term	Low cost	Town of Newbury (BOH and Emergency Mgmt. Dept. budget)	2016	Distribution of physical handbook complete. Town working to develop and make a digital version available.
Planning	Finalize Highway Operations and Safety Manual outlining roadway maintenance practices and procedures to be followed for stormwater management	Flooding	ConCom; Highway Dept; Stormwater Committee	Short-term	Medium cost	Town of Newbury (Conservation and Highway Dept. budget)	2016	O & M Plan for Town Facilities is complete

NEWBURY COMPLETED PROJECTS SINCE 2016								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Emergency Services Protection	Purchase TriTech Perform Fire software to create integrated and efficient emergency response network among Police, EMA, EMS, and Fire	All Hazards	Fire, Police, EMA, EMS	Short-term	Medium cost	Donation from Governor's Academy and funding from Town	2016	Software purchased and integrated into network.

NEWBURY DROPPED PROJECTS FROM 2016 Plan (not completed and not advancing to 2024 Plan)								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Structural	Complete design and construction of emergency access route on Plum Island north of PI Center; seek funding for construction	All Hazards	Assistant Town Administrator; Select Board; ConCom	Long-term	High cost	Town in cooperation with State Legislators and agencies/ Merrimack Valley MPO MassDOT/ Federal transportation funding	2016	No further action completed. During recent storms, the location where access route terminates on PI experienced flooding. Additionally, to date, property owners abutting access route have not granted easements required to complete the project. However, Town continues to work to address flooding risk through other measures (purchase of message boards and high-water vehicle, beach nourishment, FLAP grant) articulated in Current Projects below.
Planning/ Education	Participate in the NFIP's Community Rating System to enhance floodplain management, reduce flood risks and losses, and educate the public	Flooding	Building Inspector/ Floodplain Manager	Medium	Short-term	Town, with advice and assistance from MEMA and DCR	2008	After fully evaluating this action as part of the prioritization process, Newbury identified that the challenges of participation in the CRS program currently outweigh the benefits.

NEWBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Structural	Seek funding to implement recommendations of 2010 Gomez and Sullivan feasibility study regarding the Larkin Mill Dam on the Parker River – permitting, design, and breach/partial removal of the dam. Breach will prevent uncontrolled failure and allow for sediment transport downstream to raise elevations in the Great Marsh and thereby aid in Marsh adaptation to sea level rise	Coastal flooding from SLR Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, Tsunamis, and Other Severe Weather	Town Administrator, Assistant Town Administrator, Select Board, ConCom, Conservation Agent	10	Long-term	High cost	NOAA Climate Resiliency Grants, MVP Action Grants, National Fish and Wildlife Foundation Grants	2016	Newbury received state funding in 2021 and 2022 to advance the removal of the Larkin Mill Dam. Project is in final permitting in 2024. Larkin Dam is slated to be removed in 2025. Funding is in hand for Larkin site. Post-dam removal monitoring will continue for 4+ years by DMF. (More work may need to be done relative to the scouring of the river near the I95 bridge, but this will be a State highway issue.)
Planning	Review and update zoning, stormwater, wetland bylaws and other regulations for resiliency improvements	Flooding, Erosion, Landslide, Drought, Wildfires, Earthquakes, Invasive species, Extreme temps, Coastal Erosion	Planning Department and Board, Conservation Department and Commission, Floodplain Administrator, Building Commissioner, Select Board, Town Administrator	9	Short to Medium Term	Medium Cost	Community One Stop Grant, MVPC District Local Technical Assistance	2024	Actions to consider include: an update to the Flood Hazard Overlay District bylaw is needed prior to new FEMA FIRM maps adoption in 2025; work with Newburyport to evaluate PIOD and local wetlands regulations on Plum Island (Gloucester bylaw could be a model); review Stormwater bylaw, update bylaws and regulations to address invasive species management.
Planning/ Structural Project	Increase safety and awareness around Combined Sewer Overflow events in the Merrimack River through timely alerts and notifications	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	Newbury Board of Health	9	Long Term	Low Cost	Community Compact Cabinet Efficiency & Regionalization Grant Program	2024	Work with MVPC to conduct timely notification of CSO events and water quality for users in the Merrimack. This will entail coordinating to install QR code signage along access points and maintaining a link to the Early Alert Tool dashboard hosted by MVPC. Continue to conduct water quality beach sampling and explore possible expansion to PI Basin areas.

NEWBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning/ Education	Enhance warning systems for all natural hazards and emergencies through real time updates on Town and Police Dept webpage, Facebook and through continued use of Code Red system	Flooding, Winter storms, Hurricanes/ Tropical storms, Wildfires, Earthquakes, Tornadoes, Tsunamis	Police, Fire and Emergency Management Director	8	Short-term	Low cost	Emergency Management Department Budget	2016	Webpages and Facebook pages complete. Next steps look to further amplify program through other social media outlets, as well as bumping up service to next level of "Code Red"
Planning	Incorporate hazard mitigation in local policies, plans, and programs (e.g., Capital Improvement Program, Master Plan, Open Space & Recreation Plan, Phase II Stormwater Mgmt. Plan)	All Hazards	Planning Dept; Planning Board; Capital Planning Com.; ConCom; Open Space Com.; Stormwater Mgmt. Team; Highway Dept.	8	Short-term	Low cost	Planning Department, Conservation Department and Highway Department Budget	2008	Since 2008, themes and goals outlined in HMP have been integrated into other planning efforts (e.g. OSPR, MVP plan). Master Plan completed November 2023. As local plans and policies continue to be updated, elements of the HMP will be integrated.
Planning/ NBS	Develop & Implement DCR Fire Wise Program in heavily forested areas and neighborhoods	Wildfires/ Brushfires	Fire Department	8	Long-term	Low cost	DCR Community Forest Grant	2008	Fire Dept has met with DCR Fire Safety to review program (2024) and is considering options.
Planning/ Education	Purchase two illuminated message boards for public notification during emergencies and other events	All hazards (Emphasis on Flooding, Drought, and Major Storm Events)	Police Chief	8	Short-term	Moderate	FEMA HMG funding	2024	1. Obtain quotes for cost of boards; 2. Research grant funding; 3. Research the possibility of small speed signs w/ message boards that are attached to flood sensors, like the "Stalker Radar PMG Flood Sensor and Dynamic PMG Street Sign"
Planning	Incorporate climate change/sea level rise adaptation considerations in future hazard mitigation planning and implementation	Flooding from SLR Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, Tsunamis, and Other Severe Weather	ConCom; Building Commissioner/ Floodplain Manager; Planning Dept/ Planning Board; Board of Health; Highway Dept Ipswich River Watershed Association	7	Short-term	Medium-High cost	Town with CZM, DCR, MVPC, MRBA; Potential Funding: NOAA Climate Resiliency Grants, MVP Action Grants, National Fish and Wildlife Foundation Grants	2008	Great Marsh Coastal Adaptation Plan completed in 2017. Coastal communities are still actively working to address and manage resilience in the face of climate change/SLR. Potential actions include: incorporate new State resiliency regulations as available; bring SLR and flood projection data onto local MIMAP viewer for use in permit applications

NEWBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Through MRBA, seek State and Federal funding to dredge sand from rivers and streams in North Shore communities and southern New Hampshire for Plum Island Beach nourishment	Coastal and Inland Flooding and Coastal Erosion	Select Board; Town Administrator; Assistant Town Administrator; ConCom;	7	Long-term	High cost	ACOE BAA, Seacoast Economic Council Program	2016	Future dredging and sand placement is still being explored as needed.
Planning	Develop and implement updated stormwater management plan to ensure cleaning and maintenance of municipal stormwater facilities and waterways in compliance with NPDES MS4 permit for MA.	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	Highway Dept, Conservation Commission; Stormwater Management Team	7	Short-term	Medium cost	MS4 Municipal Assistance Grant, MVPC District Local Technical Assistance	2008	Newbury completed updates to maintain compliance with the current MS4 permit, including development of a stormwater management plan, and development of Illicit Discharge Detection Program and infrastructure inventory. New MS4 permit is anticipated next year. Next steps include continuing to share information with residents and implementing actions under new permit once released. Assess municipal properties for water quality issues caused by stormwater runoff
Structural	Continue to evaluate upgrade to or construction of a new fire station at Morgan Ave., and a permanent location for Town Hall.	Multi-Hazard (emphasis on Wildfires)	Select Board; Assistant Town Administrator; Municipal Building Committee; Finance Committee; Capital Planning Committee	6	Long-term	High cost	Tax Override – Debt Exclusion	2016, updated in 2024	Select Board and Town staff are considering capital planning solutions. The Morgan Ave Fire Station is currently under review as Town is conducting a building envelope study to document existing conditions. The Town Hall Project is "pending" as the conceptual design work has been completed.
Emergency Services Protection	Purchase a High-Water Vehicle	Coastal and Inland Flooding	Police Chief	6	Short-term	High	Purchase surplus vehicle/FEMA HMG funding	2024	Currently exploring grant opportunities to fund purchase. Waiting to hear back from NERAC about the potential for receiving grant funding

NEWBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Work with Newburyport to comprehensively review hydro-barriers in Little River watershed and to develop mitigation measures to prevent flooding in low-lying areas of the Business Park and surrounding roads	Inland flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	Town Administrator; Assistant Town Administrator; ConCom; Highway Dept; Planning Dept	4	Short-term	Medium-High cost	Town, in cooperation w/ Newburyport; potential funding: MVP Action Grant	2016	No action on plan due to lack of capacity and interest in this project; not a high priority. Next step might involve engaging Newburyport to assess their interest on this project, as well as securing funding & engaging consultants
NBS	Reduce storm vulnerability and increase resiliency through restoration of Great Marsh: 1) Manage invasive species such as pepperweed and phragmites; 2) Study water-flow patterns and sediment movement; 3) Assess and prioritize barriers that can affect river flow; 4) work with partners to explore salt marsh restoration of town-owned properties	Invasive Species, Coastal and Inland Flooding from Storm And Climatic Events, Coastal Erosion	Select Board; Conservation Commission; MVPC, MassBay National Estuary Program	4	Short-term	High cost (Hurricane Sandy Grant $1.2 million executed by MVPC & National Wildlife Federation Jan. 2015)	National Wildlife Federation Grants, NOAA Coastal Resiliency Grants; Through partnerships with Ipswich River Watershed Assoc.; UNH; Great Marsh Revitalization Task Force; MVPC	2016	Great Marsh Barriers assessment completed in 2017. Next step: Use study to continue barrier removal/ restoration. Funding received through the MVP program (2017) to assess sediment movement within region. Invasive saltmarsh plant species are monitored and managed through a collaborative effort by the Town, Parker River Refuge, MVPC, and MassAudubon.
Planning/ Nature-Based Solutions (NBS)	Evaluate/implement mitigation preventive measures to address current and long-term Plum Island beach erosion and flooding/access problems: • Develop and implement a proactive education/ outreach program for property owners on PI to support best practices and improve stability of coastal dunes • Assist interested residents in applying for elevation and land acquisition grants • Volunteer labor support for UNH dune restoration project (north of Plum Island Center)	Flooding and Coastal Erosion	Select Board; Emergency Management Team; ConCom; Planning Dept; Merrimack River Beach Alliance (MRBA)	3	Long-term	High cost	Town, in cooperation with ACOE, FEMA, DCR, DEP; Grant funding from MVP Action Grants, FLAP Grant	2008	Projects have been completed to manage flooding and erosion along Plum Island, including dune planting and restoration by UNH, and Jetty repairs by the ACOE. Newbury and Newburyport, with the Refuge, received a Federal Lands Access Program (FLAP) grant to explore solutions to flooding along Plum Island Turnpike (starting 2024). Newbury & Newburyport should work together on resiliency projects and with landowners to make their properties more resilient in the face of climate change and sea level rise.

NEWBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning/ Structural Project	Assess improvements needed (drainage improvements, culvert upgrades, etc.) in inland areas subject to flooding; seek grants to fund engineering studies, alternatives analyses, project design, and construction. • Scotland Road at Wolf Brook, at Highfield Rd. intersection and near Pikul Field • Orchard St at Courser Brook (near Central) • Hay St at Newman Rd • Newburyport Tpk. north of Old Newbury Golf Course	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	Town Administrator; Assistant Town Administrator; Highway Department, Conservation Commission; Stormwater Committee	1	Long-term	Medium-High cost	FEMA HMGP, PDM, FMA; local Town match	2008 with specific sites ID'd in 2016 and new sites added in 2024	The Great Marsh Barriers Assessment (for both fish passage and structural concerns) was completed by IRWA/PIE Rivers in 2018. Study lays out a comprehensive list of barriers with rankings for improvements/ removals. Multiple barriers have been improved since 2008. Progress continues on other identified barriers: Larkin Rd. at bridge over Wheeler Brook (completed 2023) & Orchard St. culvert at Cart Creek, near Martin Burns (in final permitting 2024)
Planning/ Structural Project	Assess improvements needed (drainage improvements, culvert upgrades, etc.) in coastal areas subject to flooding; seek grants to fund engineering studies, alternatives analyses, project design, and construction. • Plum Island Turnpike • Multiple low-lying roads on Plum Island (including but not limited to Plum Island Boulevard, Sunset Drive, Old Point Rd, Southern, Harvard, Donna's Way, 22R Old Point Rd) • Pine Island Road	Coastal Flooding from high tides and storm events, as well as SLR	Town Administrator; Assistant Town Administrator; Highway Department, ConCom; Stormwater Committee	-3	Long-term	Medium-High cost	FEMA HMGP, PDM, FMA; local Town match	2008 with specific sites ID'd in 2016 and new sites added in 2024	In 2019, Newbury and Newburyport received a Municipal Vulnerability Preparedness Action grant to conduct a Cost/Benefit Analysis on Plum Island. This report, Plum Island: Exploring the Fiscal and Economic Implications of Sea Level Rise detailed short-and long-term options for addressing flooding while considering the costs and benefits they would provide. More recently, a Federal Lands Access Program (FLAP) grant was received in 2023, for Plum Island Turnpike feasibility assessment, with Newburyport and Parker River National Wildlife Refuge. Efforts will continue to address flooding and viable short and long-term options for Plum Island

8.3.8 Town of Rowley Mitigation Action Plan

ROWLEY COMPLETED PROJECTS SINCE 2016								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Develop and implement drainage system maintenance plan to ensure regular inspection, cleaning, and maintenance of municipal stormwater facilities.	Flooding	Town Highway Dept, Conservation Commission	Short-term	Medium cost	MS4 Municipal Assistance Grant	2008	Rowley completed tasks to maintain compliance with current MS4 permit (prepare NOI, developed Stormwater Management Plan, and developed an IDDE). Currently conducting monitoring and maintained as outlined by deliverables. Community waiting for next iteration of the MS4 permit to be released, expected 2025. Completed, maintenance is ongoing.

ROWLEY DROPPED PROJECTS FROM 2016 Plan (not completed and not advancing to 2024 Plan)								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Developing and implement DCR Fire Wise Program in heavily forested areas and neighborhoods	Brushfires	Town Fire Department	Long-term	Low cost	Department of Conservation and Recreation	2008	Since the 2016 update, DCR has added staff to Essex County to respond to wildfire/brush fires. Due to bolstered capacity, Rowley does not need to upkeep Fire Wise Program.

ROWLEY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Explore opportunities to expand potable water capacity for the Town	Drought, Extreme Temps	Water Department	9	Medium-term	High cost	Town Capital Funds	2024	The water dept. is currently in the process of testing a new well site. Following outcome, next steps are to explore using well as additional water source.
Structural	Upgrade radio capabilities throughout Town for improved communication	Flooding, Severe Winter storms, Hurricane/Tropical Storms, Wildfires, Earthquake, Tornadoes, Tsunamis, Landslides	Police Department and Fire Department	8	Short-term	High cost	Town Capital Funds	2024	Radio and infrastructure equipment has been ordered, Installation began late 2023 and is expected to be completed in 2024.
Planning	As opportunities arise, acquire and protect private undeveloped open space in flood hazard areas.	Flooding, Drought, Extreme Temps, Landslides, Wildfires	Conservation Commission, Open Space & Recreation Committee	8	Long-term	High cost	MVP District Local Technical Assistance, MVP Action Grant, FEMA FMA	2008	Open Space Plan was updated in 2021. Town continues to seek opportunities to acquire open space through OSRD.
Structural	Design and construct drainage system improvements to alleviate chronic flooding due to undersized culverts/structures at following locations: 1) Newbury Road near Harrison Circle--Completed; 2) Haverhill Street (Rt. 133) at Bradford Street--Completed; 3) Wethersfield Street at Wild Pasture Lane; 4) Glen Street bridge replacement at Jewell Mill Dam over Mill River—new priority project	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather, as well as SLR; Erosion	Town Highway Dept	6	Short-term	High cost	FEMA HMGP, FMA; Municipal DER Culvert Replacement Municipal Assistance Grant Program, Town 25% match	2008. Glen Street Bridge added in 2016	Since 2016: an undersized culvert at Haverhill Street has been identified and needs to be replaced; Study/ engineering of potential culvert replacement at Wethersfield/ Wild Pasture Lane still needs to be done; Work hasn't yet been completed as the site hasn't posed an issue since the Mother's Day storm; Glen Street Bridge replacement is still a high priority. The Town is working with MassDOT through small bridge replacement program to upgrade structure.

ROWLEY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Incorporate hazard mitigation in local policies, plans, and programs (e.g., Capital Improvement Program, Master Plan, Open Space & Recreation Plan, Phase II Stormwater Mgmt. Plan) Master Plan dated 2003 and due for update	All hazards	Town Departments	6	Medium-term	Medium cost	Planning Department, Conservation Department Budgets	2008	Town has integrated main themes & recommendations from HMP planning effort into relevant community plans. Efforts will continue to be made to further integrate content as applicable (e.g. MVP 2.0).
Education/ structural	Continue to bolster municipal capacity to address invasive plant species in Rowley through maintaining and expanding opportunities for public engagement and landowner/resident involvement	Invasive Species, Drought, High Heat	Open Space Committee, Conservation Commission	6	Medium-term	Low Cost	Conservation Department Budget, Mass-Wildlife Habitat Mgmt. Grant Program	2024	The Town of Rowley conducts educational outreach and identification training of invasive species through the Open Space Committee. This is incorporated into spring and fall volunteer events. Volunteer Trail Work Days include an invasive plant control or removal activity as stewardship of protected open space lands.
Structural	Advance priority culvert projects (listed in Town Bridge and Culvert Inventory, 2019) across the Town to reduce flooding vulnerability and increase ecological functioning.	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather, as well as SLR; Erosion	Highway Department, DPW	5	Long-term	High cost	MVP Action Grants	2024	Culverts have been identified. Next steps involve seeking funding for repair/ replacement and identifying engineering consultants design/ begin updates.
Structural	Design and construct drainage improvements at Hillside Street to alleviate occasional flooding that renders the street impassable. This may involve elevating the road for a stretch of approximately 150 ft. and installing a larger culvert	Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	Town Highway Dept	1	Short-term	High cost	FEMA Flood Mitigation Assistance Grant	2008	Two locations have been identified for drainage improvements on Hillside Road: Hillside near Glen Street and Hillside near Hellman Farm. Next steps include funding for engineering/design

8.3.9 Town of Salisbury Mitigation Action Plan

SALISBURY COMPLETED PROJECTS SINCE 2016								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Update Town's Phase II Storm Water Management Plan to incorporate new EPA requirements regarding outreach, illicit discharge detection/prevention, planning, Operation & Maintenance practices and run-off controls.	Flooding	Planning/ Conservation/ DPW/ Merrimack Valley Stormwater Collaborative	Long-term	Medium-High cost	Town Planning, Conservation, DPW budget. MS4 Municipal Assistance Grant	2008	Salisbury completed tasks to maintain compliance with current MS4 permit (prepare NOI, developed Stormwater Management Plan, and developed an IDDE). Currently conducting monitoring and maintenance as outlined by deliverables. Waiting for next iteration of the MS4 permit to be released, expected 2025. Completed, but maintenance still ongoing
Structural	Construct floodwall to protect low-lying neighborhoods against tidal flooding from Blackwater River	Flooding	Town Manager, Board of Selectmen, DPW and Conservation Commission	Short-term	High cost (cost $6 million 75% from grant w/ local match split between Town & DCR State Env Bond Bill)	Army Corps of Engineers, State DCR and Town	2008	Work completed and floodwall constructed in 2016. Since then the community has worked to bolster the project with nature-based solutions such as replanting native dune and marsh species in areas adjacent to the floodwall.
Structural	Relocate 86-year-old Police Station and reduce vulnerability and access limitation of critical facility currently at 24 Railroad Avenue in coastal zone. New facility is planned for construction at 175 Beach Road by Town water & booster station.	All hazards	Town Manager/ Police Chief/ Planning Dept.	Short-term	High ($11.5 million local bond)	ARPA Funds, City fund balance, private loan	2016	New Police Station was completed at 181 Beach Road in 2017.
Structural	Replace Smallpox Brook culvert under US Route 1 with larger culvert to reduce flood risk frequency. Next step: Undertake evaluation /assessment planning study	Flooding	Mass Highway	Long-term	Medium-Cots	MassDOT	2008	Smallpox Brook culvert was replaced in 2022 with a larger culvert meeting Massachusetts Stream Crossing standards and alleviating flooding.

SALISBURY COMPLETED PROJECTS SINCE 2016								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Structural	Install new culvert and improve drainage system on Jak Len Drive to prevent future flooding	Flooding	Salisbury DPW, Conservation Commission	Long-term	Low cost ($40k)	Town Sewer Enterprise Fund	2008	Project completed- new sewer mains installed on Jak-Len Drive and new sewer pump station constructed in 2022. Project is expected to prevent future flooding.
Structural	Rebuild Merrimack River North Jetty	Flooding	MRBA/ Conservation	Short-term	High cost ($10 million)	Army Corps of Engineers	2008	Construction of the North Jetty completed in 2016. This included repair of the ~3,100' Jetty and repair of a 190-foot-long stone spur off the jetty.
Planning	Adopt "Steep Slope" regulation to prohibit or strictly regulate development on steep slopes in order to prevent stormwater runoff and erosion.	Multi-hazard	Planning Board and Conservation Commission	Long-term	Low cost	Town Budget (Planning and Conservation Dept.)	2008	Salisbury adopted Stormwater Bylaw in 2023, which includes a provision that requires erosion control on land with a 10% or greater slope.
Planning	Develop and adhere to routine inspection, cleaning, and maintenance schedule for drainage/stormwater facilities and stream channels. Next step: Develop 3-5 year maintenance plan document continued routine maintenance and cleaning of street drainage systems.	All hazards	Salisbury DPW, in consultation and cooperation with Conservation Comm.	Short-term	Low cost	Town Budget (DPW)	2008	Town formalized a plan since the last plan update to address and maintain street sweeping/catch basin cleaning twice a year. DPW is actively managing street sweeping/catch basin cleaning for Town. Completed, but maintenance still ongoing.

SALISBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Develop and establish Salisbury Beach and Dune Maintenance Plan	Coastal and Inland Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, Tsunamis, and Other Severe Weather, as well as SLR; Coastal Erosion	Conservation Department, Planning Department, DCR, Private homeowners	10	Short-term	Medium cost	CZM Coastal Resiliency Grant	2024	Salisbury is currently working to develop this maintenance plan in concert with DCR to more clearly establish a process for beach and dune maintenance.
Planning	Develop and adopt a Local Wetland Bylaw for the Town	Coastal and Inland Flooding, Drought, Extreme Temps, Wildfires	Conservation Department and Planning Department	9	Short-term	Low cost	Planning Dept. and Conservation Dept. Budgets, EEA Climate Resiliency Grants	2024	A draft of the bylaw has been written. Conservation Department is working to refine draft bylaw and aiming for adoption by 2025
Planning and Structural	Study and reconstruct State Route 1A (Beach Road) to permit emergency access and evacuation at Salisbury Beach	Coastal and Inland Flooding	Salisbury DPW, MADOT /Merrimack Valley MPO	8	Short-term	High cost	MassDOT and Army Corps of Engineer Funding, Merrimack Valley MPO TA and Funding	2016	Project has made slow progress since last update. Salisbury has reached out to MassDOT and DCR to begin collaboration. Next steps include continuing to work with both groups to identify plan to mitigate flooding along Beach Road
Planning and NBS	Develop long-term regional beach replenishment dredging program. Next steps: Establish North Shore region planning group; Prioritize action based on data generated through Coastal Resiliency Sandy Grant project of hydrodynamic sediment transfer modeling.	Coastal and Inland Flooding and Erosion from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, Tsunamis, Other Severe Weather, SLR	Town Manager, Board of Selectmen, DPW, Conservation Commission, MVPC	8	Short-term	High cost	ACOE and DCR funding, Hurricane Sandy Coastal Resiliency Grant to MVPC ($1.2 million award 2015), NOAA Coastal Resiliency Grant	2008	Department of Conservation and Recreation completed Regional Sediment Study in 2020. MRBA continues to meet regularly. Salisbury formed a sub-committee for focused action on erosion on Salisbury Beach. The sub-committee is actively working to identify both short-term and long-term solutions for beach erosion

SALISBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Adopt Floodplain Bylaw	Coastal and Inland Flooding	Planning Department, Building Inspector	8	Short-term	Low cost	Planning Department Budget	2024	A draft of the bylaw has been written. Planning Department is working to refine draft bylaw and aiming for adoption by 2025
Education	Develop and implement a proactive education/ outreach program for property owners who live in flood-prone areas and on barrier beaches to support best practices and reduce vulnerability from storm events.	Coastal and Inland Flooding, Coastal Erosion, Major Storm Events	Planning and Conservation Departments	8	Medium term	Low cost	MVP Action Grant, MVPC District Local Technical Assistance	2024	New project idea that can be expanded as an educational/ outreach campaign. Salisbury is currently conducting landowner outreach and education along Beach to assist in remediation projects & Mgmt Plan development
Planning and structural	Install larger culverts at Ferry Road and March Road to facilitate tidal flow in adjacent marshes; encourage building floodwalls or elevating buildings to protect against coastal flooding along Route 1 South; study elevating roadways to increase flood protection	Coastal and Inland Flooding and Erosion from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, Tsunamis, and Other Severe Weather, as well as SLR	Salisbury DPW, Conservation Commission	7	Short term study; long term implement ation	High cost ($300k)	DER Municipal Culvert Replacement Grant Program, MassWorks Infrastructure; FEMA Flood Hazard Mitigation or HMGP	2008	Survey and designs were completed, but implementation did not occur as permitting was not granted through MEPA due to saltmarsh impacts. Salisbury is continuing to explore possible options to address flooding in Marsh and Ferry Road Community. Next steps include exploring what work/improvements can be done under current WPA.
Planning	Maintain current list of Repetitive Loss properties; develop local program to implement appropriate mitigation measures including raising elevation of at-risk properties	Coastal and Inland Flooding	Salisbury Building Inspector and Planning Department	6	Short-term	Low cost	FEMA FMA, HMPG, MassDOT PROTECT Grant	2008	Salisbury secured their status of a CRS community (class 8) and is currently completing monitoring and management to maintain status and remain compliant with CRS requirements. Salisbury is continuing to improve their status as a CRS community.

SALISBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Structural	Improve drainage system on Central Avenue and Old Town Way Scope includes installation of pump station to reduce flood risk frequency/impact.	Coastal and Inland Flooding and Erosion from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, Tsunamis, Other Severe Weather, SLR	Salisbury DPW	5	Long-term	Medium-High cost	MassWorks, State Infrastructure	2008	Design 100%. No work performed to date. Estimated costs need to be updated.
Planning	Develop an assistance program for raising homes in the floodplain to be in compliance with floodplain regulations.	Inland and Coastal Flooding, Coastal Erosion	Salisbury Building Dept, Conservation Commission and Planning Department	5	Long-term	Medium-High cost	Town-Local homeowner match/FEMA—Flood Hazard Mitigation; Pre-Disaster Mitigation/HMGP	2016	No action due to lack of staff capacity and funding. Town plans to continue this effort by exploring options for homeowners to increase resiliency in the face of flooding and sea level rise. Town plans to work with FEMA (as part of CRS program) to seek funding eligibility for property owner assistance in structural elevations.
Planning	Acquire and protect undeveloped open space in flood hazard areas. Consider seeking funding to acquire homes from willing sellers in high-hazard areas such as coastal beachfront. Next steps: Prioritize areas for acquisition/protection	Inland and Coastal Flooding, Coastal Erosion, Drought, High Temps, Wildfires	Conservation Commission/Planning/Ipswich River Watershed Association/ MVPC	4	Planning phase short-term/ Implementation phase long-term	High cost	FEMA Flood Mitigation Assistance, EEA LAND grant	2008	Town working with Essex County Greenbelt Association and US Fish and Wildlife Servicers on open space acquisition. Currently, efforts are focused on updating Town Open Space and Recreational Development plan and identifying high priority parcels for future conservation.
Planning/ Structural	Analyze coastal and inland flood inundation areas across town. Design/implement appropriate corrective measures to address vulnerabilities.	Inland and Coastal Flooding, Coastal Erosion	Salisbury DPW and Planning Department	4	Long-term	Medium-High cost	MVP Action Grant, FEMA FMA Grant	2008	No action due to lack of funding. Next steps: Secure funding appropriation, prepare RFP for comprehensive flooding/ drainage engineering study.

SALISBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Create interdepartmental GIS database and mapping of municipal facilities and resources to enhance emergency operations and incident management	Flooding, Extreme Temps, Severe Winter Storms, Drought, Hurricanes/ Tropical Storms, Wildfires, Earthquakes, Tornadoes, Tsunamis, Landslides	Town Departments	1	Long-term	Medium cost	FEMA Pre-disaster Mitigation, MVPC District Local Technical Assistance	2008	Salisbury currently accesses GIS services through MVPC's MIMAP. Funding needs to be identified to create municipal GIS.
Planning	Develop and implement DCR Fire Wise Program in heavily forested areas and neighborhoods	Brush Fire, Invasive Species	Salisbury Fire Department	-2	Long-term	Low cost	DCR Community Forest Grant.	2008	No action due to lack of funding & other priorities. Next steps: Fire dept working with DCR in preliminary meetings to implement Fire Wise program.

8.3.10 Town of West Newbury Mitigation Action Plan

WEST NEWBURY COMPLETED PROJECTS SINCE 2016								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Participate in NFIP's Community Rating System to enhance floodplain management and reduce flood risks and losses	Flooding	Planning, Building Dept., Emergency Management Director	Long-term	Low cost	Town Planning and Emergency Mgmt. Dpt.	2008	Feasibility of Town participation assessed and community decided to not move forward with CRS due to barriers of entry for program and lack of benefit to community. West Newbury is planning to move ahead to bolster community resilience through other programs outside of CRS.

WEST NEWBURY DROPPED PROJECTS FROM 2016 Plan (not completed and not advancing to 2024 Plan)								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Participate in NFIP's Community Rating System to enhance floodplain management and reduce flood risks and losses	Flooding	Planning, Building Dept., Emergency Management Director	Long-term	Low cost	Town Planning and Emergency Mgmt. Dpt.	2008	Feasibility of Town participation assessed and community decided to not move forward with CRS due to barriers of entry for program and lack of benefit to community. West Newbury is planning to move ahead to bolster community resilience through other programs outside of CRS.

WEST NEWBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Structural	Install generators at critical facilities of Town Offices, Annex and Senior Housing complex	Extreme Temps, Severe Winter Storms, Hurricanes/ Tropical Storms, Earthquakes, Tornadoes, Other Severe Weather	DPW, Finance, Emergency Management	8	Medium-term	Moderate-High cost ($100k per facility)	Town/State Public Safety Funds &/or FEMA Hazard Mitigation (HMGP)	2016	Public Safety building has had generator installed. Study was conducted to consider microgrid for Town building complex. Capital Improvement Plan proposes generators for Town office building. Generators at select locations still need to be installed
All	Study erosion, flooding, and impacts of sea-level rise along Merrimack River. Specifically, along River Road.	Coastal and Inland Flooding (from storms and SLR), Riverine Erosion	DPW, CCRC, Finance Department, Conservation Department	8	Short-term: complete study, Medium-term: coordinate implementation plan, Long-term: complete implementation projects	Moderate cost for study/ High cost for implement ation	MVP Action Grant & Seed funding, FEMA BRIC grant, DER Municipal Culvert Replacement Grant	2024	Erosion and culvert study currently ongoing, expected completion date 2024. Next steps will be to use study to develop a comprehensive mitigation plan and find funding to begin work on projects.
Planning/ Structural Project	Replace undersized culverts, swales, and drainage systems on an as needed basis.	Coastal and Inland Flooding, Riverine Erosion	DPW, Conservation Commission	7	Short-Term planning and Medium-Long term culvert identification & implementation	Moderate cost	State Infrastructure Revolving Fund/ MassDOT/ DER Municipal Assistance Grant/FEMA FMA or BRIC grant	2008	Steps have been taken to advance this goal: 1) a New Stormwater bylaw was passed in 2021, 2) Quotes have been received to replace two Coffin Street culverts, 3) River Road culverts are currently being studied and mapped under an MVPC action grant (2023). Work is still ongoing to inventory and prioritize draining structure upgrades in CIP and enter in GIS. Town is actively seeking grants to continue implementation work.
Structural	Move communications antennas & transmitting equipment from the Parks and Rec building (planned to be demolished) to the roof of the Page School.	All Hazards	Building Department and Public Safety	7	Short-term	Moderate cost	Building Dept. and Public Safety Dept. Budget	2024	Preparing to bring project to town meeting where funding will be approved.

WEST NEWBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning, NBS, education	Increase capacity to manage invasive species in West Newbury. This will be done through a multi-pronged approach aimed at educating and mobilizing local volunteers, as well as hiring professional staff and using seasonal interns.	Invasive Species, Wildfires, Drought, Extreme Temps, Landslides	Conservation Commission, Open Space Committee, Tree Committee, DPW, CCRC, Select Board	7	Short-term (but maintenance will be ongoing)	Moderate cost	Town allocated funding, MassWildlife Habitat Management Grant Program.	2024	Progress on this action began in summer 2022 when the Town hired 2 invasive plant interns who continued in summer 2023. The Town has allocated $75,000 for professional invasive plant mgmt. on town owned land. The Town allocated $60,000 at Spring 2023 Town Meeting to study and treat ash trees for emerald ash borer. West Newbury also has active community groups working to educate the public and engage volunteers to manage invasives.
Structural	Continued monitoring of landfill site for water contamination/leaching	Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, and Other Severe Weather	Board of Health	7	Long-term	High cost	Town funds from Town Meeting, MassDEP State Revolving Loan Fund	2024	West Newbury is required to monitor Town's closed landfill per DEP approved monitoring plan. This includes testing 7 private drinking water wells for the presence of 1,4-dioxane every 3 years. In October 2023 MA DEP modified the requirements to include testing for presence of PFAS in both the landfill monitoring wells and private drinking water wells. If either of these contaminates (1,4-Dioaxane or PFAS) are identified off site, Town will likely be responsible to provide neighboring property owners w/ a potable water source. Cost is unknown, but expected to be substantial.
Planning/ Structural Project	Increase supply of potable water for West Newbury. Due to recent droughts and water supply issues, the Town is looking to expand their town water resources.	Drought, Extreme Temps	Water Department, Select Board	6	Long-term	High cost	Town Bonds, Water Rate Payers	2024	Consultants have been hired and are conducting a town-wide study to identify ideal sites. Plan to advance testing on one or more sites, upon securing an option agreement or purchase of sale.

WEST NEWBURY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Incorporate hazard mitigation in local policies, plans, and programs (e.g., Capital Improvement Program, Master Plan, Open Space & Recreation Plan, Phase II Stormwater Mgmt. Plan)	All Hazards	Planning, DPW, Selectmen, Executive Administration, Emergency Management, Open Space Committee, Conservation Commission	4	Long-term	Medium cost	Planning Dept, Conservation Commission, and DPW Budgets, MVPC District Local Technical Assistance	2008	Themes/goals identified in the 2016 HMP were integrated into local policies, plans, and programs (such as updated OSRP in 2016 and 2021 stormwater bylaw). This will continue as additional updates are made, such as Phase II MS4 plan and 2025 OSRP updates, development of a wetlands protection bylaw, and development of DPW standards.
Planning	Conduct an assessment of evacuation routes across town with regard to flood vulnerability	Coastal and Inland Flooding from Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, Tsunamis, Other Severe Weather, SLR	DPW/Public Safety Department	4	Short-term	Low cost	FEMA BRIC Grant, MVP Action Grant	2024	Local anecdotal information is currently known regarding flooding and access routes. Next steps would be to formally identify evacuation routes and known flooding vulnerability . This knowledge is critical for current and future hazard planning and could help to inform future projects across Town and seek funding to improve resilience of critical transportation routes.

8.3.11 Merrimack Valley Region Mitigation Action Plan

MERRIMACK VALLEY COMPLETED PROJECTS SINCE 2016								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Education	Educate public and landowners on importance of removing vegetative detritus in or near forested areas to reduce risk of wildfire	Brushfires	Municipal Fire Departments/ Emergency Management	Medium-term	Low	Municipalities, DCR, MEMA	2008	Since 2016, many communities in the region have been working to increase tree pruning and invasive species management to address risk of brushfire.
Planning	Organize planning process for Regional Climate Change Adaptation & Resiliency	All Hazards	MVPC, municipal planning departments	Short-term	Moderate	MVPC; State agencies; federal agencies including EPA Planning & FEMA; Regional partners including Storm Surge and MassBays Program	2016	Since 2016, MVPC has worked with communities to advance climate change planning and resiliency efforts. This includes saltmarsh monitoring and restoration efforts, MVP designation and associated Action grant projects, Great Marsh Barriers assessment, and the integration of climate planning into ongoing regional and local planning efforts. While this work is ongoing, specific projects are outlined and included in more detail below, so this action is being marked as complete.
Education	Work with Federal/State agencies, partner organizations, and communities to educate municipal officials, residents, & businesses about projected sea level rise impacts and potential management solutions	All Hazards	FEMA,MEMA, DCR, MVPC, 8TGM and communities	Long-term	Low	State/Federal agencies, Great Marsh Coalition, 8Towns & Bay, MVPC	2008	MVPC has continued to work through partner orgs and regional partnerships to promote sea level rise education and integrate data into local planning (e.g. 2024 HMP). While this effort is still relevant and ongoing, this goal has been integrated into the broader climate related action below.

MERRIMACK VALLEY DROPPED PROJECTS FROM 2016 PLAN (not completed and not advancing to 2024 Plan)								
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Work with the Office of Dam Safety and local communities to ensure that DCR records are up to date and reflects work accomplished by the communities and private parties to inspect, repair, and renovate dam structures	Flooding	MVPC, DCR, local communities	Short-term	Low	DCR, local communities, dam owners	2008	DCR Office of Dam Safety (ODS) manages and updates state-records. Communities work directly with ODS to complete inspections and update records. Because process does not operate at the regional level and MVPC does not have direct influence over the process, therefore this action has been dropped.
Planning	Work cooperatively with the District 5 Fire Warden to inventory and map access roadways through the region's state forests	Brushfires	DCR Fire District 5; Local municipalities	Long-term	Moderate	DCR Fire District 5 and municipal fire/emergency management departments	2016	No work has been done. Communities have not identified as a current priority. Project is currently being dropped, but could be added later if needed.

MERRIMACK VALLEY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Provide technical assistance to communities in the development, adoption and maintenance of local multi hazard mitigation plans	All Hazards	MVPC and local communities	10	Long-term	Low	HMP BRIC Funding	2008	MVPC worked with communities to update and adopt their HMP Plans in 2016. With this new update in 2024, MVPC has also put systems in place to track progress annually and ensure timely maintenance moving forward.

MERRIMACK VALLEY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Identify and pursue public & private sources of technical assistance and funding for residents, business, and municipalities to implement sound hazard mitigation measures throughout the region	All Hazards	MVPC & local communities	10	Long-term	Low	District Local Technical Assistance, FEMA HMGP, BRIC	2008	MVPC worked with communities to advance HMP plans between 2016-2022 through providing technical assistance and seeking funding. Moving forward, MVPC will continue to use outcomes from plan to support communities in receiving funding and advancing actions.
Planning/ Education	Develop and maintain a comprehensive natural hazard mitigation webpage for the region	All Hazards	MVPC	10	Short-term	Low	FEMA BRIC, District Local Technical Assistance	2024	Build off of the current MVPC Hazard Mitigation webpage to include more information about regional hazards, as well as take-aways from the current 2024 Plan.
Planning	Promote climate adaptation planning and integration of best available climate data into future planning and implementation efforts.	All Hazards	MVPC, Municipalities	10	Long-term	Moderate	CZM Coastal Resiliency Grant Program, NOAA Climate Resiliency Grants	2024	Stay up to date with best available climate data. Ensure information is readily accessible to communities, and that data is used for long-term planning efforts.
Planning	Encourage municipalities to integrate hazard mitigation considerations into other local planning initiatives (e.g. Master Plans, Capital Improvement Plans, OSRPs, Municipal Vulnerability Plans)	All Hazards	MVPC and local communities	9	Long-term	Low	District Local Technical Assistance	2008	MVPC worked with communities to integrate HMP findings into other community plans between 2016-2022. Moving forward, MVPC will continue to make data available and help to integrate findings into other community and regional plans.

MERRIMACK VALLEY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Incorporate natural hazard mitigation and best planning practices into MVPC's regional planning work and activities	All Hazards	MVPC, local planning Departments	9	Long-term	Moderate	District Local Technical Assistance	2008	HMP findings integrated into 2015 Regional Priority Growth Strategy (PGS). MVPC is currently completing another update to the PGS and actively integrating HMP findings. PGS will be shared broadly with communities in region.
Planning	Identifying priority restoration areas/ GI areas along the Merrimack River	Inland and Coastal Flooding, Riverine Erosion, Drought, Extreme Temps	MVPC, Merrimack River Watershed Council, Municipalities, DEP, DER	9	Medium-term	Moderate	319 grant, 604b grant, DER priority project funds, MVP Action Grant	2024	MVPC and partners have identified priority projects through DER's Restoration Partnership program and through watershed-based planning initiatives along the river and its tributaries. Next steps include seeking implementation funding to initiative first identified steps.
Planning, Education	Provide education and support to address CSO events in the Merrimack River	Inland Flooding, Precipitation Events, Winter Storms, Hurricane/ Tropical Storms, And Other Severe Weather	MVPC, Merrimack River Watershed Council, Merrimack River Collaborative, Municipalities	9	Long-term	High	Community Compact Cabinet Grants	2024	MVPC is working to develop the Merrimack River Early Alert tool to provide predictive AI alerts around water quality following CSO events. Next steps include final development, signage installation, and working with adjacent communities to promote tool. Future efforts to further address and support risk reduction from CSOs are also a priority.

MERRIMACK VALLEY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Work with MassDOT and MPO to prioritize repair of structurally deficient bridges over waterways through the Transportation Improvement Program process.	Inland and Coastal Flooding, Riverine Erosion, Earthquakes, Major Storm Events	MassDOT and Merrimack Valley MPO	7	Long-term	High	MassDOT TIP, MVMPO, Dam and Seawall Grant Program	2008	Since 2016, MVPC has worked to coordinate regional projects. As part of its performance monitoring program, MVPC will continue to track status and work with MassDOT to program resources and advance projects in the region.
Planning	Work with MVPC communities to encourage the incorporation of Low Impact Development techniques in subdivision regulations and site/neighborhood redevelopment plans	Inland Flooding, Drought, Extreme Temps, Brushfires/ Wildfires	MVPC, local communities	7	Medium-term	Moderate	MS4 Municipal Assistance Grant	2008	Merrimack Valley Stormwater collaborative continues to meet on a near monthly basis. Several MS4 Technical Assistance grants have been procured to amend bylaws and provide municipal trainings on the topic of LID. Work towards this goal continues.
Planning	Develop emergency access, evacuation plans, and longer-term solutions for neighborhoods subject to isolation from flooding or by blockage from railroad lines.	Inland and Coastal Flooding, Major Storm Events	MVPC, municipalities	7	Medium-term	Moderate	MassDOT, MVMPO, FEMA HMGP	2008	No major action to date. Individual communities have been working to identify and address acute locations of flooding (e.g. Newbury/ Newburyport Plum Island Turnpike). Next steps: Seek funding and opportunities to support communities across the region in long-term planning actions (e.g. purchasing equipment, raising roads, etc.)

MERRIMACK VALLEY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Education	Provide training to local Conservation Commission and other local land use regulatory board members on enforcement and model bylaws/ordinances	Flooding, Drought, Extreme Temps, Erosion, Wildfires, Invasive Species, Major Storm Events	MVPC, municipalities	7	Long-term	Moderate	Citizen Planner Training Collaborative, MVP Action Grant, Community Compact Regionalization Grant	2016	MVPC provided assistance to ConComs and Planning Boards to revise local bylaws through EEA Climate Resiliency and MS4 Municipal Assistance Grants in 2023. Next steps include seeking opportunities to provide trainings directly to committee/board members and municipal staff
Planning	Assist communities in the identification & implementation of strategies aimed at protecting cultural and historic resources from natural hazards	All Hazards	MVPC, local historic commissions, Mass. Historical Commission, National Park Service, 8Towns& Bay	6	Long-term	Moderate	FEMA Public Assistance (PA) Grant Program	2008	MVPC has worked directly with communities to identify and protect cultural and historic resources (e.g. Lawrence Canal District). Through the new Arts and Culture Position at MVPC, more resources are available to assist communities in identifying at risk cultural and historic sites across region (e.g. Salisbury Ocean Front/ Boardwalk area). This work is ongoing.
Planning	Conduct a Merrimack River Watershed Barriers Assessments	Inland and Coastal Flooding, Erosion	MVPC, IRWA, MRWC, CZM	6	Long-term	Moderate	MVP Action Grant, DER Partnership Funding	2024	Expand off current Great Marsh Barriers Assessment (2017) report by inventorying all barriers to flow in the Merrimack River watershed.

MERRIMACK VALLEY CURRENT MITIGATION ACTIONS TO ADVANCE									
Category of Action	**Description of Action**	**Hazard Addressed**	**Responsible Group**	**Priority**	**Timeframe**	**Cost**	**Resources/ Funding**	**Year Added**	**2024 Project Update**
Planning	Review & Update local regulations and implement management practices to comply with updated MS4 Stormwater Permit	Inland and Coastal Flooding	Municipalities	6	Short-term	Moderate	MS4 Municipal Assistance Grant	2016	MVPC assisted ConComs and Planning Boards across all MVPC communities to revise local bylaws through EEA Climate Resiliency and MS4 Municipal Assistance Grants in 2023 to ensure compliance with MS4 permit. MVPC continues to work with communities to update bylaw language as new MS4 permit is released.
Planning	Develop agreement on siting convenient, accessible regional shelter in Lawrence/ Methuen/Haverhill area; and formalizing agreement in coastal communities	Extreme Temps, Severe Winter Storms, Hurricanes/ Tropical Storms, Earthquakes, Tornadoes, Tsunamis	Local Communities	5	Short-term	Low	FEMA Public Assistance Grant	2016	Since 2016, little to no regional action. In the 2024 update, Six of the ten participating communities identified a need for the establishment of or expansion/ improvement of sheltering options in their communities. This continues to be a priority to explore regional options.
Planning	Promote multi-state collaboration between MA and NH to better coordinate range of natural hazard topics including (flooding, CSO events, dam operations, climate change, coastal restoration). * Action changed to reflect the goal of increased collaboration.	All Hazards	MA and NH state environmental agencies, communities, and MVPC	5 (elevated based on priority, although feasibility is a challenge)	Long-term	Low	DER Partnership Funding, MRC State Funding	2008	No activity to date. Bordering communities are working to address and advance flooding conditions within MA through planning processes (e.g. watershed based plans). MVPC is working to promote collaboration between MA and NH (e.g. CSO coordination, Merrimack River Collaborative, saltmarsh restoration).

SECTION 9. PLAN ADOPTION AND MAINTENANCE

This section discusses how the Merrimack Valley Region Multi-Hazard Mitigation Plan Update will be adopted by MVPC and the region's participating local jurisdictions, 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 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 prior to seeking formal adoption of the plan by the local communities and the Merrimack Valley Planning Commission. FEMA reviewers document their evaluation of the Plan using the Local Mitigation Plan Review Tool.

Mitigation plans are approved by FEMA when they receive a "satisfactory" for all requirements. Once a final plan is submitted, the FEMA Regional Office generally completes the review within 45 days. In the event that the plan is not approved, the FEMA Regional Office will provide comments on the areas that need improvement. FEMA will then 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 affirmative vote of the community's City Council or Board of Selectmen/Select Board. A resolution signed by the Council President or Select Board Chair serves as documentation of the Plan's local adoption. Local adoption by the community indicates that the community feels they have been directly involved in the process, and that the Plan accurately reflects local conditions and goals. Upon submittal of the signed resolution to FEMA, FEMA issues a letter notifying the community of their approval of the plan. The Plan will then serve as a non-binding guidance document for the community, outlining comprehensive strategies to minimize risk and vulnerability from natural hazards over the next five years.

9.2 Plan Maintenance

The measure of success of the Merrimack Valley Regional Multi-Hazard Mitigation Plan will be the number of identified mitigation actions implemented, either wholly or in part, by each of the ten participating communities. In order for the region 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.

9.2.1 Plan Monitoring

Accordingly, a review of the Plan will be completed annually by each community's Lead Representative (*Table 9.1)* and/or LHMPT through the completion of an annual survey assessing progress on identified mitigation actions and evaluating the Plan's effectiveness (*Annual Survey Template can be found in Appendix C: Module 6*). Findings will be shared in the form of a report with members of the LHMPT and each communities' governing body. Survey results will also be compiled by MVPC and used to inform the formal evaluation.

9.2.2 Plan Evaluation

A formal evaluation of the Plan will be undertaken every five years in accordance with the Disaster Mitigation Act of 2000. The evaluation will include a full review of the plan, and revisions to reflect progress in local mitigation efforts and changes in priorities. Annual surveys will provide insight and relevant content that will be used to inform the plan update. The Plan will be evaluated and updated prior to the next scheduled five-year update as needs and funding opportunities arise. To ensure the region remains compliant and eligible for mitigation project grant funding, the update process will begin in the third year following plan approval. Similar steps to those taken for the 2024 update will be followed to initiative the next plan update process, through coordinating with the Chief Elected Official and re-engaging Lead Representatives (*Table 9.1)* and LHMPTs.

Table 9.1 Each participating communities' current Lead Representative and Title/Position within the Community.

LEAD REPRESENTATIVES		
Community	**Individual**	**Title/Position**
City of Amesbury	James Nolan	Fire Chief
City of Amesbury	Robert Serino	Deputy Fire Chief
Town of Boxford	Chris Olbrot	Dept. of Public Works Superintendent
Town of Groveland	Rebecca Oldham	Town Administrator
Town of Groveland	Annie Schindler	Town Planner & Conservation Agent
City of Haverhill	Robert Pistone	Chief of Police
City of Haverhill	Adam Durkee	Deputy Director of Emergency Management
City of Lawrence	Dan McCarthy	Land Use Planner & Conservation Agent
City of Methuen	Joseph Cosgrove	Environmental Planner & Energy Manager
Town of Newbury	Martha Taylor & Kristen Grubbs	Planning Director
Town of Rowley	Mark Emery	Fire Chief & Emergency Management Director
Town of Salisbury	Lisa Pearson	Planning Director
Town of West Newbury	Christine Wallace	Dept. of Public Works Project Manager

9.2.3 Public Participation

The public will be given opportunities to be involved in the plan maintenance and update process. The approved/updated plan with be posted to the MVPC website as well as each communities' website. Residents, businesses, and other vested groups will be notified when updates and reports are available, and when significant hazard mitigation issues are brought before the City Council or Board of Selectmen/Select Board using normal meeting protocols. Notification will be done through posting of meeting agendas in City/Town Hall and on each communities' website. The public will also be included in the preparation of the five-year update using the same public participation process for the development of this plan update.

In addition, the public will have the opportunity to be directly involved in ongoing mitigation actions. Using newly updated Mitigation Action Plans, each community has identified potential opportunities for public engagement in ongoing mitigation projects. These opportunities are outlined in greater detail in *Table 9.2*.

Table 9.2 Opportunities for public participation in Mitigation Action Plans across the Merrimack Valley.

REGIONAL PUBLIC PARTICIPATION OPPORTUNITIES		
	Mitigation Action	**Public Participation Opportunity**
City of Amesbury		
1	Increase public awareness of hazard risk and vulnerability through a public education program	The public will be engaged through a series of outreach initiatives including: providing natural hazard education/ outreach for contractors, general public, and students; providing natural hazard pre-mitigation materials to all residents via the website and local broadcasting; maintaining, reviewing and publicizing the current action plan on an annual basis; and coordinating with the MVPC to maintain, review and publicize evacuation routes.
2	Develop and implement a Volunteer Disaster Assistance Program or Community Emergency Response Team (CERT).	Amesbury's emergency management agency is predominantly volunteer. Amesbury could utilize grant funding to train volunteers to have them certified in additional emergency response for the City.
3	Address erosion and promote public accessibility at City Boat Ramp	Amesbury plans to engage the public in the Washington Park Project to ensure the public has access to and knowledge about the park! This could include an opening day event.
Town of Boxford		
1	Amend local subdivision rules and regulations to require the maximum practicable use of low impact development	The public will be invited to engage with this action by attending public hearings and public meetings through the Planning Board and Select Board.
2	Create interdepartmental GIS MIMAP database and mapping	Public outreach will be conducted to identify locations of potential private connections to catch basins, green infrastructure, and private wells across Town.
3	Develop a Tree Maintenance and Vegetation Plan for the Town	Local residents, clubs, and organizations will be engaged to help track and manage invasive species in Boxford. This may consist of holding volunteer workshops to train volunteers and conducting a few annual volunteer field days at key locations.
Town of Groveland		
1	Perform town-wide tree assessment. Establish pruning cycle to remove hazardous trees and perform utility line clearance.	Invite the community to assist with inventory by creating a location on the Town's website to report overhanging branches on wires. Once locations scheduled for maintenance, inform residents when tree work will take place.
2	Address stormwater management challenges through expanded education and outreach	Distribute information on stormwater features and how to maintain them to residents and other community members. Add a "hotline" call number if people have questions about specific locations.
3	Complete design, permitting and construct improvements to the Johnson’s Creek Dam.	Continue to discuss the failure of the dam at Board of Selectman meetings and keep the public informed of grant opportunities the community is applying for to ensure public awareness and support of Town efforts.

REGIONAL PUBLIC PARTICIPATION OPPORTUNITIES		
	Mitigation Action	**Public Participation Opportunity**
City of Haverhill		
1	Explore additional water supply options, such as the Merrimack River	Hold public meetings to explain the need for additional potable water sources in Haverhill and offer education on how this will be accomplished for City.
2	Develop a comprehensive strategy for sheltering in the City.	Convene different community stakeholders to discuss topic, share ideas, and begin to develop a plan to advance this action for the City.
3	Upgrade the wastewater treatment plant to increase wet weather treatment capacity and address CSO's.	Develop and launch a public information campaign to educate residents and community members on ways to reduce CSO volume and occurrence during wet weather events.
City of Lawrence		
1	Explore green energy options for Lawrence, including electric car parking stations and electric bicycle public libraries	The City is working to expand the electric bike program and engage the community through raffles and public events focused on green energy options.
2	Continue to address CSO events through small and larger projects.	The City could conduct public outreach to inform residents and help mitigate CSO events. This could include circulating informational handouts around CSO events and how residents can help to reduce personal usage during precipitation events.
3	Establish and adopt the MBTA overlay district	The City will hold public meetings and provide opportunities for public questions and input into the development of the MBTA overlay district.
City of Methuen		
1	Separate combined system sewer/drain line in Arlington District	Community Development Block Grant funds have been allocated for community outreach on this major sewer/drain separation project to plan and involve neighborhood in project design and mitigation of anticipated construction impacts.
2	Develop Municipal Decarbonization/ Energy Transition Plan	To Support this goal, community education and outreach will be undertaken as Methuen sets goals and strategies for reducing carbon emissions in buildings, transportation, waste disposal and energy sources.
3	Amend local subdivision rules and regulations to require the maximum practicable use of low impact development techniques in all new development and redevelopment projects	The City will hold a training summit for Methuen Land Use Board members and hold a public meeting on regulatory changes. The City website will also be updated with informational material on stormwater management best practices and LID policies/techniques.
Town of Newbury		
1	Evaluate/implement mitigation preventive measures to address current and long-term Plum Island beach erosion and flooding/access problems	Work with New Hampshire Sea Grant to schedule a Town-wide volunteer day to get residents out to the dunes and help to learn about nature-based solutions as well as help restore local sand dunes.

REGIONAL PUBLIC PARTICIPATION OPPORTUNITIES		
	Mitigation Action	**Public Participation Opportunity**
Town of Newbury (continued)		
2	Enhance warning systems for all natural hazards and emergencies through real time updates on Police Department webpage and Facebook and through continued use of Code Red system	Work with the public (particularly Plum Island residents) to create a document PSA for new residents on Plum Island to educate them on the actions and considerations needed to live on a barrier island and what resources they need in the event of an evacuation.
3	Reduce storm vulnerability and increase resiliency through restoration of Great Marsh habitat	Educate public on types of invasive species and on how they can be eliminated or controlled and organize opportunities for members of the public to engage in eradication/control efforts
Town of Rowley		
1	Explore opportunities to expand potable water capacity for the Town	The Town can support this action by working to promote water conservation and responsible. This could include providing educational information through mailers to community members promoting water conservation strategies and noting benefits.
2	Incorporate hazard mitigation planning into local policies, plans and programs	The public will have the opportunity to be involved in the updating of upcoming community plans through town meetings, listening sessions, and other opportunities to give public input.
3	Advance priority culvert projects and drainage system improvement projects	The public will be engaged through ongoing community meetings (e.g. ConCom, Planning Board, Town meeting) in which project updates will be provided and public input can be received.
Town of Salisbury		
1	Develop long-term regional beach replenishment dredging program.	The Town plans to work with a committee consisting of Town officials, DCR Staff, and members of the public to address the issue of beach erosion.
2	Analyze existing flooding problem areas and design/implement appropriate corrective measures	The Town plans to meeting monthly with Public Officials, Town Staff, and members of the public to address this issue and identify solutions.
3	Develop and adopt a Wetlands Bylaw for the Town	The Town will work with the public to review and adopt a local Wetlands Bylaw through posting draft copies for public review and comment.
Town of West Newbury		
1	Study Erosion and Sea Level Rise at River Road	Partner with the Climate Change Resiliency Committee (CCRC) to host public education events (e.g. site visits, community meetings, etc.)
2	Install Generators at Critical Facilities	Partner with the Council on Aging to educate seniors on emergency preparedness
3	Increase Supply of Potable Water	Provide project updates and conservation tips to residents via water bills
4	Increase capacity to manage invasive species on town owned land	Provide education to residents through in person events and website/email communications to increase resident awareness of the invasive plant problem and encourage residents to address invasive plants on their own properties.

SECTION 10. PLAN IMPLEMENTATION

This section outlines the municipal positions, systems and resources that will be employed to implement the updated Merrimack Valley Regional Multi-Hazard Mitigation Plan. Plan integration through these established systems will further ensure the Plan's goals are achieved across the region.

10.1 Pivotal Role of Local Governments

The implementation of the 2024 Merrimack Valley Region Multi-Hazard Mitigation Plan will take place at the State, Regional, and Local levels of government. However, local governments in particular will play a pivotal role in hazard mitigation. *Table 10.1* provides a summary of local boards and departments and their corresponding roles in implementing the action items contained in the Hazard Mitigation Action Plans.

Each municipality participating in the Plan will be responsible for implementing its own community-specific mitigation actions. To the extent possible, these actions have been directed toward a particular department or board in order to assign responsibility and accountability and to increase the likelihood of implementation. This approach will enable individual municipalities to implement and update their unique Local Mitigation Action Plan as needed. The identification of locally-specific actions also ensures that each municipality will only be held responsible for monitoring and implementing their local actions, and not those of the other municipalities involved in the planning process.

10.2 Broad Integration of Plan

The incorporation of the recommendations of this Plan into other local and regional planning documents and procedures 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 responsible groups, and providing budget and financial oversight for implementation funding.

Since the last plan update in 2016, communities have been actively working to integrate actions and recommendations from the Merrimack Valley Multi-Hazard Mitigation Plan into recently updated planning documents. As other relevant community plans continue to be reviewed, updated, and newly developed, it is the responsibility of LHMPTs to ensure continued plan integration is completed. Through integration of all major community plans, comprehensive planning and successful improvements may be achieved. Table 10.2 details how each jurisdiction has integrated their last HMP into local planning mechanisms resulting in action and advancement since 2016. The table also details how each jurisdiction plans to continue this momentum by integrating information from this plan update into future planning mechanisms and actions.

Table 10.1 Role of Local Boards and Departments

Role of Local Boards and Departments		
Dept, Board, or Committee	**Function**	**Effect on Risk 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 bylaws. The state building code also contains sections on wind, snow, structural loads, and seismic retrofitting.	Insures that NFIP standards and other mitigation standards are uniformly applied across the community and region.
Public Works Department and/or City/ Town Engineer	The Public Works Department and/or engineer are primarily responsible for municipal drainage and stormwater management issues, taking the lead in ensuring compliance with Stormwater Regulations.	These regulations contain performance standards which address flood control and storm damage prevention.
Conservation Commission	The Conservation Commission is responsible for implementing the Rivers Protection Act of 1996 (MGL Chapter 258, 310 CMR 10.58), and the Wetlands Protection Act (MGL Chapter 131, Section 40, 310 CMR 10.00). 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 (except in the case of densely developed urban areas such as Lawrence, where it is within 25 feet of a river or stream).	These regulations contain performance standards which address flood control and storm damage prevention.
Planning Board and Planning Department	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". In most communities, the Planning Board is responsible for maintaining local floodplain bylaws and ordinances.	In many communities, the Planning Department coordinates the hazard mitigation planning process and the implementation of Plans. Additionally, the Planning Board is uniquely situated to consider amendments to and enforcement of bylaws and ordinances related to zoning/building, etc.
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. Some communities opt to adopt 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.
City Council or Board of Selectmen	In the Merrimack Valley region, the Cities of Amesbury, Haverhill, Lawrence, Methuen, and Newburyport are governed by a City Council, and the Towns by a Board of Selectmen.	The City Council/ Board of Selectmen must adopt the Hazard Mitigation Plan. In addition, their approval is necessary for hazard mitigation grant applications and potential projects.
Emergency Management Department	Each community has an emergency management director 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, as well as other plans required by MEMA and FEMA.

Table 10.2 Past and Future Integration of Multi-Hazard Mitigation Plan

Integration of HMP into Local Planning Mechanisms	
	City of Amesbury
Previous Integration	In the last plan update, Amesbury identified flooding as a major natural hazard of concern. Information from this planning process, as well as action goals identified in the 2017 update were used to inform key planning documents (Stormwater Regulations update, Open Space and Recreation Plan update, Municipal Vulnerability Plan and development, Amesbury Water Body Assessment development) and advance key community actions (mapping updates, Smart911, participation in Regional Stormwater Collaborative).
Future Strategy	Amesbury's LHMPT has committed to ensuring the HMP acts as a living document. The plan will be circulated to other City departments and personnel, be publicly available on the City's website, and will be referenced and integrated into other planning mechanisms through regular review and advancement by the LHMPT members. Amesbury's LHMPT represents a large diverse group of departments and stakeholders across the City. Upcoming initiatives include updating the City's Master Plan, Municipal Vulnerability Plan, and Comprehensive Emergency Management Plan, as well as conducting a comprehensive flood assessment, and developing an invasive species monitoring and management plan.
	Town of Boxford
Previous Integration	In the last plan update, Boxford identified flooding, winter storms and associated power outages as a major natural hazard of concern. Information from this planning process, as well as action goals identified in the 2016 update, were used to inform key planning documents (Open Space and Recreation Plan update, Comprehensive Emergency Management Plan update, Stormwater Management Plan update, and Municipal Vulnerability Plan development) and advance key community actions (Culvert replacement projects and drainage management system improvements).
Future Strategy	As a small and collaborative team, Boxford's LHMPT also plays a critical role in advancing other planning initiatives and projects across the Town relating to emergency preparedness and response, building, planning, conservation, and DPW projects. With an in-depth knowledge of the information and goals laid out in the HMP, each member will actively work to carry forth the knowledge and goals identified in their involvement to advance future efforts. Upcoming initiatives include: Updates to the Town's OSRP and MVP, as well as developing a tree maintenance and vegetation plan, and bylaw/ regulation updates to promote LID techniques.
	Town of Groveland
Previous Integration	Information from the 2016 planning process, as well as action goals identified in the previous plan were used to inform key planning documents (Open Space and Recreation Plan updates, Master Plan updates, Municipal Vulnerability Plan development) and advance key community actions (emergency dispatch center upgrades, land conservation projects, development of natural hazard preparedness webpage for Town).
Future Strategy	Due to the broad representation of the LHMPT across municipal departments and boards/committees, participation by LHMPT members on other community plans and initiatives will enable information and actions identified in the HMP to be integrated into other efforts. Additionally, the LHMPT has identified the benefit of developing a comprehensive summary of findings of all major community planning mechanisms to ensure alignment across efforts for the Town. Upcoming initiatives include: the development of hazardous tree and limb removal services, updates to the Comprehensive Emergency Management Plan, as well as the Town's Floodplain Bylaw, Subdivision Rules and Regulations, Stormwater Management and Land Disturbance Bylaw, and Aquifer Protection Overlay District. Additionally, the Town looks to seek funding to address the deficient structures identified through the HMP - a priority that overlaps with other community initiatives.

Integration of HMP into Local Planning Mechanisms	
	City of Haverhill
Previous Integration	Information from the 2016 planning process, as well as action goals identified in the previous plan were used to inform key planning documents (Stormwater Management Ordinance and Municipal Vulnerability Plan development, as well as updates to the Flood Overlay District, Master Plan, and Comprehensive Emergency Management Plan) and advance key community actions (formation of Haverhill Agricultural Commission, Green Community Designation, recertification of the downtown flood protection system).
Future Strategy	Haverhill's LHMPT represents a large diverse group of departments and stakeholders across the City. Each LHMPT member will be tasked with acting as a representative to bring forth and actions and information contained within the HMP to integrate into new and updated planning processes. Upcoming initiatives include: the development of hazardous tree and limb removal services, updates to the forest management program, Local Open Space and Recreation Plan, promote LID through City ordinances/regulations, expansion of municipal potable drinking water, developing comprehensive sheltering plan.
	City of Lawrence
Previous Integration	Information from the 2016 planning process, as well as action goals identified in the previous plan were used to inform key planning documents (Community Development Plan, Sewer & Stormwater Ordinance, Open Space and Recreation Plan updates, and Municipal Vulnerability Plan development) and advance key community actions (Invasive Species Management Plan, CodeRed Emergency Notification System and public education webpage, Citizen Serve online reporting platform, Green Community Designation).
Future Strategy	Lawrence's LHMPT represents a large diverse group of departments and stakeholders across the City. Each LHMPT member will be tasked with acting as a representative to bring forth actions and information contained within the HMP to integrate into new and updated planning processes. This will be conducted as part of the City's current Departmental Review process which is conducted for new construction, major renovation, and municipal infrastructure projects. The Lawrence's Lead Representatives will also continue to serve as the point person to ensure the plan and its contents are integrated into future planning efforts across the City. Upcoming initiatives include: updating the City's Comprehensive Emergency Management Plan, Municipal Vulnerability Plan, development of a Master Plan, promoting LID through City ordinances/regulations, development of the latest Smart Growth Overlay District, updates to the City Zoning Ordinance, and expansion of municipal potable drinking water.
	City of Methuen
Previous Integration	Information from the 2016 planning process, as well as action goals identified in the previous plan were used to inform key planning documents (Stormwater Ordinance and Regulations, Open Space and Recreation Plan, Municipal Vulnerability Plan, updates to Comprehensive Emergency Management Plan) and advance key community actions (Spicket River Watershed Based Planning, Water Infrastructure Risk and Resilience Assessment, Reverse911 Emergency Alert System, Green Community Designation).
Future Strategy	Methuen's Lead Representative is actively involved in other planning and implementation efforts across the City and will continue to serve as the point person to ensure the plan and its contents are integrated into future planning efforts through direct participation on, or communication with, future project teams. Upcoming initiatives include: updating the City's Master Plan, MVP Plan, Floodplain Zoning District Ordinance, and Sewer and Water Asset Management Plan, developing Municipal decarbonization/energy transition plan, and conducting flooding and culvert upgrade projects.

Integration of HMP into Local Planning Mechanisms	
	Town of Newbury
Previous Integration	Information from the 2016 planning process, as well as action goals identified in the previous plan were used to inform key planning documents (Stormwater Management Bylaw and Regulation updates, Master Plan updates , Municipal Vulnerability Plan development) and advance key community actions (Green Community Designation, Code Red Emergency Alert System, natural hazard outreach and education, O&M plan for Town facilities).
Future Strategy	Due to the broad representation of the LHMPT across municipal departments and boards/committees, participation by LHMPT members on other community plans and initiatives will enable information and actions identified in the HMP to be integrated into other efforts. Additionally, the LHMPT has identified the potential of re-establishing Newbury's Municipal Vulnerability/Resiliency Committee to work proactively within the Town, neighboring municipalities, and partner organizations. With a focus on resiliency and adaptation, the HMP will serve as a key guiding document for the Town. Upcoming initiatives include: updating the Town's Open Space and Recreation Plan, the Beach Management Plan, the Comprehensive Emergency Management Plan, the Municipal Vulnerability Plan, and the Town's bylaws and regulations to incorporate strategies to increase climate resiliency and implement draining improvement projects.
	Town of Rowley
Previous Integration	Information from the 2016 planning process, as well as action goals identified in the previous plan were used to inform key planning documents (Floodplain District Protective Zoning Bylaw update, Stormwater Mgmt., and Erosion Control Bylaw & Regulation updates, Local Wetland Protection Bylaw updates, Open Space & Recreation Plan updates, development of Municipal Vulnerability Plan) and advance key community actions (Green Community Designation, drainage system maintenance plan and upgrades).
Future Strategy	Rowley's LHMPT has committed to ensuring the HMP acts as a living document. The plan will be circulated to other Town departments and personnel, be publicly available on the municipal website, and will be referenced and integrated into other planning mechanisms through regular review and advancement by the LHMPT members. Upcoming initiatives include: Updating the Town's subdivision Rules & Regulations, Master Plan, Comprehensive Emergency Management Plan, and Municipal Vulnerability Plan, as well as exploring new potable water sources for the Town, upgrading radio capabilities, and advancing draining system improvements.
	Town of Salisbury
Previous Integration	In the last plan update, Salisbury identified inland and coastal flooding as well as coastal erosion as a major natural hazard of concern. Information from the 2016 planning process, as well as action goals identified in the previous plan were used to inform key planning documents (Stormwater Management updates, Subdivision Roles and Regulations, Zoning Bylaw, Comprehensive Emergency Management Plan, and Steep Slope Regulations) and advance key community actions (Green Community Designation, Floodwall construction, culvert upgrades, and stormwater infrastructure management plan).
Future Strategy	Salisbury's LHMPT has committed to ensuring the HMP acts as a living document. The plan will be circulated to other Town departments and personnel, be publicly available on the municipal website, and will be referenced and integrated into other planning mechanisms through regular review and advancement by the LHMPT members. Upcoming initiatives include: Developing and establishing a Beach and Dune maintenance Plan, a Local Wetland Bylaw, and a Floodplain Bylaw, as well as advancing projects to assess and address inland and coastal flooding through land conservation, home and road raising, and education/outreach campaigns.

Integration of HMP into Local Planning Mechanisms	
	Town of West Newbury
Previous Integration	Information from the 2016 planning process, as well as action goals identified in the previous plan were used to inform key planning documents (Floodplain District Bylaw update, Stormwater Bylaw and Regulations update, Open Space and Recreation Plan update, and Municipal Vulnerability Plan development) and advance important community actions (Hazardous Tree and Limb Removal maintenance, Invasive Species Management, and MVP Action Grant to assess the resiliency of River Road).
Future Strategy	As a small and collaborative team, West Newbury's LHMPT also plays a critical role in advancing other planning initiatives and projects across the Town relating to emergency preparedness and response, building, planning, conservation, and DPW projects. With an in-depth knowledge of the information and goals laid out in the HMP, each member will actively work to carry forth the knowledge and goals identified in their involvement to advance future efforts. Additionally, West Newbury's Lead Representative and Town Manager will continue to serve as point people to ensure the plan and its contents are integrated into future planning efforts across the Town. To ensure the Plan is used and integrated, it will be circulated to other Town departments and personnel, be publicly available on the municipal website, and will be referenced and integrated into other planning mechanisms. Upcoming initiatives include: Updates to the Open Space & Recreation Plan, continued work toward improving the resiliency of River Road, culvert system upgrades and drainage system improvements, reconstruction of the Middle Street Bridge, exploring additional sources of potable water for the Town, expanded efforts to manage invasive plant species, and assessment of evacuation routes.

SECTION 11. FINANCIAL RESOURCES

This section outlines financial resources that communities in the Merrimack Valley may access to support the advancement of their identified mitigation actions, ultimately leading to reduced risk and vulnerability from natural hazards and increased resiliency for their communities.

Appropriate action is needed to ensure that financial resources are available to implement hazard mitigation projects. Many communities in the region are able to leverage funds to address hazard mitigation activities through avenues including: capital improvements funds; property, sales, and other taxes; utility fees; bonding capacity; etc. In instances where additional funding is needed, communities in the Merrimack Valley are well-situated to seek outside support through state and federal grants. In the past, communities in the region have 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, EPA Technical Assistance Grants, and others. In addition, communities have raised funds by passing dept exclusions, overrides and Community Preservation Acts.

Moving forward, Merrimack Valley communities plan to continue applying 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 Federal and State Funding Programs

Federal and State Funding Programs				
Program	**Type of Assistance**	**Availability**	**Managing Agency**	**Funding Details**
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	Variable	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 (pre- and post-disaster)	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

Federal and State Funding Programs				
Program	**Type of Assistance**	**Availability**	**Managing Agency**	**Funding Details**
Building Resilient Infrastructure and Communities	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	Post-disaster aid to state and local governments	Post disaster program	MEMA	FEMA
Municipal Vulnerability Preparedness Action Grants	Funding for designated MVP Communities to advance priority climate adaptation actions to address climate change	Annually	EEA	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: 1) Adopt the Flood Insurance Rate Maps as an overlay regulatory district; 2) Require that all new construction or substantial improvement to existing structures in the flood hazard area will be elevated; and 3) 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 nonprofit 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.

Building Resilient Infrastructure and Communities (BRIC) program: The BRIC program (previously known as the Pre-Disaster Mitigation program and 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) 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 Hazard Mitigation Plan.

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.

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.

Plan Appendix

Appendix A: Hazard Mitigation Plan Outreach and Engagement

- Local Hazard Mitigation Planning Teams
- Public Engagement / Input

Appendix B: Natural Hazard and Community Lifeline Maps

Appendix C: Hazard Mitigation Module Templates